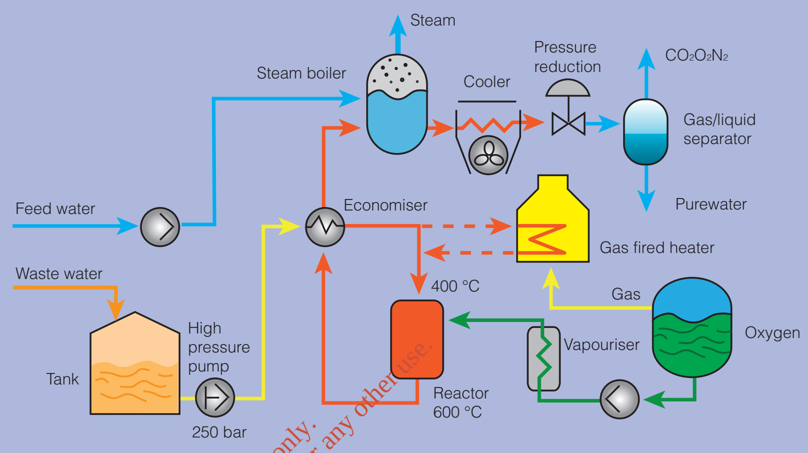
AQUA CRITOX®

Aqua Critox® ™ Sustainable sludge handling for the 21st century

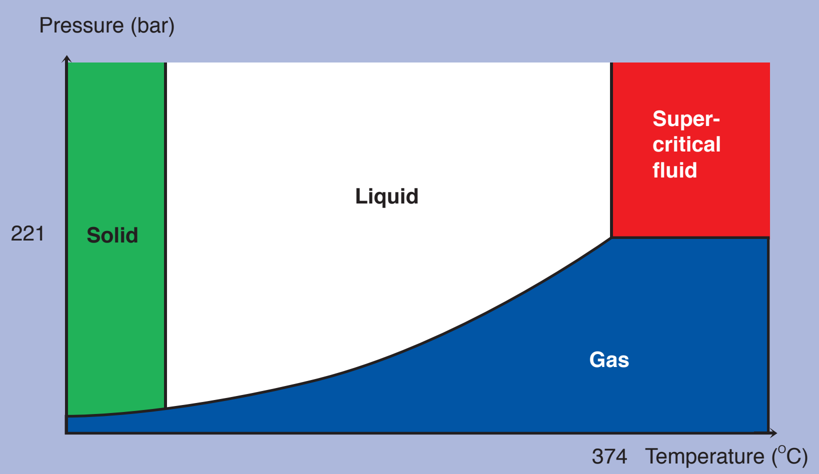
The Aqua Critox® process uses the unique properties of supercritical water to completely oxidise all organic contaminants from sewage or drinking water sludge. The effluent is separated into a clean water phase and a pure inorganic phase. The inorganic phase is treated in a subsequent step to recover either or both of phosphorous and coagulant. All that remain is a small fraction of inert material that can be utilised as a construction material or landfilled as non-hazardous material.



Process Schematic

The Aqua Critox®™ Technology

The Aqua Critox® ™ technology was developed for the complete destruction of organic material in sewage and drinking water sludge followed by recovery of phosphorous and coagulant from the inorganic residue. The process is based on SCFI's extensive knowledge of supercritical water and their Aqua Critox ®SCWO process.



Phase Diagram

The recovery process.

The sludge is passed through the Aqua Critox® plant, where, under supercritical conditions, oxygen is added and the organics are destroyed, producing clean water containing a fine particulate phase of inorganic material. The inorganic phase can easily be separated from the water phase, through thickening or dewatering, and treated in a subsequent step to recover either or both of coagulant and phosphorous.

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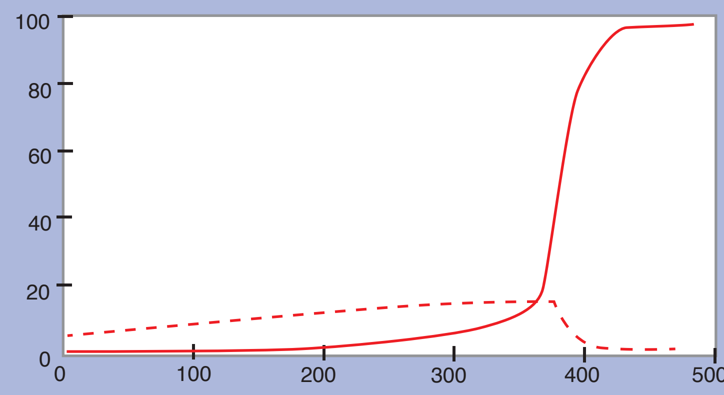
AQUA CRITOX®

Sludge to clear water

Solubility in Water versus Temperature

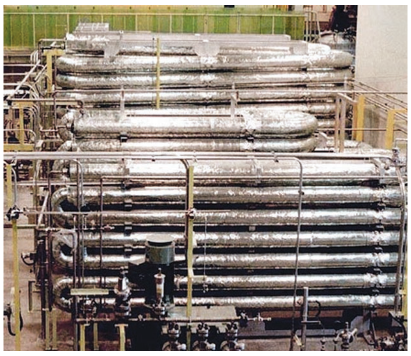


Why chose Aqua Critox® ?

Facts about Aqua Critox®™

Technology

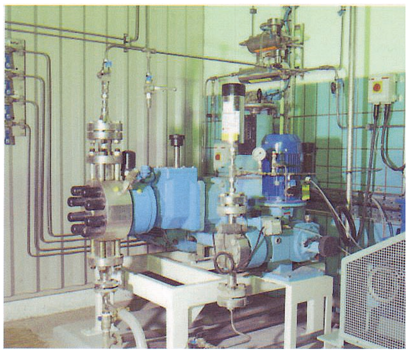
- Rapid & complete destruction of organics.
- No harmful by-products.
- No exhaust gas cleaning requirements.
- Continuous process.
- Easily recoverable coagulants and phosphorous.
- Phosphorous can be selectively extracted.
- Can be applied to both sewage and drinking water sludge.
- Full CO_2 recovery as liquid for resale.
- Total conversion of organics to CO_2, H_2O, N_2



Tubular Reactor

Summary of Advantages

- A continuous exothermic process with potential to generate renewable electricity and heat.
- The recovery of by-products (i.e. coagulants, phosphorous and carbon dioxide) results in little if any residual materials.
- The purity of the carbon dioxide by-product offers the potential for industrial use.
- The residual materials are non hazardous.
- Permitting requirements are not demanding.
- The process does not fall under the waste incineration directive.
- The plant can process 3% to 25% dry solid content.
- Reduces over all carbon foot print of works.
- It may reduce or eliminate flocculent use for dewatering.
- There are no odour issues.
- On site installation eliminates haulage movements.
- The foot print is small.



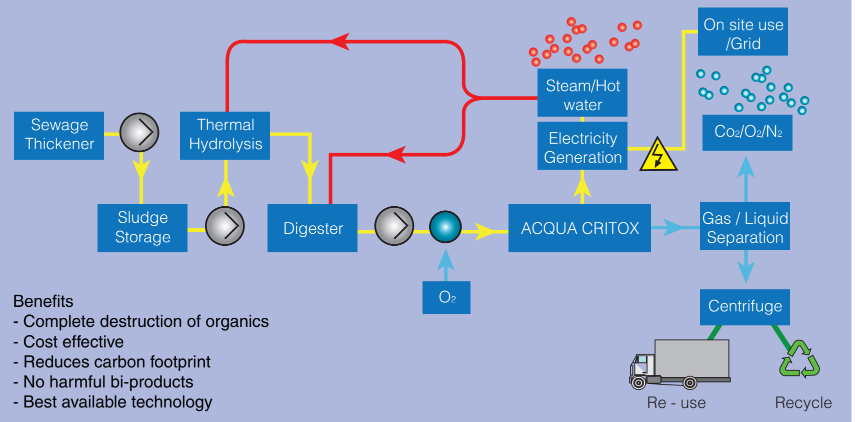
Feed Pump

AQUA CRITOX®

Destruction of sludge with respect for the environment.

Aqua Critox®
For digested and raw sludge.

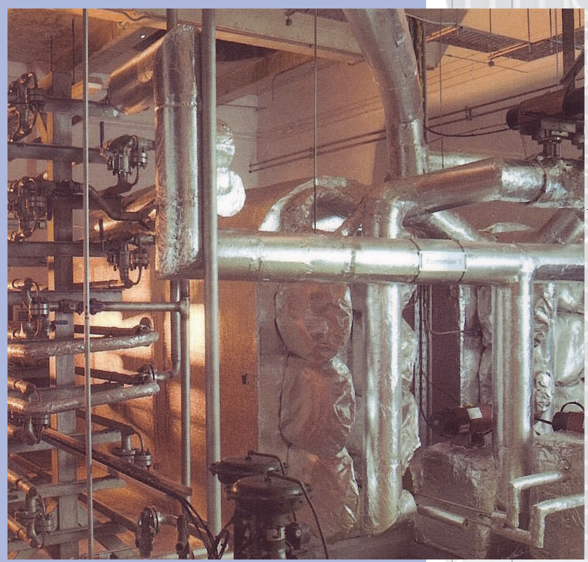
Aqua Critox®
Can eliminate requirement for anaerobic digesters if required.



Benefits
- Complete destruction of organics
- Cost effective
- Reduces carbon footprint
- No harmful bi-products
- Best available technology

Electricity Generation

Aqua Critox® offers the ability to generate electricity from even digested sludge.



Part of the validation facility

The process is controlled by sophisticated software.

Scfi
SMARTER ENVIRONMENTAL TECHNOLOGIES

Offer to customers a technically and economical solution to sludge treatment.

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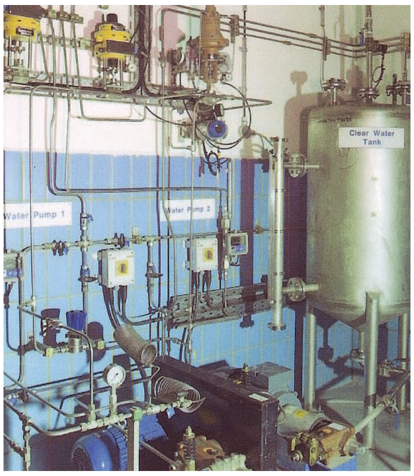
AQUA CRITOX®

Treatment of Industrial sludges & waste streams.

The Aqua Critox® process will handle biodegradable and non biodegradable organic streams.

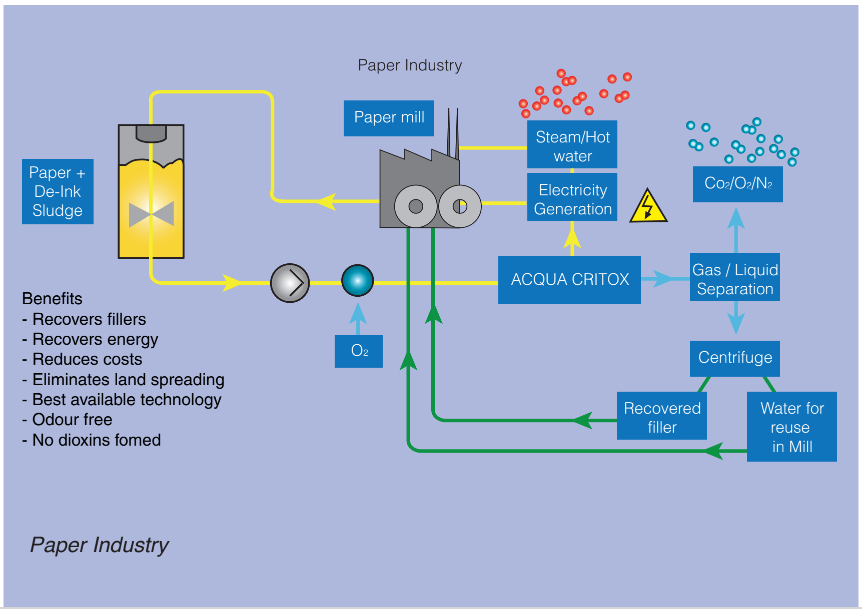
- 30g/L - 200g/ltr COD range
- The generation of electricity is possible where COD > 100g/ltr and volume > 3M³/hr
- Effluent from the process will have a COD < 5ppm
- All inorganics are easily separated as non- ash-like material for reuse
- Off gas is N_2 & O_2



Who will benefit from use of Aqua Critox® ?

- Chemical/Pharmaceutical & Petrochemical Industry
- Bio Pharma
- Paper Industry
- Toll treatment facilities
- Sewage treatment plants
- Food waste generator/ processor
- Catalyst recovery
- Electronic scrap processor

De-inking sludge with filler recovery



Paper Industry

For the Paper Industry

- Filler recovery
- Electricity generation
- Steam/hot water generation

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Phosphorus & Coagulant recovery.

The Aqua Critox® Technology

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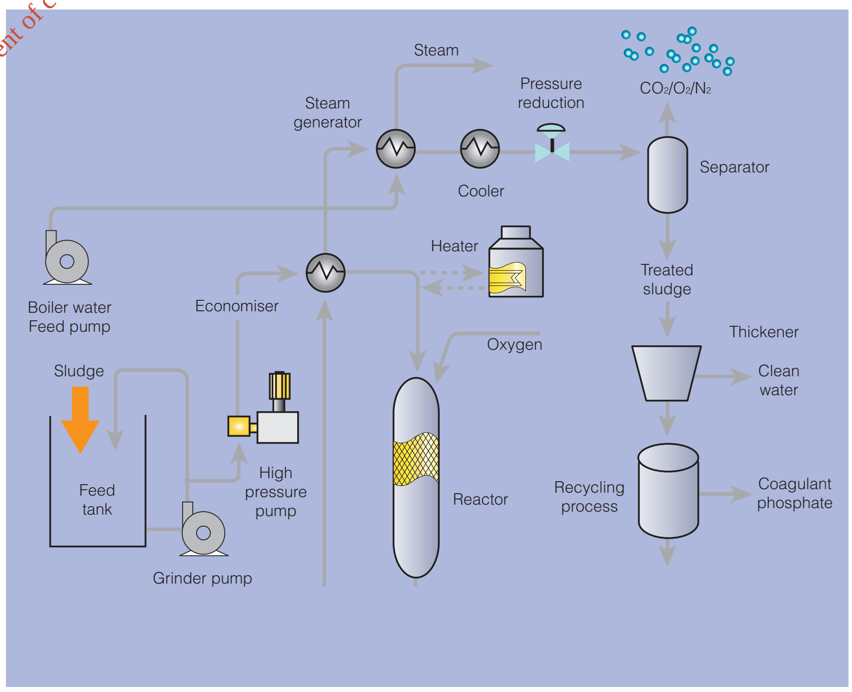
Facts about the Aqua Critox® Technology

- Rapid & complete destruction of organics
- No harmful by-products
- No exhaust gas cleaning requirements
- Continuous process
- Easily recoverable coagulants and phosphorous
- Phosphorous can be selectively extracted
- Can be applied to both sewage and drinking water sludge

Benefits of Aqua Critox®

- Low consumption of chemicals
- Good heat recovery
- Compact design
- No incineration - Easier permitting

Sewage sludge before and after treatment.



Simplified Aqua Critox™ process flow scheme.

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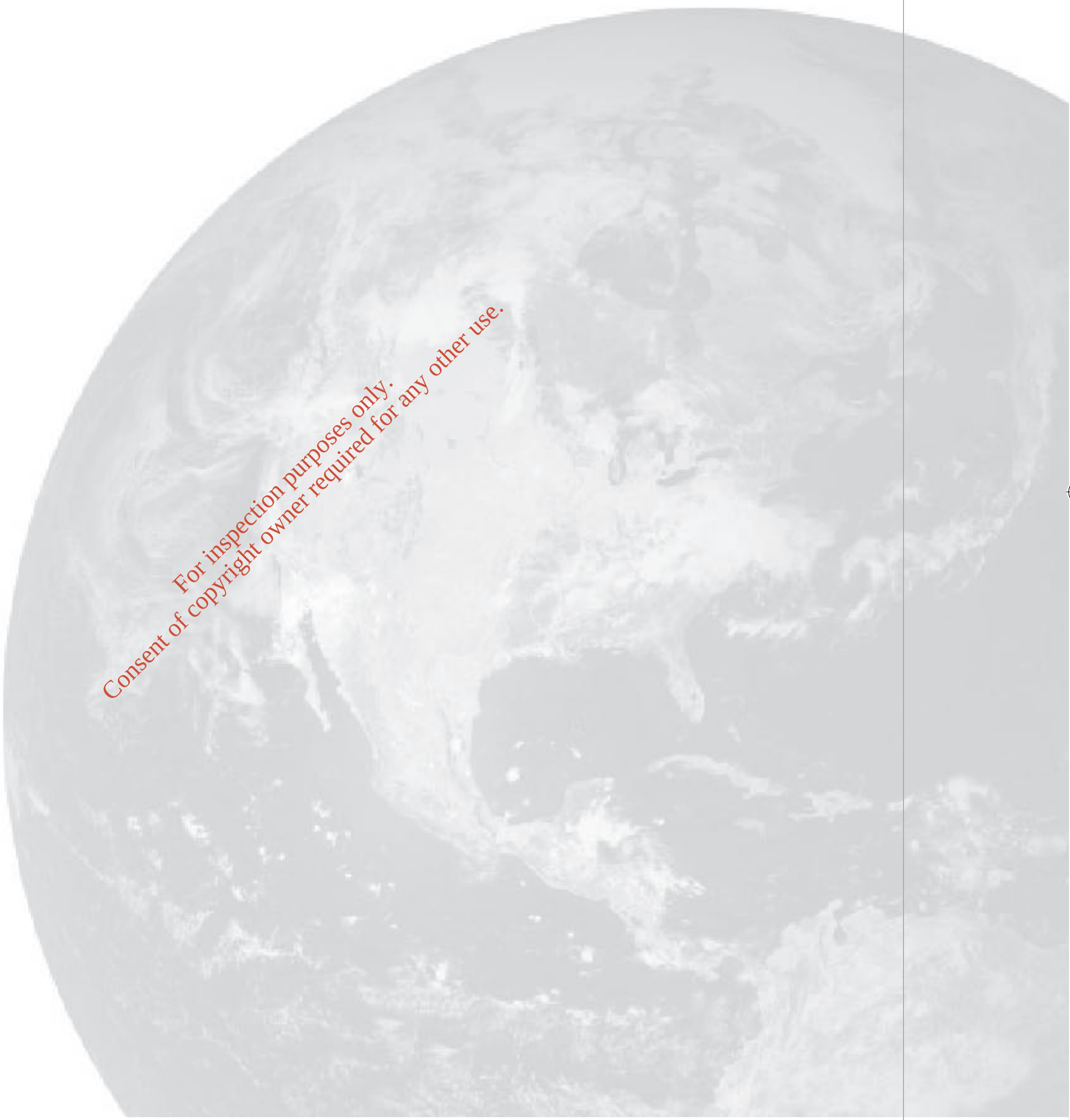
AQUA CRITOX®



SMARTER ENVIRONMENTAL TECHNOLOGIES

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Destruction is achieved by oxidation of the organic fraction in water at or above its Supercritical Point. Water enters the Supercritical region when above 374^{o}C and 221 bar. On entering this phase the physical properties change dramatically. In the supercritical region organics, oxygen and water become completely miscible, thus eliminating mass transfer constraints. This means the reaction rate is very fast, enabling complete oxidation within 30 to 60secs, with over 99.99% destruction efficiency regardless of the nature of the contaminants.

The waste stream is pumped from a feed tank, to the system, in excess of 250bar. The feed enters the economiser where it is pre-heated by the reactor effluent to above the supercritical point. The hot feed enters the reactor where the required amount of oxygen is added. Oxidation of the organics commences immediately. The reaction is exothermic and the final temperature is controlled to a maximum of 600^{o}C. Reaction time is under 60secs. From the reactor the effluent is directed to the economiser, where it heats the incoming stream.

The waste heat from the economiser/reactor set is used to generate steam for power generation. In this case a heat exchanger effectively takes the place of a boiler in a standard steam loop. The steam generated is then used to drive turbines for power generation. The size and type of turbine will depend on the quantity of waste treated, however in general condensing turbines are used. The condensed steam then returns through the loop to be reheated by the reactor/economiser waste heat.

The power generation set effectively acts as the primary cooler for the effluent stream. The effluent will then be further cooled as necessary and following gas/liquid/solid separation is suitable for discharge. The gas stream does not contain any harmful compounds and no further treatment is required. The water stream is clean (a COD <5ppm is achievable) and requires no further treatment before discharge. It is also suitable for re-use. Any inorganics settle as an inert, non-leachable residue and are easily removed from the liquid stream. These solids can be used as a construction material or disposed of as non-hazardous landfill material. It is also possible to recover coagulants and/or phosphorus from this solid residue.

2.0 Process Description

The basic process description is the same for all waste options, in that there are the same unit operations regardless. There is however a difference in feed system, equipment size, utility requirements and oxygen usage depending on the waste treatment.

3.1 Sludge Handling and Pumping

The initial handling of the sludge will depend on the actual point in the main WWTP that sludge is diverted to the SCFI process. There may be a requirement for basic dewatering or other pre-treatment steps which are not covered here. This description assumes that the sludge is at 10 – 15% Total Solids.

Sludge delivered to the AquaCritox® plant will be initially held in a holding tank(s) sized for a minimum of 24 hours storage. This tank will be equipped with agitation. The holding tank acts as small buffer storage to ensure continuous feed to the Aqua Critox® Process and to allow the main plant to feed to the Aqua Critox® plant during routine maintenance. The tank(s) are designed with appropriate conveying/discharge screws for transportation of the sludge.

Where necessary the sludge is agitated and pumped through a maceration system to the main feed tank. The macerator acts to prevent large particles/lumps being sent to the plant which could reduce the efficiency of the high pressure pumps.

In the main feed tank the sludge is further agitated for consistency and can be heated to a feed temperature of approximately 80°C where necessary. Sludge is generally thixothropic and the agitation and elevated temperature help ensure a consistent feed to the High Pressure Pumps. This tank is an enclosed system and in order to prevent odour, the breathing vent is fitted with suitable carbon filtration.

The sludge is recirculated around this tank via a progressive cavity pump. The high pressure pump is fed from this recirculation line. This ensures that the NPSH is maintained to the pump at all times.

For sewage sludges a uniquely modified piston diaphragm type pump is used to raise the pressure of the sludge to the operating pressure of 250barg, and from this pump sludge is fed forward to the Economiser system.

3.2 Economiser & Reactor Systems

The Economiser and Reactor arrangement of the AquaCritox® process is a proprietary system protected by patents.

The high pressure feed enters the Economiser at up to 80°C and is heated to above the Supercritical point by the hot effluent leaving the reactor.

The unique tube in tube type design of the economiser provides efficient heating while reducing the potential for blockages and therefore limiting the requirements for CIP. Due to the nature of the sludge as it enters the Economiser, there will however be a requirement for cleaning to maintain heat transfer efficiency. They plant is therefore provided with redundant Economiser capacity operating on a duty/standby arrangement in order to maintain continuous operation.

On exiting the Economiser the now supercritical fluid stream enters the reactor and oxygen is added to start the oxidation reaction.

The reactor is a patented plug flow tubular reactor system, designed to give the highest efficiency of operation in the minimum volume. The hot effluent leaving the reactor is used to heat the incoming stream in the economiser. On leaving the economiser the effluent is still above the super critical point and can be used to generate steam as part of the energy recovery/power generation process.

At start-up when there is no hot supply from the reactor, external heating is used to raise the feed temperature to above the supercritical point. An electrical induction coil is used as standard, however gas burners can be used if preferred. Regardless of the heating system employed, it is turned off once the system reaches steady state.

The temperature in the reactor rises to in excess of 580°C due to the oxidation reaction. For higher calorific value streams it may be necessary to quench the process to maintain the temperature below the operating maximum of 600°C. The system therefore is provided with an automatic water quench process. A water tank supplies a dedicated high pressure quench pump which supplies water at 250 bar and ambient temperature to the process. The amount of quench added is automatically controlled to maintain the reactor outlet temperature to 580°C +/- 5°C.

The system may also be supplied with a feed quench system. In this patented configuration only a portion of the feed is heated via the economiser. Oxygen is added in the reactor as described above and the reaction is then quenched using further cold feed. The quench reduces the temperature in the reactor back to the initial starting temperature of just above the supercritical point and then further oxygen is added thus restarting the reaction. This step may be repeated several times depending on the fuel type. The advantage of this arrangement is that a relatively small portion of the fluid leaving the reactor is required to heat the incoming stream. As with the standard arrangement, the remainder is then used to generate steam as part of the energy recovery/power generation step, however at >150°C hotter than the standard arrangement, the potential for energy recovery as power is significantly increased.

Oxygen is supplied to the reactor at in excess of 250bar. Generally Aqua Critox® utilises liquid oxygen (LOX). The LOX is stored in a large vessel, usually supplied by the gas supply company. This LOX is pumped to pressure and then vapourised before being supplied to the process as a pressurised gas. Alternative arrangements are also possible however, including on-site generation by PSA followed by gas compression. Aqua Critox® includes the liquid/gas pressurisation and delivery equipment as standard, and the scope can be extended to include the gas/liquid generation and storage where required.

3.3 Power Generation, Cooling & Depressurisation

In the standard arrangement, on exiting the Economiser the reactor effluent, although cooled still contains significant heat. Before gas/liquid separation can occur the stream must be cooled to below 100°C. In order to achieve this cooling and to recover the system energy, the hot liquid passes through a heat exchanger. There are a number of options for energy recovery. The effluent can be used to generate low pressure steam or hot water for use in the main plant where required. Alternatively the heat can be used to generate steam or heat an organic fluid (Organic Rankine Cycle – ORC) for use in power generation. The steam or organic fluid is then circulated in a closed loop system and used to drive turbines for electricity generation. The sizing of the turbines depends on the size of the waste system. Condensing turbines are used as standard.

In the feed quench arrangement the effluent is also used to generate steam, however the higher temperatures allow for increased steam generation and allows for steam turbines to be used as standard. These have a higher efficiency than ORC systems and therefore overall energy recovery is higher.

On leaving the main energy recovery heat exchanger the effluent stream will be in the 100 – 150°C range. This heat can be further recovered/dissipated by using it to heat the raw waste stream or where installed to provide heat to the anaerobic digesters. It is of course also possible to cool using cooling tower water where required.

Once the steam is below 100°C it passes through the depressurisation system. Depressurisation is achieved by passing the effluent through a patented pressure reduction system, which reduces the pressure to below 10 barg.

3.4 Separation & Discharge

The effluent stream now passes through a gas/liquid separator. An in-line, multi channel gas analyser and mass flow meter are installed on the off-gas stream providing real time monitoring for quality and control.

Liquid passes into a holding vessel, where COD, pH and other control parameters are monitored. Generally at this point the liquid and solid stream together may be added back into the main site outfall with negligible effect on overall total solids readings for the site. However where solids removal is required the stream can be pumped to a liquid solid separation system where the inorganic residue is separated from the final liquid stream. The appropriate separation system (decanter, filter etc.) is site specific but can be included in the SCFI scope of supply. The water is clean with a COD of <5ppm achievable and is suitable for discharge or reuse as required. Further cooling can be provided at this point if required.

For a Municipal WWTP the solids are generally mostly comprised of silica. Any metals have been oxidised to their highest oxidation state and are rendered inert. The solid fraction is suitable for reuse as a building material or bulking agent. Where there is no alternative use available to solids are suitable for non-hazardous landfill.

3.5 Control & Safety

In order to ensure quality and efficiency of operation the AquaCritox® plant is controlled by a central, SCADA based control system. The system monitors all operations.

Temperature is controlled throughout and a full temperature map of the reactor is monitored at all times to ensure the reaction is fully controlled. The amount of quench water/feed added to the system is controlled to ensure the temperature is maintained within the set parameters.

The system operates with a slight excess of oxygen at all times to ensure complete oxidation. The rate of oxygen supply is controlled by monitoring the quantity of oxygen and Carbon Monoxide in the off gasses. If CO levels increase above trace then oxygen is automatically increased on the system returns into balance. Oxygen addition is also controlled to ensure that the system temperature is maintained within the operating range at all times.

System pressure is constantly monitored and all pumps are supplied on VSDs as standard.

The system is fitted with inline gas and COD monitors at discharge to ensure that all discharges are within the licensed parameters.

All safety interlocks and systems are monitored using a dedicated safety plc as standard. The system and its control ate designed and manufactured in accordance with the European Pressure Equipment Directive (PED) and is ATEX compliant.

3.5 CIP & Ancillary Services

The AquaCritox® process is supplied with integrated CIP. Fouling of the heat exchange surfaces is controlled by monitoring the pressure and heat transfer rates at the Economiser. When the heat transfer slows to a pre-set point, the Economiser automatically switches over to the stand-by unit and the duty unit goes onto CIP. The CIP system is also designed to flush and clean the complete system before shut down or as required by the user.

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The system operates with a slight excess of oxygen at all times to ensure complete oxidation. The rate of oxygen supply is controlled by monitoring the quantity of oxygen and Carbon Monoxide in the off gasses. If CO levels increase above trace then oxygen is automatically increased on the system returns into balance. Oxygen addition is also controlled to ensure that the system temperature is maintained within the operating range at all times.

System pressure is constantly monitored and all pumps are supplied on VSDs as standard.

The system is fitted with inline gas and COD monitors at discharge to ensure that all discharges are within the licensed parameters.

All safety interlocks and systems are monitored using a dedicated safety plc as standard. The system and its control ate designed and manufactured in accordance with the European Pressure Equipment Directive (PED) and is ATEX compliant.

3.5 CIP & Ancillary Services

The AquaCritox® process is supplied with integrated CIP. Fouling of the heat exchange surfaces is controlled by monitoring the pressure and heat transfer rates at the Economiser. When the heat transfer slows to a pre-set point, the Economiser automatically switches over to the stand-by unit and the duty unit goes onto CIP. The CIP system is also designed to flush and clean the complete system before shut down or as required by the user.

APPENDIX 3

6.0 SOILS & GEOLOGY

6.1 INTRODUCTION

6.1.1 Background & Objectives

Hydro-Environmental Services (HES) was engaged by ERAS Eco. Ltd to carry out an assessment of the potential impact of a proposed upgrade to an existing waste recovery / transfer facility at Foxhall, Youghal Co. Cork on the soil and geological environment.

This report provides a baseline assessment of the environmental setting of the site in terms of soil & geology and discusses the potential impacts of the construction and operation of the proposed development may have on them. Where required appropriate mitigation measures to limit any identified significant impacts to soils and geology are recommended.

6.1.2 Existing and Proposed Developments

The existing development has planning permission (Ref: 04/7531) for the recovery/transfer of waste and a sludge drying facility. The development comprises of:

- Waste Recovery & transfer building;
- Sludge dry facility;
- Wastewater treatment and balance tanks;
- Stormwater tanks, wheel wash & bunded storage areas;
- Ancillary building and facilities; and,
- Outputs which include dry sludge and wastewater.

The proposed development which is the subject of this EIS comprises:

- Hazardous waste treatment facility using Aqua Citrox[R] Technology;
- Handling / storage area for solvents;
- Lime stabilisation unit;
- Anaerobic digestion unit; and,
- Outputs which will include inert solids, water and gases.

6.1.3 Relevant Legislation

The EIS is carried out in accordance with the follow legislation:

- S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) Regulations and subsequent Amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000, S.I. No. 538 of 2001), S.I. No. 30 of 2000 the Planning and Development Act, 2000 and S.I. 600 of 2001 Planning and Development Regulations and subsequent Amendments, on the assessment of the effects of certain public and private projects on the environment; and,
- S.I. No. 4 of 1995: The Heritage Act 1995.

6.1.4 Relevant Guidance

The soils and geology section of the EIS is carried out in accordance with guidance contained in the following documents:

- Environmental Protection Agency (2003): Advise Notes on Current Practice (in the Preparation of Environmental Impact Statements);
- Environmental Protection Agency (2002): Guidelines on the Information to be Contained in Environmental Impact Statements;

Institute of Geologists Ireland (2002): Geology in Environmental Impact Statements – A Guide;
National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes; and,
County Cork Development Plan (2003);

6.2 SCHEDULE OF WORKS

6.2.1 *Desk Study*

A desk study of the site and the surrounding area was largely completed in advance of undertaking the walkover survey and site investigation. This involved collecting all relevant geological data for the site and surrounding area. This included consultation with the following:

Environmental Protection Agency database (www.epa.ie);
Geological Survey of Ireland - National Draft Bedrock Aquifer map;
Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
Bedrock Geology 1:100,000 Scale Map Series, Sheet 25 (Geology of South Cork). Geological Survey of Ireland (GSI, 2004);
Geological Survey of Ireland – 1:25,000 Field Mapping Sheets;
The Department of Communications, Marine and Natural Resources - Exploration and Mining Division website (www.minex.ie);
General Soil Map of Ireland 2nd edition (www.epa.ie);
Ordinance Survey of Ireland – Discovery Series and 1:50,000 maps;
Geotechnical Site Investigation Report by Geotech Specialists Ltd (August, 2004);
Letter to EPA Inspector from Minerex Ltd dated 19th January, 2007; and,
Report on Site Investigation by Minerex Ltd (April, 2007).

6.2.2 *Walkover survey*

A walkover survey of the site was undertaken by Hydro Environmental Services on 5th August 2010. A visual inspection of the site was carried out whereby all potential sources of contamination including chemical and waste storage areas were checked for signs of leakages such as discolouration and smell. Groundwater levels were recorded in the 3 no. on-site monitoring wells.

6.2.3 *Impact Assessment Methodology*

Using information from the desk study and data from the previous site investigations an estimation of the importance of the soil and geological environment within the study area is assessed using the criteria set out in Table 6.1 (NRA, 2005).

The evaluation criteria (EPA, 2002 and EPA, 2003) for the assessment of impacts require that likely impacts are described with respect to their extent, magnitude, complexity, probability, duration, frequency, reversibility and transfrontier nature (if applicable). The descriptors used in this environmental impact assessment are those set out in EPA (2002) *Glossary of Impacts* and are as follows in Table 6.2. In addition the two impact characteristics proximity and probability are described for each impact and these are defined in Table 6.3.

In order to provide an understanding of this descriptive system in terms of the geological /hydrolological environment, elements of this system of description of impacts are related to examples of potential impacts on the hydrology and morphology of the existing environment, as shown in Table 6.4

Table 6.1: Estimation of Importance of Soil and Geology Criteria (NRA, 2005)

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying route is significant on a national or regional scale.	Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying site is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage. Large recent landfill site for mixed wastes Geological feature of high value on a local scale (County Geological Site). Well drained and/or highly fertility soils. Moderately sized existing quarry or pit Marginally economic extractable mineral resource.
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying site is moderate on a local scale.	Contaminated soil on site with previous light industrial usage. Small recent landfill site for mixed Wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit. Sub-economic extractable mineral Resource.
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying site is small on a local scale.	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomically extractable mineral Resource.

Table 6.2. Impact Descriptors as per EPA, 2003

Impact Characteristic	Degree/Nature	Description
Quality	Positive	A change which improves the quality of the Environment.
	Neutral	A change which does not affect the quality of the Environment.
	Negative	A change which reduces the quality of the environment.
Significance	Imperceptible	An impact capable of measurement but without noticeable consequences.
	Slight	An impact which causes noticeable changes in the character of the environment without affecting its' sensitivities.
	Moderate	An impact that alters the character of the environment in a manner consistent with existing and emerging trends.
	Significant	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
	Profound	An impact which obliterates sensitive characteristics.
Duration	Temporary	Impact lasting for one year or less.
	Short-term	Impact lasting one to seven years.
	Medium-term	Impact lasting seven to fifteen years.
	Long-term	Impact lasting fifteen to sixty years.
	Permanent	Impact lasting over sixty years.
Type	Do Nothing	The environment as it would be in the future should no development of any kind be carried out.
	Cumulative	The addition of many small impacts to create one larger, more significant impact.
	Indeterminable	When the full consequences of a change in the environment cannot be described.
	Irreversible	When the character, distinctiveness, diversity, or reproductive capacity of an environment is permanently lost.
	Synergistic	Where the resultant impact is of greater significance than the sum of its constituents.
	Residual	Degree of environmental change that will occur after the proposed mitigation measures have taken effect.
	Worst Case	The impacts arising from a development in the case where mitigation measures substantially fail.

Table 6.3. Additional Impact Characteristics

Impact Characteristic	Degree/Nature	Description
Proximity	Direct	An impact which occurs within the area of the proposed project, as a direct result of the proposed project.
	Indirect	An impact which is caused by the interaction of effects, or by off-site developments.
Probability	Low	A low likelihood of occurrence of the impact.
	Medium	A medium likelihood of occurrence of the impact.
	High	A high likelihood of occurrence of the impact.

Table 6.4. Impact Descriptors Related to the Receiving Environment

Impact Characteristics		Potential Hydrological Impacts
Quality	Significance	
Negative only	Profound	Widespread permanent impact on: - The extent or morphology of a cSAC. - Regionally important aquifers. - Extents of floodplains. Mitigation measures are unlikely to remove such impacts.
Positive or Negative	Significant	Local or widespread time dependent impacts on: -The extent or morphology of a cSAC / ecologically important area. -A regionally important hydrogeological feature (or widespread effects to minor hydrogeological features). -Extent of floodplains. Widespread permanent impacts on the extent or morphology of an NHA/ecologically important area, Mitigation measures (to design) will reduce but not completely remove the impact – residual impacts will occur.
Positive or Negative	Moderate	Local time dependent impacts on: - The extent or morphology of a cSAC / NHA / ecologically important area. - A minor hydrogeological feature. - Extent of floodplains. Mitigation measures can mitigate the impact OR residual impacts occur, but these are consistent with existing or emerging trends
Positive, Negative or Neutral	Slight	Local perceptible time dependent impacts not requiring mitigation.
Neutral	Imperceptible	No impacts, or impacts which are beneath levels of perception, within normal bounds of variation, or within the bounds of measurement or forecasting error.

6.3 THE EXISTING ENVIRONMENT

6.3.1 *Site Location and Description*

The site is located off Regional Road R634 (former N25 Waterford – Cork National Road) adjacent to Youghal Landfill and Civic Amenity Centre. The site itself and the surrounding area are situated on low-lying land (approximately 5m OD Malin Head) reclaimed from the Blackwater Estuary which is known locally as Youghal Mudlands. The northern and western boundaries of the site are defined by a public access road and an adjacent development respectively. The southern and western boundaries overlook undeveloped reclaimed land.

The site which has an approximate area of 2.32Ha currently operates as a non-hazardous waste recovery /transfer facility. The existing development which is completely constructed on concrete hardstanding comprises three main buildings. These include a waste recovery/transfer building, a dry sludge building and an administration block. Wastewater treatment (domestic and process water) and stormwater attenuation facilities are situated on the northeast corner of the site. This area also acts as a chemical store for the wastewater treatment works (*i.e.* NaOCl, $Al_2(SO_4)_3$ and NaOH). All chemical storage containers, which are located outside, are bunded by plastic spill trays. Located on the southern part of the site is a bunded hydrocarbon storage area and an outside waste storage area which is surrounding by concrete walls. Youghal Landfill facility is located approximately 300m to the northeast of the site. The Foxhall waste management site historically comprised part of the neighbouring landfill facility and housed a diesel storage area near the current site entrance (*i.e.* east of the administration block). Historical site soil contamination is discussed below in *Section 6.3.4.*

6.3.2 Soils and Subsoils

The published soils map (www.epa.ie) for the area is shown as Figure 6.1. Soils mapped in the vicinity of the site include deep mineral (AminDW) and marine which are associated with the estuary of the Blackwater River (Estuary) to the east of the site. Deep well drained mineral soil is mapped to the west of the site. The published subsoils map of the area (www.gsi.ie) shows the site to be underlain by made ground which is consistent with the historical background of the area which involved reclamation of land within the area known locally as the Youghal Mudlands. Natural mapped subsoils in this area include marine sands in the vicinity of the estuary and sandstone tills further west of the site (refer to Figure 6.2).

Site specific information on the superficial geology of the site was initially obtained by Geotech Ltd in August 2004 during site investigation work for the exsting development. A summary of the stratum encountered is shown in Table 6.5. No bedrock was encountered at a maximum depth of 12m below ground level (mbgl).

Table: 6.5 Summary of Strata Encountered (Geotech Ltd, 2004)

Stratum Encountered	Proven Thickness (m)
MADE GROUND – Gravelly sandy clay with building and household rubbish	0.3 – 2.3
GLACIAL TILL – Stiff gravelly clay with occasional cobbles	≤ 11.6
FLUVIO-GLACIAL DEPOSITS – Loose clayey slightly gravelly SAND	≤1.8

A summary of stratum encountered by Minerex Environmental Ltd during the installation of groundwater monitoring wells (MW1, MW2 & MW3) in April, 2007 is shown in Table 6.6. The made ground was reported to comprise predominately of gravelly clay with fragments of plastic (4-5%), wood (1%), glass (2%) and ceramics (2-3%). The underlying natural subsoils generally consisted of stiff grey/brown CLAY or red/brown gravelly CLAY with cobbles which were underlain by loose clayey sandy GRAVEL. No bedrock was encountered at a maximum depth of 14m bgl.

Table 6.6: Summary of Strata Encountered (Minerex Ltd, 2004)

Stratum Encountered	Proven Thickness (m)
Concrete	
MADE GROUND – clay with plastic, Wood, metals & ceramics	0 – 3.0
Firm-stiff red/brown gravelly CLAY with cobbles	2 – 10.6
Loose clayey sandy GRAVEL	0.3 – 2.0

6.3.3 *Bedrock Geology*

Based on the mapped geology of the area (www.gsi.ie) the bedrock underlying the site consists mainly of the Waulsortian Limestones. The formation consists of massive, unbedded mounds of calcareous deposits in the form of mudstones, wackestones and packstones. Devonian rocks which are situated to the north and south of the site include the Ballysteen and Gyleen Formations, part of which is referred to as the Old Red Sandstone. Synclinal folding associated with the Variscan orogeny means that these limestones are surrounded on all sides by progressively older rocks. The bedrock map is shown as Figure 6.3.

6.3.4 *Historical Site Contamination Sources*

Historical reclamation work in this area has resulted in made ground with a proven thickness of up to 3m (Minerex, 2007) being present in the area of the site. Site investigation work as described in *Section 6.3.2* identified the made ground to be predominately clay with small portion of construction and demolition waste. The site was then was used by the neighbouring landfill and housed a diesel storage area in the vicinity of the current site entrance (located to the east of the administration building). The area measured approximately 7m x 6.5m. Results of soil analysis undertaken by Minerex (2007) in this area were below the limit of detection (for hydrocarbons) used by the laboratory. PID readings for the samples taken were 0ppm and no odour of hydrocarbons was detected. It was concluded in the report (Minerex, 2007) that Diesel Range Organics (DRO's) were likely to be present in very minute concentrations above background levels.

6.3.5 *Resource Importance*

Using the criteria set out in Table 6.1 (NRA, 2005) the economic importance of the soils and geology underlying the site is "Low". This is based on criteria - "recent landfill site for construction and demolition wastes", which is within the lowest importance category.

6.4 CHARACTERISTICS OF THE DEVELOPMENT

The existing concrete yard is to be retained and used as a base for a new fibre mesh reinforced concrete slab. The new concrete will be laid to fall to a new grit trap and collection chamber located in the northern part of the site. A transfrontier shipment (TFS) compound will be constructed on the proposed newly constructed slab. The TFS will be bunded and the construction of this bund will consist of a 2m high reinforced concrete wall and a 450mm high reinforced concrete raised traffic bump. Runoff from the bunded area will be diverted to a grit trap/ collection manhole which will then drain to existing surface water drainage system via an automated butterfly valve. Stringent testing will be undertaken before runoff is allowed enter the existing surface water system. Due to the potentially hazardous and corrosive characteristics of the proposed waste it is proposed that pipework between the collection and discharge manholes are fabricated using stainless steel.

6.5 POTENTIAL IMPACTS OF DEVELOPMENT

6.5.1 *Do Nothing Scenario*

The site would remain as a waste recovery/transfer facility for non-hazardous waste.

6.5.2 *Worst Case Scenario*

Contamination of soils/subsoil due to leaks and cracks in the bunded area and leaks from the surface water drainage system.

6.5.3 Likely impacts and Mitigation measures

The likely impacts of the proposed development and mitigation measures that will be put in place to eliminate or reduce them are shown in Table 6.7.

6.6 RESIDUAL IMPACTS

No residual impacts are anticipated on the soil and geological environment.

6.7 Non-Technical Summary

The natural geology underlying the site includes gravelly clay with cobbles and limestone bedrock at depth. Overlying the natural soils in the vicinity of the site is a layer of made ground which was imported to reclaim the area from the estuary. The made ground comprises construction and demolition waste. The existing site which was constructed over this material is completely underlain by concrete hardstanding.

The proposed development which will be constructed on the existing hardstanding will have no physical impacts on the underlying soils and geology whatsoever. It is proposed that a reinforced concrete slab will be poured over the existing concrete hardstanding area. This will rule out any potential leakages that may have occurred from cracks within the existing hardstanding concrete.

Due to the hazardous and corrosive characteristics of the waste it is proposed that pipework between the collection chamber and the discharge manhole is fabricated using stainless steel. This will prevent corrosion and leakage of pipes into the future. Only non-hazardous runoff will be allowed continue into the existing surface water drainage system.

It is proposed that twice yearly inspections be carried out by suitably qualified engineers and written certification be recorded of these inspections to ensure the bunded area remains fit for purpose. Regular monitoring of groundwater quality up-gradient and down-gradient of the hazardous waste operation will indicate if leakages into the underlying soils are occurring.

No impacts on the soil and geological environmental are anticipated.

6.8 REFERENCES

Environmental Protection Agency (2003): Advice Notes on Current Practice (in the preparation on Environmental Impact Statements).

Environmental Protection Agency (2002): Guidelines on the Information to be contained in Environmental Impact Statements.

Geotech Ltd (2004): Geotechnical Site Investigation Report at Youghal, Co. Cork.

Institute of Geologists Ireland (2002): Geology in Environmental Impact Statements – A Guide.

Minerex Ltd (2007): Report on Site Investigation at Foxhall Waste Facility, Youghal, Co. Cork.

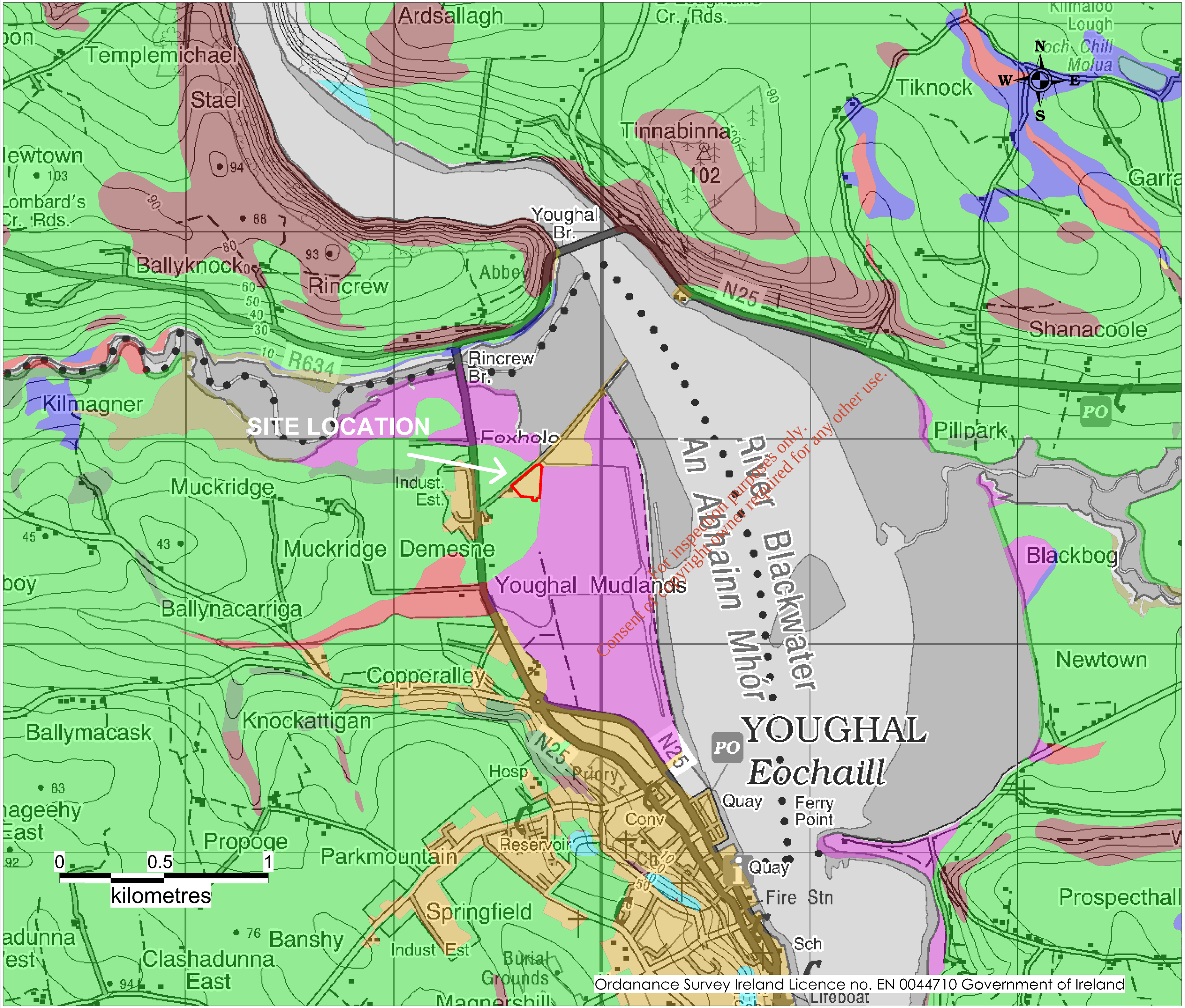
Minerex Ltd (2007): Letter to the EPA Inspector dated 19th January 2007.

National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

Table 6.7 Impacts Table Construction

	Hazard / Source and character of potential impact	Pathway	Receptor	Potential Impact on soils and geology(refer to Table 6.2 to 6.4 for definition of impact descriptors and classification).	Proposed Mitigation Measures	Residual Impact
SG1	Excavation of soil and bedrock during construction works It is proposed that the new waste storage and treatment area be constructed on the existing site hardstanding area. Therefore, there will be no physical changes made to the soil and geology of the site as no excavation will be required.				None required	
SG2	Contamination of soils/subsoils underlying the site due to leakages from bunded areas and surface water drainage water drainage systems. Runoff from waste storage areas.	Cracks in existing hardstanding areas and surface water drainage routes.	Soil/subsoil	Negative, significant, direct, low probability impact on soils and geology	Design measures to prevent accidental leaks of waste include: To contain spillages within the bunded area it is proposed that a reinforced concrete slab will be poured over the existing concrete hardstanding area. This will rule out any potential leakages that may have occurred from cracks within the existing hardstanding concrete. Runoff from the TRS will be prevented by the construction of a 2m high concrete wall. Access to the bunded will be guarded by a 450mm concrete ramp which will also prevent runoff leaving the bunded area. Due to the hazardous and corrosive characteristics of the waste it is proposed that pipework between the collection chamber and the discharge manhole is fabricated using stainless steel. This will prevent corrosion and leakage of pipes into the future. Only non-hazardous runoff will be allowed continue into the existing surface water drainage system. This will be determined by analysis. Monitoring and maintenance measure: It is proposed that twice yearly inspections be carried out by suitably qualified engineers and written certification be recorded of these inspections to ensure the bunded area remains fit for purpose. Maintenance of the TOC and butterfly valve should conform to their respective manufacturers' specifications. The TOC sensor contains perishable material that will need to be changed at regular intervals in addition to general maintenance as required. Regular monitoring of groundwater quality up-gradient and down-gradient of the hazardous waste operation which will indicate if leakages into the underlying soils are occurring.	Neutral, imperceptible, low probability, long term impact on soils/subsoils

FIGURES



Legend:

- Site Boundary
- Deep Mineral Soil (AminDW)
- Marine Sands
- Made Ground
- Alluvium
- Rock at Surface
- Poorly Drained Mineral (AminPD)

Title: Local Soils Map
Client: Eras Eco Ltd
Job: Foxhall Waste Facility
Project No. P1165
Figure No. 6.1
Sheet Size: A4
Drawing No. P1165-1110-A4-601-00A
Date: 08/11/2010
Scale: 1:25,000
Drawn by:DB / Checked by: MG

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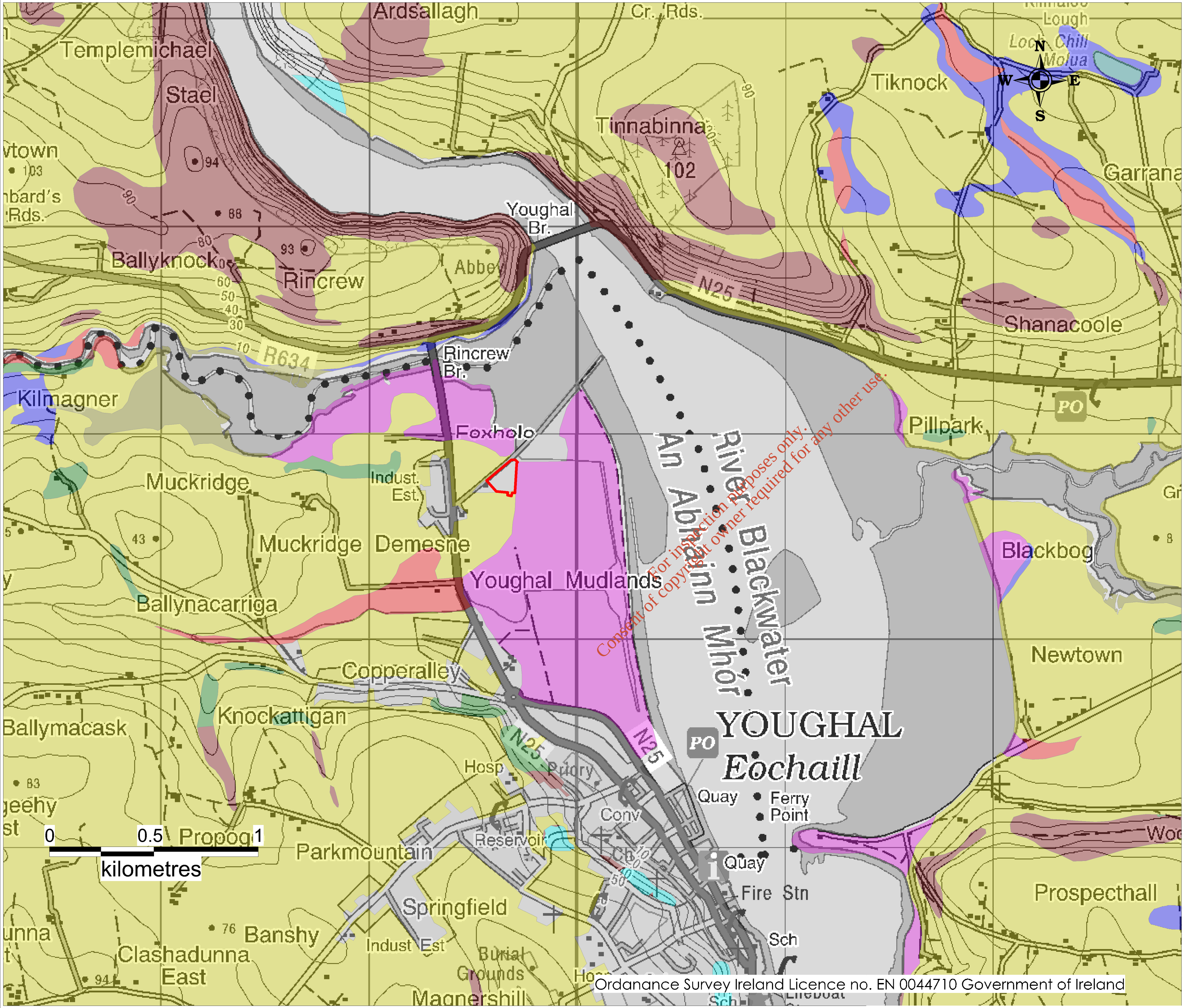

Legend:

- Site Boundary
- Sandstone Tills
- Marine Sands
- Made Ground
- Rock at Surface
- Sandstone/shale Tills
- Alluvium

Title: Local Subsoils Map	
Client: Eras Eco Ltd	
Job: Foxhall Waste Facility	
Project No. P1165	
Figure No. 6.2	
Sheet Size: A4	
Drawing No. P1165-1110-A4-602-00A	
Date: 08/11/2010	
Scale: 1:25,000	
Drawn by:DB	Checked by: MG

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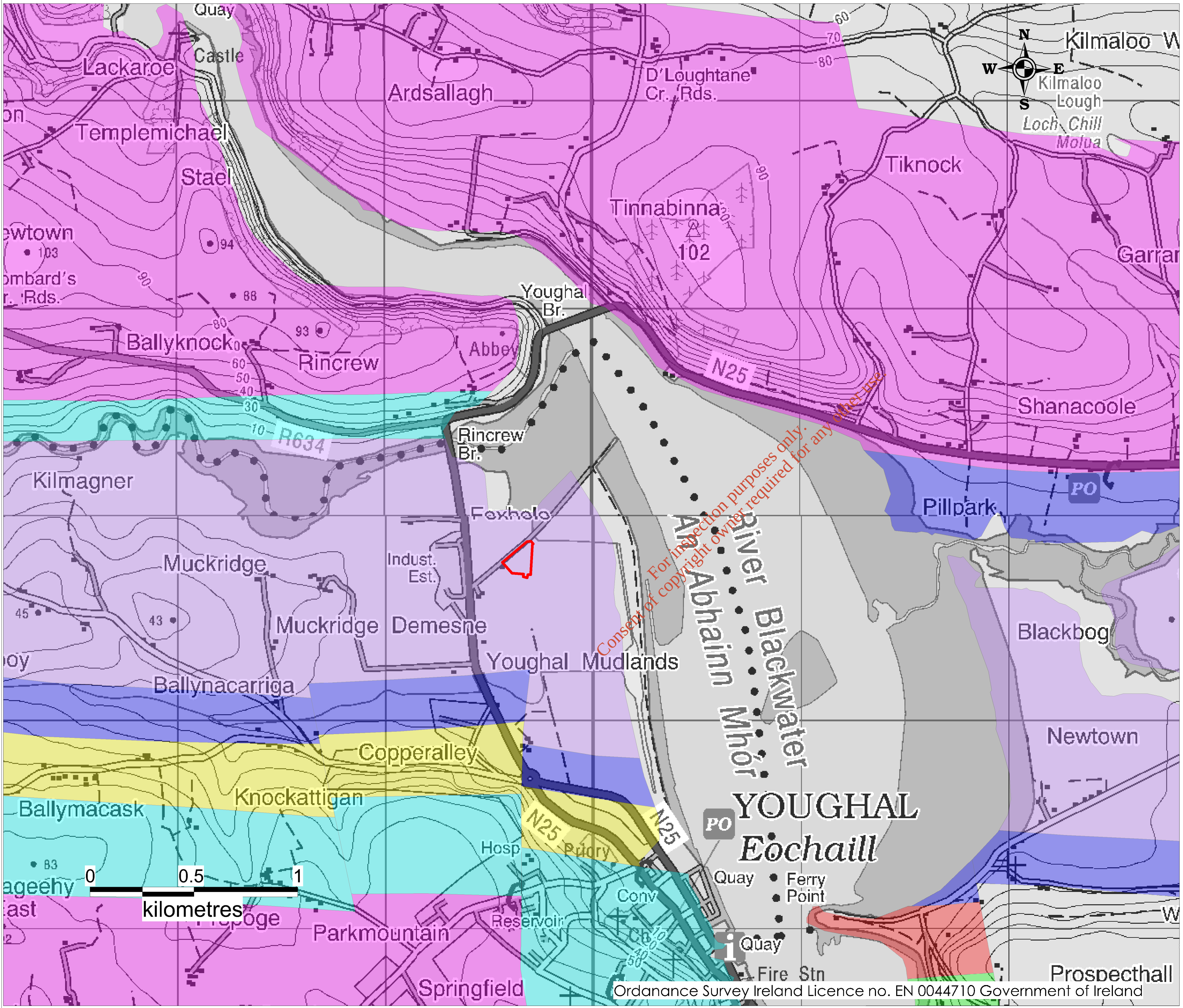

Legend:

- Site Boundary
- Waulsortian Limestones
- Ballysteen Formation
- Ballytrasna Formation
- Gyleen Formation
- Crows Point Formation

Title: Local Bedrock Geology	
Client: Eras Eco Ltd	
Job: Foxhall Waste Facility	
Project No. P1165	
Figure No. 6.3	
Sheet Size: A4	
Drawing No. P1165-1110-A4-603-00A	
Date: 08/11/2010	
Scale: 1:25,000	
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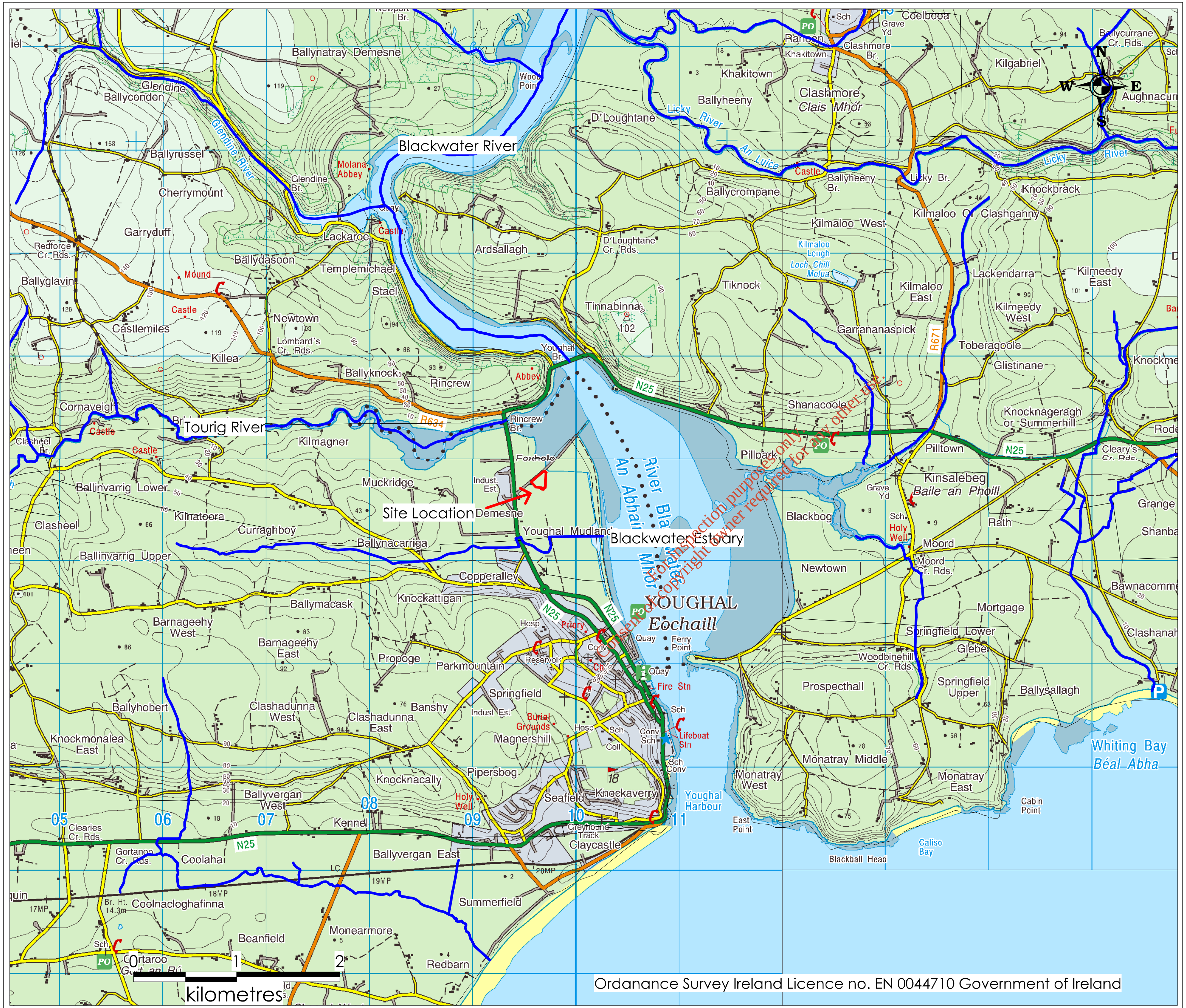

Legend:

- Site Boundary
- Stream/River

HYDRO-ENVIRONMENTAL SERVICES

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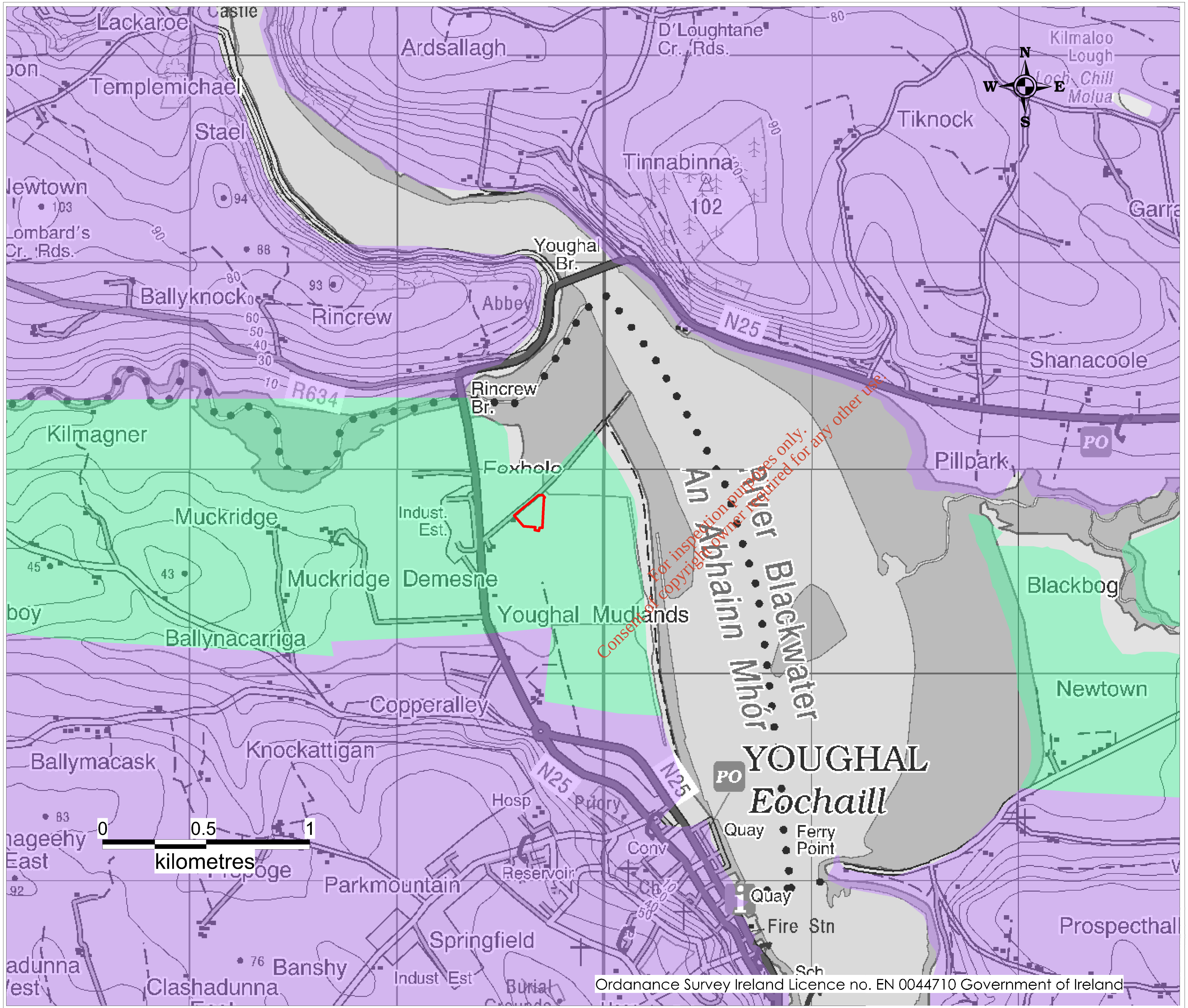
Title: Regional Hydrology Map	
Client: Eras Eco Ltd	
Job: Foxhall, Youghal	
Project No: P1165	
Figure No: 7.1	
Sheet Size: A4	
Drawing No: P1165-1110-A4-701-00A	
Date: - 08/11/2010	
Scale: - 1:50000	
Drawn By: DB	Checked By: MG



Legend:

- Site Boundary
- Poorly Productive Aquifer
- Karstified Aquifer

Title: Aquifer Map	
Client: Eras Eco Ltd	
Job: Foxhall Waste Facility	
Project No. P1165	
Figure No. 7.2	
Sheet Size: A4	
Drawing No. P1165-1110-A4-702-00A	
Date: 08/11/2010	
Scale: 1:25,000	
Drawn by:DB	Checked by: MG

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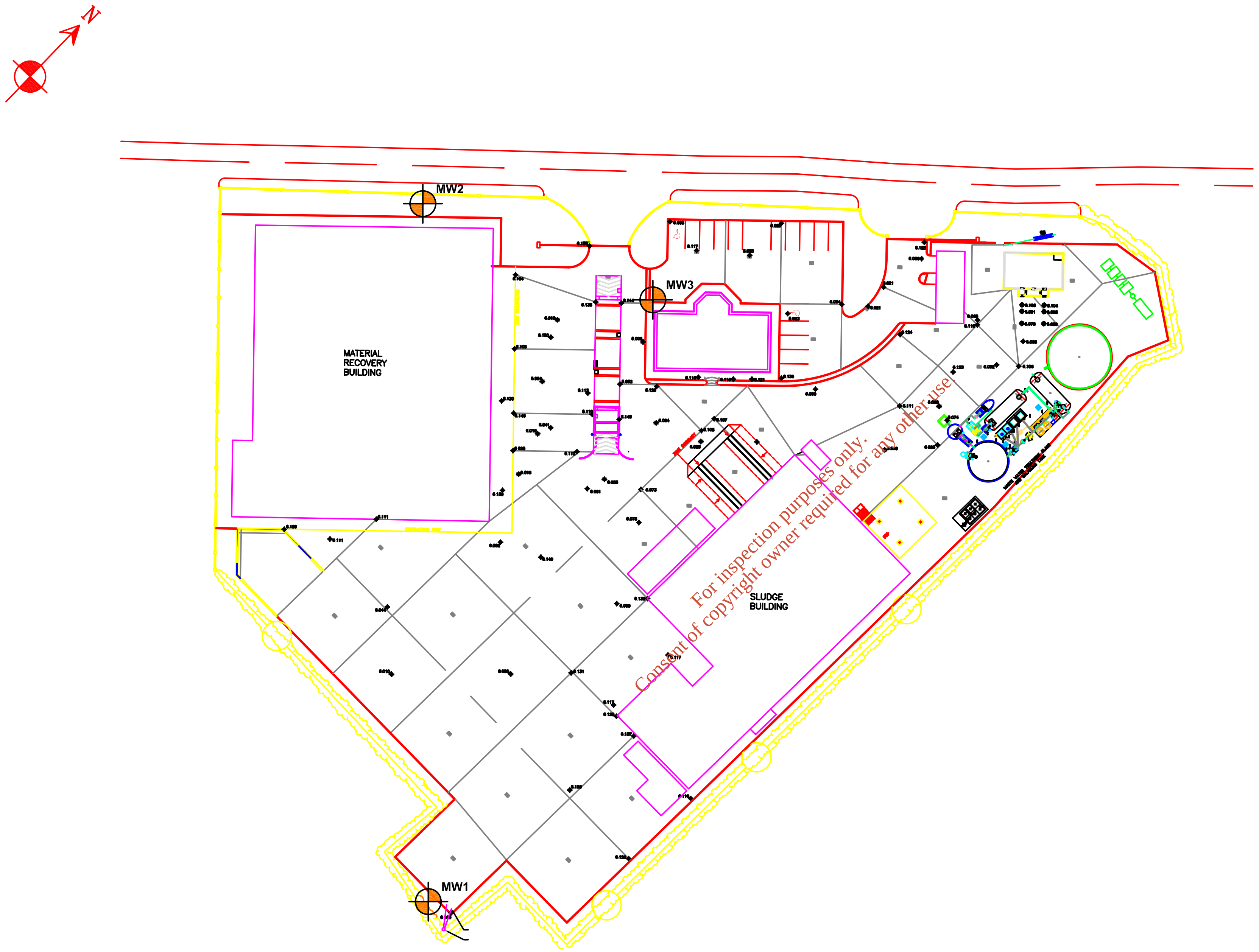

LEGEND:

MW1 BOREHOLE LOCATIONS

Date	Description	Chkd	Signed

Revisions

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Job: Foxhole, Youghal, Co. Cork

Title: Borehole Locations

Figure No: 7.3

Drawing No: P1165-1110-A4-703-00A

Sheet Size: A4	Project No.: P1165
Scale: 1:1,000(A4)	Drawn By: MGill
Date: 08/11/2010	Checked By: MG

APPENDIX 4

7.0 WATER

7.1 INTRODUCTION

7.1.1 Background & Objectives

Hydro-Environmental Services (HES) was engaged by ERAS Eco. Ltd to carry out an assessment of the potential impact of a proposed facility upgrade and waste licence review for an existing waste recovery / transfer facility at Foxhall, Youghal Co. Cork on water aspects (hydrology (freshwater) and hydrogeology (groundwater)) of the receiving environment.

The objectives of the assessment include:

- Produce a baseline study of the existing water environment (surface and groundwater) in the area of the proposed development;
- Identify likely positive and negative impacts of the proposed development on surface and groundwater during construction and operational phases of the development; and,
- Identify mitigation measures to avoid, remediate or reduce significant negative impacts.

Surface water relates to freshwater hydrology, and the impact on estuarine/marine water quality is dealt with else where in the EIS.

7.1.2 Characteristics of the Existing and Proposed Developments

Operations under the existing EPA Waste Licence (Reg no. W0211-01) include:

- Waste Recovery & transfer building;
- Sludge drying facility;
- Wastewater treatment and balance tanks;
- Stormwater tanks, wheel wash & bunded storage areas;
- Ancillary building and facilities; and,
- Outputs which include dry sludge and wastewater.

Proposed operations for which a review is been sought:

- Hazardous waste treatment facility using Aqua Citrox[R] Technology;
- Handling / storage area for solvents; and,
- Anaerobic digestion unit.

7.1.3 Relevant Legislation

This assessment is carried out in accordance with the follow legislation:

- S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001), S.I. No. 30 of 2000, the Planning and Development Act, and S.I. 600 of 2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/373/EEC and subsequent Amendments, on the assessment of the effects of certain public and private projects on the environment;

S.I. No. 600 of 2001 Planning and Development Regulations, 2001;

S.I. No. 94 of 1997 European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);

S.I. No. 293 of 1988 Quality of Salmon Water Regulations, resulting from EU Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life;

S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009 and S.I. No. 722 of 2003 European Communities (Water Policy) Regulations which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (WDF). The key objectives of the WFD are that all water bodies in member states achieve (or retain) at least 'good' status by 2015. Water bodies comprise both surface and groundwater bodies, and the achievement of 'Good' status for these depends also on the achievement of 'good' status by dependent ecosystems. Phases of characterisation, risk assessment, monitoring and the design of programmes of measures to achieve the objectives of the WFD have either been completed or are ongoing. In 2015 it will fully replace a number of existing water related directives, which are successively being repealed, while implementation of other Directives (such as the Habitats Directive 92/43/EEC) will form part of the achievement of implementation of the objectives of the WFD;

S.I. No. 41 of 1999 Protection of Groundwater Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);

S.I. No. 249 of 1989 Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (repealed by 2000/60/EC in 2007);

S.I. No. 439 of 2000 Quality of Water intended for Human Consumption Regulations and S.I. No. 278 of 2007 European Communities (Drinking Water No. 2) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);

S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations; and,

S.I. No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations 2010.

7.1.4 Relevant Guidance

The water section of the EIS is carried out in accordance with guidance contained in the following:

Environmental Protection Agency (2003): Advise Notes on Current Practice (in the preparation on Environmental Impact Statements);

Environmental Protection Agency (2002): Guidelines on the Information to be Contained in Environmental Impact Statements;

Institute of Geologists Ireland (2002): Geology in Environmental Impact Statements – A Guide; and,

National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

7.2 METHODOLOGY

7.2.1 *Desk Study*

A desk study of the site and the surrounding area was completed in advance of undertaking the site visit. This involved collecting all relevant geological, hydrological, hydrogeological and meteorological data for the area. This included consultation with the following:

- Environmental Protection Agency database (www.epa.ie);
- Geological Survey of Ireland - National Draft Bedrock Aquifer map;
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- The Department of Communications Marine and Natural Resources - Exploration and Mining Division website (www.minex.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive "*WaterMaps*" Map Viewer (www.wfdireland.ie); and,
- OPW Indicative Flood Maps (www.flooding.ie).

7.2.2 *Site Investigations*

A walkover survey of the site was undertaken by Hydro-Environmental Services on 5th August 2010. A visual inspection of the site was carried out whereby all potential sources of contamination including chemical and waste storage areas were checked for signs of leakages such as discolouration and smell. Groundwater levels were recorded in the 3 no. on-site monitoring wells. All surface drainage in the vicinity of the site was mapped.

7.2.3 *Impact Assessment Methodology*

Please refer to the Soils and Geology Chapter of the EIS for details on the impact assessment methodology (EPA, 2002). In addition to the above methodology the sensitivity of the water environment receptors were assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in Table 7.1 are then used to assess the potential effect that the proposed development may have on them.

Table 7.1: Receptor Sensitivity Criteria (Adapted from www.sepa.org.uk).

Sensitivity of Receptor:
Not sensitive: Receptor is of low environmental importance (*e.g.* surface water quality classified by EPA as A3 waters or seriously polluted), fish sporadically present or restricted). Heavily engineered or artificially modified and may dry up during summer months. Environmental equilibrium is stable and is resilient to changes which are considerably greater than natural fluctuations, without detriment to its present character. No abstractions for public or private water supplies. GSI groundwater vulnerability "Low" – "Medium" rating and "Poor" aquifer importance.
Sensitive: Receptor is of medium environmental importance or of regional value. Surface water quality classified by EPA as A2. Salmonid species may be present and may be locally important for fisheries. Abstractions for private water supplies. Environmental equilibrium copes well with all natural fluctuations but cannot absorb some changes greater than this without altering part of its present character. GSI groundwater vulnerability "High" rating and "Locally" important aquifer.
Very sensitive: Receptor is of high environmental importance or of national or international value i.e. NHA or SAC. Surface water quality classified by EPA as A1 and salmonid spawning grounds present. Abstractions for public drinking water supply. GSI groundwater vulnerability "Extreme" rating and "Regionally" important aquifer.

7.3 RECEIVING ENVIRONMENT

7.3.1 *General Site description*

The site is located south of Regional Road R634 (former N25 Waterford – Cork National Road) adjacent to Youghal Landfill and Civic Amenity Centre. The site itself and the surrounding area are situated on low lying land (approximately 5m OD Malin Head) reclaimed from the Blackwater Estuary which is known locally as Youghal Mudlands. The northern and western boundaries of the site are defined by a public access road and an adjacent development respectively. The southern and western boundaries overlook undeveloped reclaimed land.

The site which has an approximate area of 1.43Ha currently operates as a non-hazardous waste recovery/transfer facility. The existing development which is completely constructed on concrete hardstanding comprises three main buildings. These include a waste recovery/transfer building, a sludge drying building and an administration block. Wastewater treatment (domestic and process water) and stormwater attenuation facilities are situated on the northeastern corner of the site. This area also acts as a chemical store for the wastewater treatment works (*i.e.* NaOCl, $Al_2(SO_4)_3$ and NaOH). All chemical storage containers, which are located outside, are bunded by plastic spill trays. Located on the southern part of the site is a bunded hydrocarbon storage area and an outside waste storage area which is surrounding by concrete walls.

Youghal Landfill facility is located approximately 300m to the northeast of the site. The Foxhall waste management site historically comprised part of the neighbouring landfill facility and housed a diesel storage area near the current site entrance (*i.e.* northeast of the administration block).

7.3.2 *Regional & Local Hydrology*

The existing site is located on reclaimed estuarine land to the west of the Blackwater River which enters the sea at Youghal Harbour approximately 4km southeast of the site. The nearest gauging station where long-term flow data is available is upstream at Tallow approximately 20km northwest of the site (Station no. 18060). The Dry Weather Flow (DWF) and 95%ile flow at this station are $0.51m^3/s$ and $0.99m^3/s$ respectively. The Tourig River, which enters the estuary to the north of the site *(i.e.* up-gradient), is the second major river to enter the Blackwater Estuary close to the site. The closest gauging station where long-term flow data is available is at Clasheel (Station no. 18042) approximately 7km up-stream of the site. The DWF and the 95%ile flow at this station are $0.03m^3/s$ and $0.06m^3/s$ respectively. A number of minor streams drain from the reclaimed land to the south of the site. A regional drainage map is shown as Figure 7.1.

7.3.3 *Site Drainage*

There are no natural drainage features within the site boundary (stormwater management is covered in *Section 7.3.13* below). Outside the site boundary a drainage ditch runs adjacent to the site access road to the northwest of the site. This ditch receives runoff from the access road and from reclaimed land to the northwest of the site. Several other minor drains exist to the east and southeast of the site. All ditches drain into the estuary to the east of the site.

7.3.4 *Flood Risk Assessment*

OPW's indicative river and coastal flood map (www.flooding.ie) was consulted to identify those areas as being at risk of flooding. Based on consultation with management at the facility there were no instances of flooding where the site was affected. Based on OPW records there are reports of flooding in the area of the Youghal Mudlands. The flooding was associated with ditches that drain the Mudlands area to the south of the site. Reports indicate that flooding was primarily caused by extreme high tides combined with wind surges. Based on the available data the flood risk to the development is considered to be low. The available OPW flood report and map for this location is attached in Appendix 7.1.

7.3.5 *Surface Water Hydrochemistry*

Q-rating data (www.epa.ie) is available for the upper Blackwater River and some of its tributaries. Most recent data (2009) show that upstream EPA monitoring points to the site have a Q-4 rating. The upstream monitoring point on the Tourig River has also a Q-4 rating. Estuarine and coastal water quality monitoring by the EPA show the lower Blackwater and the Lower Tourig to be Eutrophic[1].

Surface water characterisation undertaken under Article 5 of the Water Framework Directive (www.wfdireland.ie) has given the surface water catchments of the Tourig River a "Good" status[2]. Surface water catchments to the Blackwater, which are numerous, generally fall into the "moderate" to "poor" status.

7.3.6 *Hydrogeology*

The aquifer map (www.gsi.ie) of the area is shown as Figure 7.2. The Geological Survey of Ireland (GSI) has classified the Dinantian pure unbedded limestones which underlie the site as a Locally Important Karstified Aquifer. The pure unbedded limestones of the South Munster region are generally highly productive (GSI, 2004). Faults and joints were enlarged by karstification as groundwater moved through the limestones (GSI, 2004). A search of the GSI well database identified one well used for water supply within the aquifer. A yield of 979m^3/d was reported for this source. This well is located approximately 5km west of the site (*i.e.* up-gradient). This would be considered an excellent well[3] in terms of water supply. A search of the GSI karst database indicates that there are no karst features within the area of the site.

Groundwater levels at the site were determined from 3 no. on-site monitoring wells (refer to Figure 7.3). Groundwater levels recorded during the walkover survey (5th August 2010) along with summary borehole installation data (Minerex, 2007) are shown in Table 7.2. Groundwater levels at the site varied between 1.15m below ground level (mbgl) and 4.07mbgl. The levels suggest that the groundwater flow direction in the superficial deposits is to the southeast beneath the site towards the estuary. The steep gradient (*i.e.* difference in water levels from up-gradient to down-gradient wells) may also indicate a perched water table within the superficial deposits.

[1] Having waters rich in mineral and organic nutrients which promote algae growth
[2] Reference condition of the ecological status of the surface water body (www.wfdireland.i.e)
[3] GSI Well Classification System: Excellent wells (>400m^3/d), Good (100-400m^3/d), Moderate (40-100m^3/d) & Poor (<40m^3/d)

Table 7.2: Summary of Well Installation Data & Water Levels (05/08/2010).

Well No.	Stratum	Depth (mbgl)	Water Level (mb datum)	Water level (mOD Malin)
MW1-P1	Sandy gravel with cobbles	3-5	4.07	1.13
MW1-P2	Made ground	0.9-1.9	-	-
MW2-P1	Loose gravelly clay	6.3-7.3	1.15	4.82
MW2-P2	Made ground	0.3-1.3	1.29	4.68
MW3-P1	Loose sandy gravel	13-14	1.99	4.12
MW3-P2	Made ground	0.8 – 1.8	1.75	4.36

7.3.7 Groundwater Vulnerability

The vulnerability of the aquifer underlying the site is rated as predominately "High" by the GSI (www.gsi.ie). However, investigations at the site encountered up to 11.8m of stiff glacial CLAY till beneath the site. Therefore, based on GSI criteria the groundwater vulnerability at the site can be rated as Moderate[4] to Low[5].

7.3.8 Groundwater Hydrochemistry

In accordance with condition 6.18.1 and Schedule C.6 of the existing waste licence groundwater monitoring is carried out at the site biannually. Results of the 2009 monitoring period which were presented in the 2009 Annual Environmental Report (Eras Eco, 2009) are shown in Table 7.3 alongside EPA Interim Guideline Values for Groundwater (IGV).

Based on the measured groundwater levels at the site MW2 and MW3 are located up-gradient within the site and MW1 is located down-gradient. Exceedences were noted in up-gradient and down-gradient wells. P2 and P1 of the well name relates to shallow and deep piezometers respectively. Shallow piezometers are constructed primarily in the made ground and deep piezometers in the underlying natural subsoils.

Diesel range organics and petrol range organics were recorded in MW2 (P2) on 15/12/2009. This would indicate a shallow source of contamination up-gradient of the site. Cadmium was detected in MW1 (P2) and MW2 (P2) at concentrations exceeding the EPA Interim Guideline Value (IGV). This indicates again that contamination is within the made ground. The highest concentration of 60µg/l was recorded in MW2 (P2) which is up-gradient within the site. Other exceedences include ammonia in MW (P2).

Iron and manganese were elevated in most wells and this is potentially due to the background geology of the area and the estuarine environment. Chloride was also elevated in respect of IGV values, and this is also likely due to the proximity of the site to the estuary which is tidal. The groundwater results would indicate that some contamination is present within the made ground in the vicinity of the site. The background groundwater quality within the area of the estuary is naturally poor due to saline intrusion and would be significantly below drinking water standards.

[4] Low permeability subsoil with a thickness of 5m – 10m (GSI, 1999).
[5] Low permeability subsoil with a thickness exceeding 10m (GSI, 1999).

Table 7.3: Groundwater Monitoring Results for 2009 (Eras Eco Ltd, 2009).

Parameter	Unit	MW1-P1[6]	MW2-P1	MW3 - P1	MW1-P2[7]	MW2-P2	MW3 - P2	IGV*
		10/6/09	10/6/09	10/6/09	15/12/09	15/12/09	15/12/09	
Diesel Organics	µg/l	<10	<10	<10	<10	303	<10	10
Petrol Organics	µg/l	<5	<5	<5	<5	59	<5	10
Organohalogens	µg/l	<10	<10	<10	<10	10	<10	-
Cadmium	µg/l	<1	<1	<1	18	60	1	5
Copper	µg/l	<1	<1	<1	<1	10	<1	30
Iron	mg/l	0.808	0.544	0.808	0.51	0.24	0.88	0.2
Manganese	mg/l	0.041	0.282	0.119	0.112	0.109	0.098	0.05
Arsenic	µg/l	<1	<1	<1	4	5	<1	10
Chloride	mg/l	164.8	39.2	39.1	84.2	47.8	47.7	30
Nitrate (as NO3)	mg/l	15.2	10	2.2	17.6	11.4	25.4	25
Conductivity (at 25°C)	µS/cm	665	396	925	962	532	676	1000
pH	pH units	6.96	7.68	6.62	6.80	7.41	7.18	6.5 – 9.5
Ammonia (as N)	mg/l	0.09	0.01	<0.01	0.09	4.25	0.01	0.15
COD	mg/l	<1	<1	18	2200	1100	<1	-

Notes: *EPA Interim Guideline Values for Groundwater. Bold equals IGV exceedence.

7.3.9 Designated Sites

Designated sites include National Heritage Areas (NHAs), Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

The Blackwater River and estuary is designated a Special Protected Area (SPA), a proposed National Heritage Area (pNHA) and a Special Area of Conservation (SAC). The site itself is located outside the designated zone. However, discharge from the facility does enter the Blackwater estuary.

7.3.10 Water Resources

There are no recorded wells within close proximity of the site. There are no mapped source protection zones within the vicinity of the site. However, a public supply well to Youghal Town is mapped 5km up-gradient of the site. Due to the sites close proximity to the estuary, the groundwater in the area would not be suitable for drinking or otherwise.

7.3.11 Receptor Sensitivity

The aquifer underlying the site is classified as a Locally Important Aquifer and therefore can be considered a sensitive receptor. However, the groundwater quality within the area of the estuary is naturally poor due to saline intrusion and is therefore not a suitable source of

[6] P1 – deep piezometer installation
[7] P2 – shallow piezometer installation

potable water. There are no water supply wells recorded within the reclaimed estuarine area. All recorded water supplies are located more than 4km up-gradient of the site. There are no down-gradient wells as the estuary is adjacent to the site. Due to the designated status of the Blackwater Estuary it can be considered very sensitive.

7.3.12 Existing Site Discharges

Under the current waste permit licence (Licence Reg No. W0211-01) the plant is permitted to discharge into the Blackwater Estuary Lower at a maximum rate of 170m^3/d (7m^3/hr). The discharge arises from the wastewater treatment works which receives effluent from the sludge drying facility and domestic effluent from administration block. The domestic effluent is initially treated by means of a Puraflo system prior to been released at the discharge point. The emission limits for the discharge are shown in Table 7.4 below. All parameters are generally in compliance with discharge limits except the Chemical Oxygen Demand (COD) and ammonia. The permitted limit for COD is 125mg/l. Based on long-term monitoring data the average COD at the outfall in 2008 and 2009 was 304mg/l and 220mg/l. Though elevated there appears to be an improvement in the discharge quality. At the EPA's request ERAS ECO Ltd has been monitoring ammonia since May 2010. This testing has revealed that ammonia had risen to high levels with the maximum concentration reported at 92mg/l during week 36 of 2010 (Eras Eco, 2010). As with COD there appears to be an overall improvement in ammonia as the level recorded in week 43 had reduced to 0.469mg/l which is below the emission limit of 0.5mg/l. A proposed wastewater treatment improvement programme (Eras Eco, 2010), which will include additional treatment measures such as Dissolved Air floatation (DAF) and breakpoint chlorination, has been approved by the EPA. The proposal will aim to achieve a long-term ammonia concentration below the compliance level of 0.5mg/l.

Table 7.4: Discharge Limits as per Licence Reg No. W0211-01.

Parameter	Emission Limit
Temperature	25^{0}C (Max)
pH	6.0 - 8.5
	mg/l
BOD	20
COD	125
Suspended Solids	35
Total Nitrogen	10
Sulphate	100
Ammonia	0.5
Phosphorus	1
Cynide	0.01
	µg/l
VOC	50
Semi VOC	50
Lead	5
Zinc	100
Copper	30
Cadnium	5
Arsenic	20
Chromium	15
Nickel	25
Faecal Coliforms	<250fc/100mls

Stormwater from roofs and non-waste storage hardstanding areas is discharged into a public drain on the northeast of the site via a non-return valve. The public drain discharges into the estuary to the east of the site. Two silt/ oil interceptors (Class 1 and designed in accordance I.S. EN 858) together with a pH controlled stormwater retention tank are installed on-site before the final surface water outlet pipe to retain any potential spillages that could occur on-site. Results of quarterly monitoring from the Annual Environmental Report (Eras Eco Ltd, 2009) are shown in Table 7.5. All results for the 2009 period were within an acceptable range for stormwater discharge.

Table 7.5: Resulting of Quarterly Stormwater Monitoring (Eras Eco Ltd, 2009).

Parameters	Units	SW1 Q1	SW1 Q2	SW1 Q3	SW1 Q4
pH	pH units	7.65	7.5	7.72	8.1
Conductivity	uS/cm	300	397	1034	2139
Suspended Solids	mg/l	1	<1	10	<5

7.4 POTENTIAL IMPACTS OF THE DEVELOPMENT

7.4.1 Changes in Discharge Volumes and Quality

It is proposed that when the upgraded waste facility is in operation the existing emission limits and volumes will still apply. The proposed hazardous waste treatment facility will process waste using Aqua Citrox Technology (refer to Chapter 1 of the EIS for details of the system). The proposed concentrations of parameters in the discharge from the Aqua Citrox system are shown in Table 7.6 alongside the existing emission limits. The proposed discharge concentrations comply with existing emission limits as per Licence Reg No. W0211-01. Based on monitoring data for the existing discharge, it is proposed that the Aqua Citrox system will improve the overall quality of the discharge from the site. The proposed discharge rate will range from 1 – 11m^3/hr, with a typical rate of 3.5m^3/hr.

Table 7.6: Proposed Discharge Parameters & Concentrations.

Parameter	Existing Emission Limit	Proposed Discharge Concentrations
	mg/l	mg/l
COD	125	<85
Suspended Solids	35	<30
Total Nitrogen	10	<8
Sulphate	100	<90
Ammonia	0.5	<0.5
Phosphorus	1	<1.0
Cyanide	0.01	<0.01
	µg/l	µg/l
VOC	50	<40
Lead	5	<4
Zinc	100	<90
Copper	30	<25
Cadmium	5	<4
Arsenic	20	<16
Chromium	15	<15
Nickel	25	<25

7.4.2 Do Nothing Scenario

The development would remain as a waste recovery / transfer facility for non-hazardous waste and operate under existing Waste Licence Registration No. W0211-01.

7.4.3 Worst Case Scenario

Contamination of the underlying aquifer and surface waters during the construction and operational phases of the upgraded development. Mitigation measures will be in place to prevent such occurrences.

7.4.4 Likely Impacts and Mitigation Measures

The likely impacts of the proposed development and mitigation measures that will be put in place to eliminate or reduce them are shown in Table 7.8.1 and 7.8.2.

7.4.5 Non Technical Summary

The site is located on reclaimed land adjacent to the Blackwater Estuary which is a Special Area of Conservation (SAC), a proposed National Heritage Area (pNHA) and a Special Protected Area (SPA). The primary fresh surface water features in the facility of the site are the Blackwater River and the Tourig River which flow into the Blackwater Estuary upstream of the site.

The aquifer underlying the site comprises limestone bedrock which is known to be fractured and dissolved in places by moving groundwater. Based on water levels measured at the site, the direction of groundwater flow is to the southeast in the direction of the estuary. Based on an approximate depth of 11m of clay overburden overlying the aquifer at the site, the vulnerability of the aquifer to surface pollution is Low to Moderate.

Groundwater monitoring undertaken at the site indicates that the groundwater quality in the vicinity of the site is poor. This is partially due to the sites location within an estuary where groundwater would generally be undrinkable due to natural saltwater intrusion. However, the sites previous use as a landfill also means that contaminants such as hydrocarbons are also present in very small concentrations.

The aquifer underlying the site can be considered sensitive to environmental impact. However, the groundwater quality within the area of the estuary is naturally poor due to salt water intrusion and is therefore not valuable as a water source. Also, there are no downstream wells as the estuary is adjacent to the site. The Blackwater River and Estuary is a designated area and is therefore is very sensitive to environmental impact.

Potential impacts of the proposed development on groundwater quality in the area are considered to be low. The site is covered by concrete which is to be further reinforced as part of the proposed development works. Therefore, the potential for contaminants to move downward into the aquifer is low. The aquifer in this area is also overlain by a thick layer of clay overburden which provides protection from surface pollution.

All surface water runoff from the site is currently directed to the stormwater treatment tank and oil interceptor prior to discharge from the site. During the construction phase additional inspections will be put in place to ensure the quality of the stormwater discharge is maintained as per the discharge limits. Visual inspections and measurements of quality will be undertaken regularly during wet periods. Surface water discharge will be closely monitored during the operational phase. There will be no increase in surface runoff from the site as there is to be no change in site hardstanding or roof area.

It is proposed that there will be no changes to the current emission limits as set by the existing Waste Licence. Based on specifications from the manufacturer, the effluent from the proposed waste treatment technology (Aqua Citrox) will be of a high quality. The proposed discharge criteria are well below the existing emission limits. Therefore there will be an overall improvement in the quality of the discharge from the proposed development in comparison to the existing situation.

7.5 REFERENCES

Environmental Protection Agency (2003): Advice Notes on Current Practice (in the preparation on Environmental Impact Statements).

Environmental Protection Agency (2002): Guidelines on the Information to be contained in Environmental Impact Statements.

Eras Eco Ltd (2009): Annual Environmental Report.

Eras Eco Ltd (2010) WWTP Improvement Program (Ref: W0211-01), Letter to EPA dated 24th November 2010.

Geological Survey of Ireland (2004): Tourig Group Groundwater Body Characterisation Report.

Geological Survey of Ireland (1999): Groundwater Protection Schemes.

Institute of Geologists Ireland (2002): Geology in Environmental Impact Statements – A Guide.

Minerex Ltd (2007): Report on Site Investigation at Foxhall Waste Facility, Youghal, Co. Cork

National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

Table 7.8.1 Potential impacts (PI) during the Construction Phase

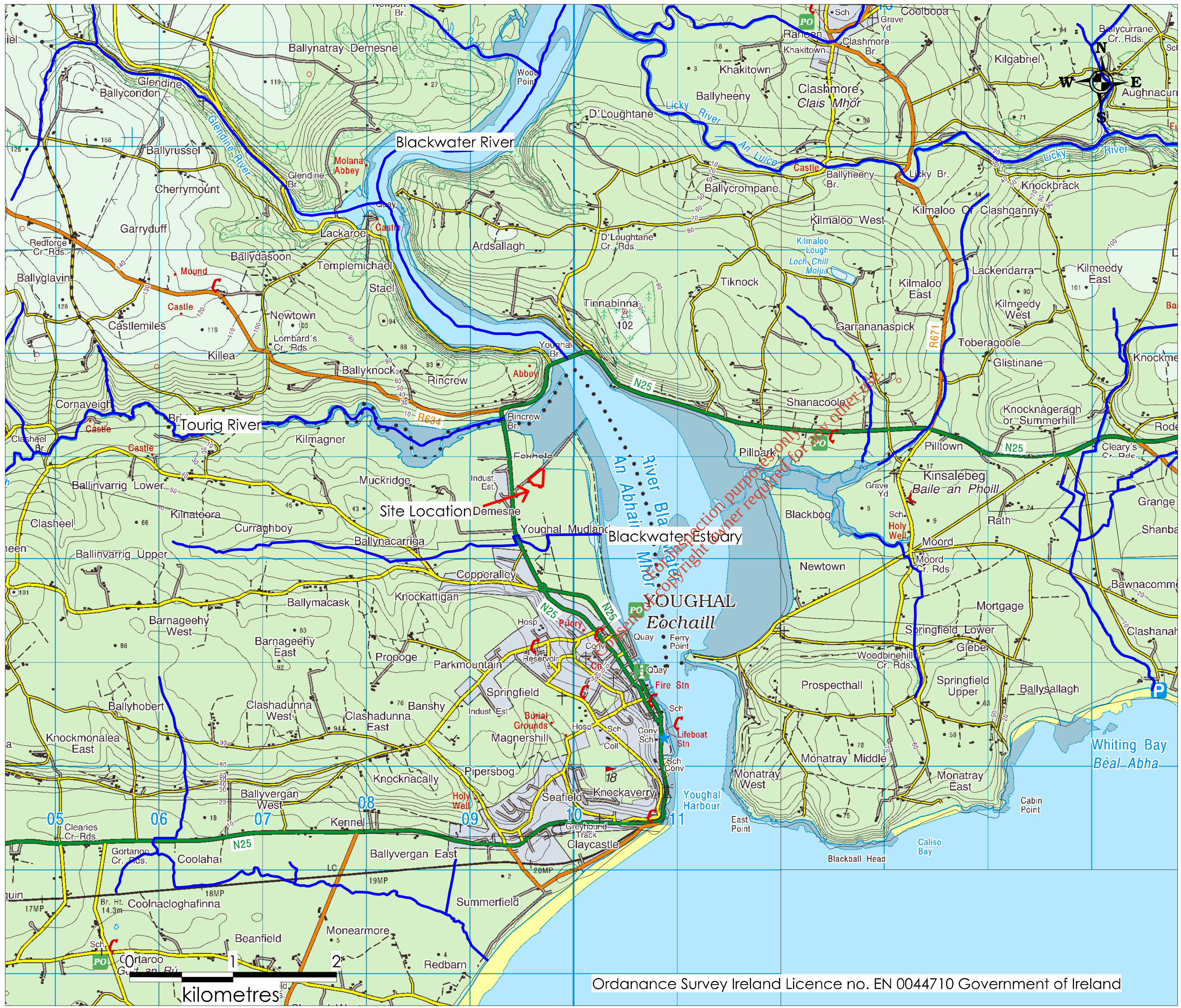
	Hazard / Source and character of potential impact	Pathway	Receptor	Potential Impact on hydrology (refer to Tables 6.1 to 6.4 of the Geology Section for definition of impact descriptors)	Proposed Mitigation Measures	Residual Impact
H1	Potential impact on local groundwater quality resulting from spillages during the construction phase. Accidental spillage during construction phase work (*i.e.* petroleum hydrocarbons or other construction chemicals).	Surface runoff, infill and soil pore space	Groundwater	Negative, direct, slight, low probability impact on groundwater quality.	The existing site is completing overlain in hardstanding comprised of reinforced concrete. All construction work will take place on the existing hardstanding areas and there will be no exposure of the underlying soil. The site is completely kerbed and there will be no fugitive runoff from the site. Any fuels or chemicals that are required during the construction phase will be placed over plastic spill trays as is currently done at the site, therefore preventing leakages into hardstanding areas.	Negative, direct, slight, low probability impact.
H2	Runoff from hardstanding areas to surface water bodies during the construction phase Release of surface runoff which potentially could contain contamination from construction products such as hydrocarbons and solvents.	Discharge routes to surface water	Surface waters and dependant ecosystems	Direct, negative, moderate, short term, low probability impact.	All runoff from the site is currently directed to the stormwater attenuation tank and hydrocarbon interceptor prior to discharge from the site. During the construction phase additional inspections will be put in place to ensure the quality of the stormwater discharge is maintained as per the discharge limits. Visual inspections and measurements of unstable parameters such as pH and electrical conductivity will be undertaken regularly during wet periods. Any fuels or chemicals that are required during the construction phase will be placed over plastic spill trays, therefore preventing leakages into the stormwater system.	Negative, imperceptible, short-term, low probability impact on surface waters

Table 7.8.2 Operational Phase

	Hazard / Source and character of potential impact	Pathway	Receptor	Potential Impact on hydrology (refer to Tables 6.1 to 6.4 of the Geology Section for definition of impact descriptors)	Proposed Mitigation Measures	Residual Impact
H3	Groundwater contamination Contamination of groundwater underlying the site due to leakages from bunded areas and surface water drainage systems.	Cracks in existing concrete areas and surface water drainage routes	Groundwater	Negative, moderate, direct, low probability impact on groundwater	The site is located in an area with a groundwater vulnerability rating of low to moderate. Stiff clayey tills were noted to be up to 11.8m in thickness beneath infill. This layer in turn is then covered by infill and concrete. Therefore, the site in its current condition means the risk to groundwater is low. Design measures to prevent accidental leaks of waste include: 1. To contain spillages within the bunded area it is proposed that a reinforced concrete slab will be poured over the existing concrete hardstanding area. This will rule out any potential leakages that may have occurred from cracks within the existing hardstanding concrete. 2. Runoff from the waste acceptance area will be prevented by the construction of a 2m high concrete wall. Access to the bunded area will be guarded by a 450mm concrete ramp which will also prevent runoff leaving the bunded area. 3. Due to the hazardous and corrosive characteristics of the waste it is proposed that pipework between the collection chamber and the discharge manhole is fabricated using stainless steel. This will prevent corrosion and leakage of pipes into the future. Only non-hazardous runoff will be allowed continue into the existing surface water drainage system. 4. Maintenance of the TOC and butterfly valve should conform to their respective manufacturers' specifications. The TOC sensor contains perishable material that will need to be changed at regular intervals in addition to general maintenance as required. 5. Regular monitoring of groundwater quality up-gradient and down-gradient of the hazardous waste operation which will indicate if leakages into the underlying soils are occurring. This will be done as part of the waste licence. 6. There are no known drinking water supply wells located with close proximity to the site. All recorded wells are significantly up-gradient of the site, and therefore cannot be impacted by the development. The groundwater in the area is generally of poor quality which is primarily due to the location of the site on land reclaimed from the estuary. The local groundwater is unlikely to be suitable for potable drinking supply.	Direct, imperceptible, low probability, long term impact on groundwater.
H4	Potential impact on the quality of the Blackwater Estuary and Youghal harbor. It is proposed that effluent from the hazard waste treatment technology will be routed through the existing waste water works and released as per the existing Waste Licence and discharge point.	Discharge route	Down-stream Surface and estuarine waters	Negative, moderate, direct, medium probability impact on surface water.	It is proposed that there will be no amendments to the current emission limits as set by the waste Licence. Based on specifications from the manufacturer, the effluent from the proposed Aqua Citrox technology will be of a high quality that is well below the existing discharge limits. It is proposed that the quality of the final discharge from the development will be improved when mixed with the effluent from the Aqua Citrox technology.	Neutral, direct, slight, high probability impact on surface and estuarine waters.

H5	Potential of flooding down-stream of site due to run-off from hardstanding areas.	Discharge routes	Down-stream Surface and estuarine waters	Negative, slight, direct, low impact on surface water.	The proposed development will be constructed on the existing hardstanding area. There will be no increase in site hardstanding area.	Neutral.

FIGURES



Legend:

Site Boundary

Stream/River

HYDRO-ENVIRONMENTAL SERVICES
22 Lower Main Street
Dungarvan, Co. Waterford
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Title: Regional Hydrology Map

Client: Eras Eco Ltd

Job: Foxhall, Youghal

Project No: P1165

Figure No: 7.1

Sheet Size: A4

Drawing No: P1165-1110-A4-701-00A

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