ARUP

Indaver Ireland Limited

IE Licence Review Application

Operational Report

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1. Introduction

1.1 Overview

Indaver Ireland Limited (Indaver) operate a waste to energy (WtE) facility in Carranstown, Duleek, Co. Meath. As per the sites Industrial Emissions (IE) Licence (Reg. No. W0167-03) the site is permitted to undertake the following activities:

Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants

(a) for non-hazardous waste with a capacity exceeding 3 tonnes per hour, and

(b) for hazardous waste with a capacity exceeding 10 tonnes per day.

This Operational Report, which forms part of an application for a revised Industrial Emissions Licence, describes the plant, methods, processes, ancillary processes, abatement, recovery and treatment systems, and operating procedures for the existing facility and the proposed new development.

The proposed development includes the following:

- Increase in the amount of hazardous waste accepted at the facility for treatment in the waste to energy plant from the current permitted 10,000 tonnes per annum (tpa) up to a maximum of 25,000 tpa;
- It is also proposed to increase the annual total waste accepted at the site for treatment in the waste to energy facility from the currently permitted 235,000 tpa to 250,000 tpa;
- Development of an aqueous waste tank farm and unloading area for the storage and processing of aqueous liquid wastes currently accepted at the facility;
- Development of a $10MW_e$ hydrogen generation unit for connection to the natural gas distribution network and for mobile hydrogen transport applications and other potential uses;
- Development of a bottom ash storage building for the storage of up to 5,000 tonnes of bottom ash which is currently produced on site;
- Additional waste acceptance capacity and infrastructure to accept up to 30,000 tpa (bringing the site total to 280,000 tpa) of third-party boiler ash and flue gas cleaning residues and other similar residues for treatment in the existing ash pre-treatment facility on site;
- Development of a warehouse, workshop and emergency response team (ERT)/office building to support existing maintenance activities on the site;
- Development of a new concrete yard and parking area for up to 10 trucks, tankers or containers on the site;
- Demolition and re-building of an existing single storey modular office building on site with a slightly increased footprint; and
- Other miscellaneous site upgrades.

Following construction of the proposed development, two new activities as outlined in the First Schedule of the EPA Act 1992, as amended, will be carried out on site:

5.13 *(a) The production of inorganic chemicals, such as gases, such as ammonia, chlorine or hydrogen chloride, fluorine, or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride (production means the production on an industrial scale by chemical or biological processing); and*

11.6 *Temporary storage of hazardous waste, (other than waste referred to in paragraph 11.5) pending any of the activities referred to in paragraph 11.2, 11.3, 11.5 or 11.7 with a total* *capacity exceeding 50 tonnes, other than temporary storage, pending collection, on the site where the waste is generated.*

1.2 Existing Site Layout

The existing site layout consists of the following infrastructure:

- Facility entrance, weighbridge, gatehouse (security) & staff car park;
- Waste to energy process building which includes (dimensions in L x W x H):
  - Waste tipping hall and waste bunker for solid waste acceptance and storage (tipping hall: 32m x 35m x 20m; bunker: 35m x 18m x 35m);
  - Furnace and boiler hall for waste treatment and recovery of energy (33m x 28m x 41m);
  - Steam-condensate area with associated steam turbine and electricity generator (18m x 28m x 41m);
  - Flue gas cleaning area and 65m high stack complete with emissions monitoring system (79m x 28m x 30m);
  - Bottom ash hall for metals removal and storage (45m x 28m x 12m);
  - Boiler ash and flue gas cleaning residue tanker loading area (11m x 6.5m x 12m);
  - Boiler ash and flue gas cleaning residue pre-treatment area (11m x 8.5m x 12m); and
  - Control room and office accommodation for Indaver staff (22m x 8m x 21m).
- Air-cooled condenser for re-circulating low pressure steam from the turbine as condensate to the steam-condensate system;
- 38kV import/export compound for electricity;
- 70m^3 mobile tank and associated aqueous waste unloading area;
- 44m^3 diesel fuel oil tank for fuelling the burners used for start-up and maintaining the minimum temperature of 850°C in the furnace when required; and
- 60m^3 Aqueous ammonia tank which is used for NO_x reduction in the flue gases.

In addition, the existing site includes the following infrastructure and support systems:

- Warehouse for spare parts and workshop for the mechanical maintenance team;
- Contractors' compound and Indaver modular site offices for ancillary Indaver staff;
- Overground Firefighting water/process water tank and associated firewater pumphouse;
- Stormwater drainage network and attenuation pond of 2,887m^3;
- Underground firewater/contaminated water retention tank of 300m^3;
- Sanitary effluent collection and treatment systems.

The existing site layout can be seen in Figure 1 below.

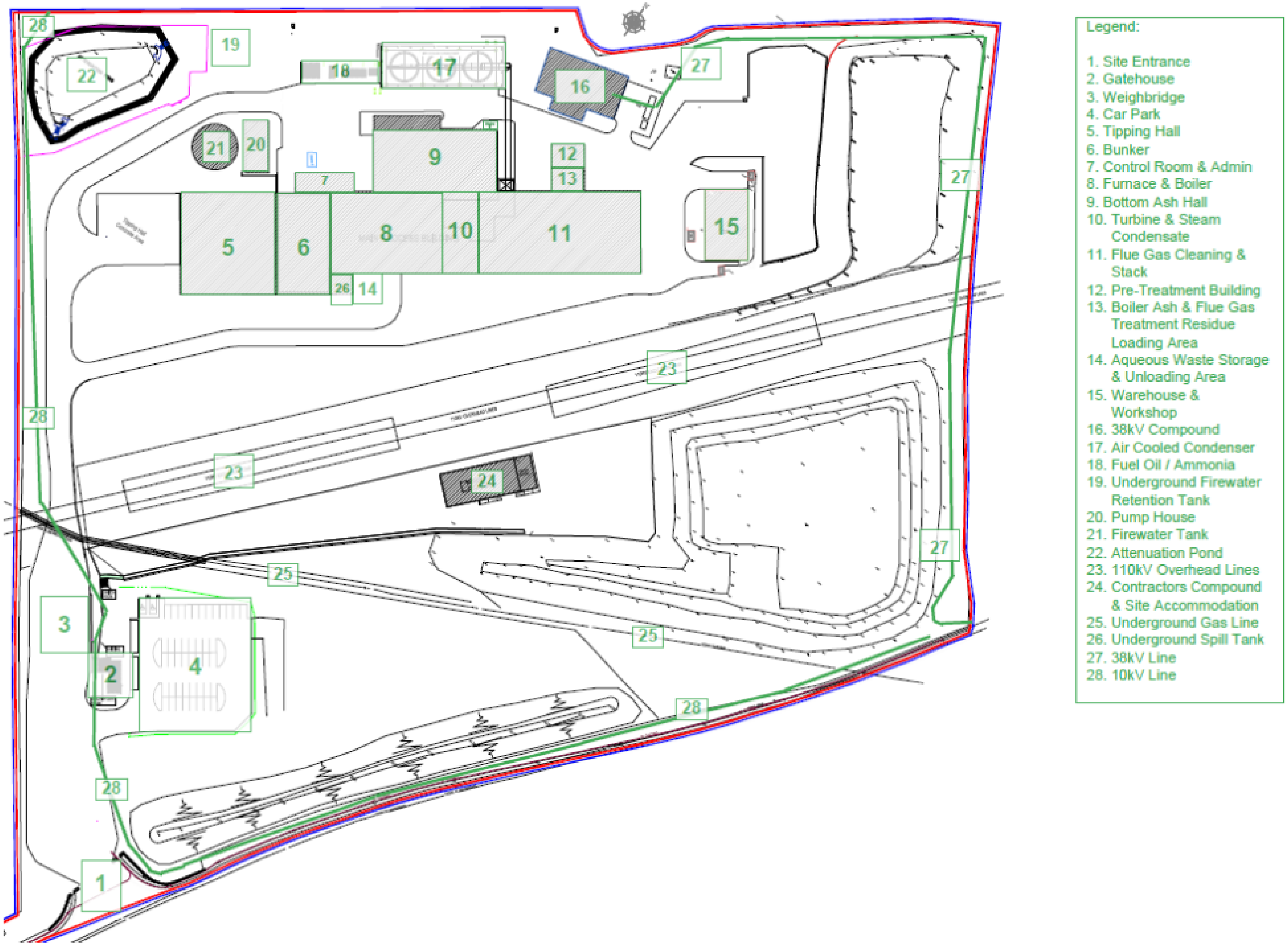

Figure 1 - Existing Indaver Site Layout. Not to scale

1.3 Proposed Site Layout

The proposed development will consist of the following main elements:

- Development of an aqueous waste tank farm and unloading area for the storage and processing of aqueous liquid wastes;
- Development of a $10MW_e$ hydrogen generation unit for connection to the natural gas distribution network, for mobile hydrogen transport applications and other potential uses;
- Development of a bottom ash storage building for the storage of up to 5,000 tonnes of bottom ash which is currently produced on site;
- Development of a warehouse, workshop and emergency response team (ERT)/office building to support existing maintenance activities on the site.
- Development of a new concrete yard and parking area for up to 10 trucks, tankers or containers on the site;
- Demolition and re-building of an existing single storey modular office building on site with a slightly increased footprint; and
- Other miscellaneous site upgrades.

Figure 2 shows the main elements of the proposed development.

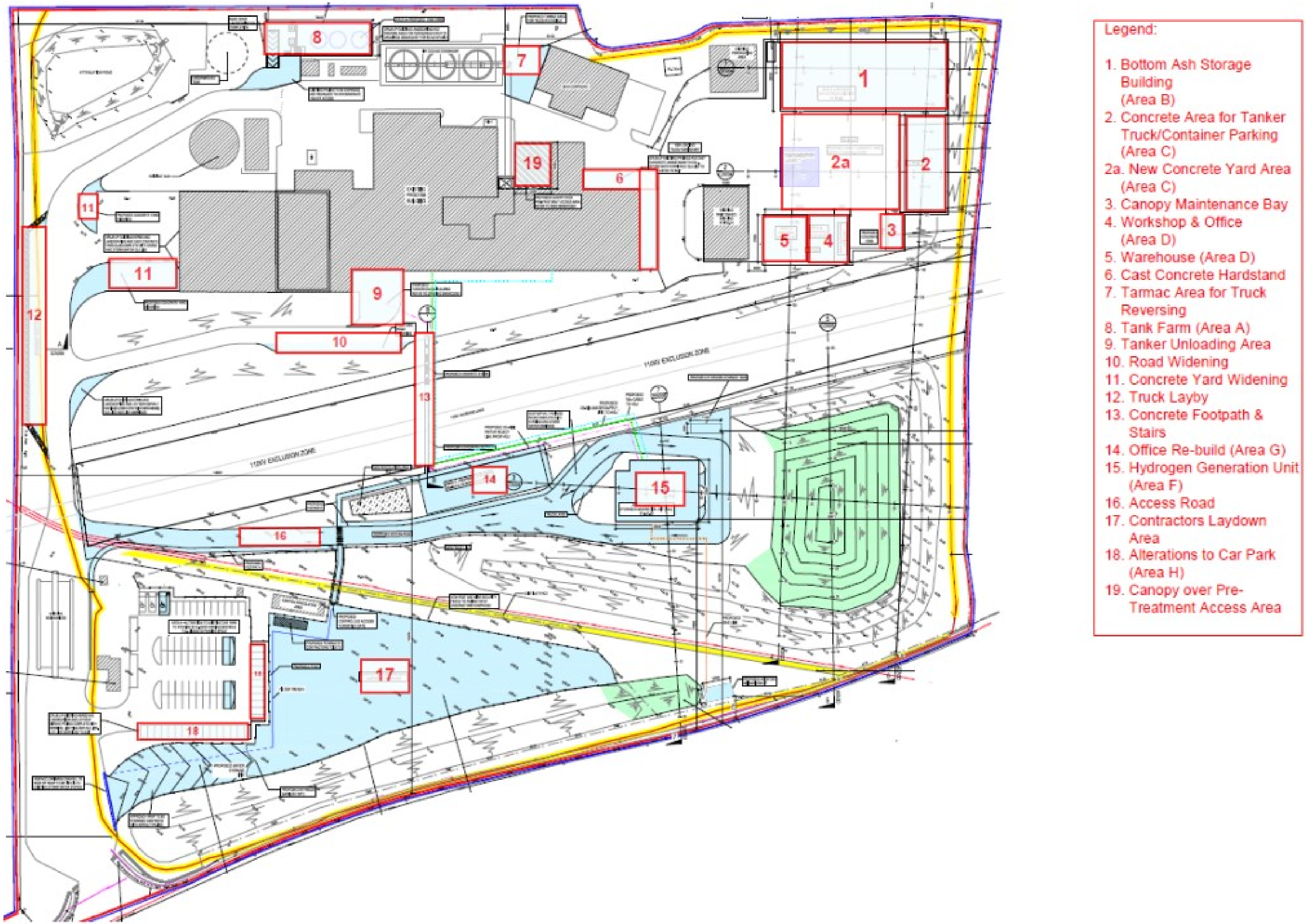

Figure 2 - Proposed Development on the site. Not to scale.

2. Unit Operations

2.1 Existing Unit Operations

Operational activities within the Indaver site can be described in two processes: (i) Waste to Energy Process and (ii) Flue Gas Cleaning Process.

2.2 Waste to Energy Process

The waste-to-energy process operates in compliance with an industrial emissions licence issued by the EPA (Industrial Emissions Licence Number: W0167-03). The facility accepts waste six days per week with the plant running 24 hours per day and for over 8,000 hours per annum.

Waste arriving at the facility is checked in at the gatehouse and passed over the weighbridge before being directed to the tipping hall (solid waste deliveries) or to the tanker unloading area (aqueous waste deliveries). Acceptance checks are performed at both acceptance points to ensure that the waste delivered meets the required specifications.

Solid waste is unloaded from trucks to the waste bunker from the tipping hall where two waste cranes mix the waste prior to feeding towards the waste hopper and feeding chute prior to introduction to the furnace. Bulk Aqueous wastes are unloaded to the temporary storage tank (70m^3 capacity) on site and either pumped from the tank or directly from an incoming tanker for treatment in the furnace.

Figure 3 and Figure 4 show the process of waste accepted at the facility.

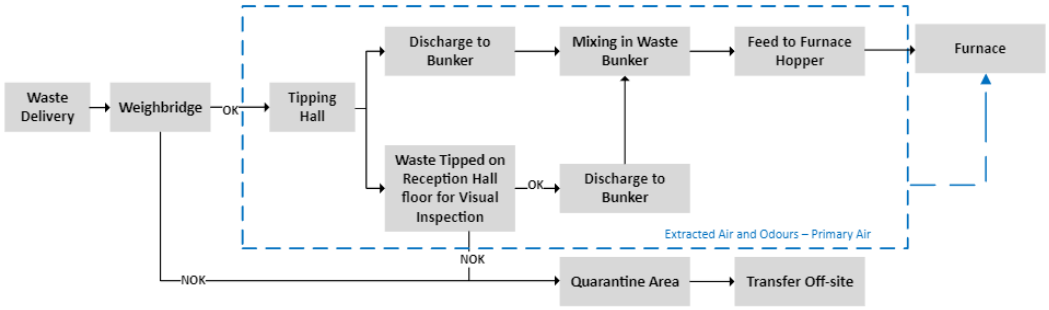

Figure 3 - Waste acceptance process

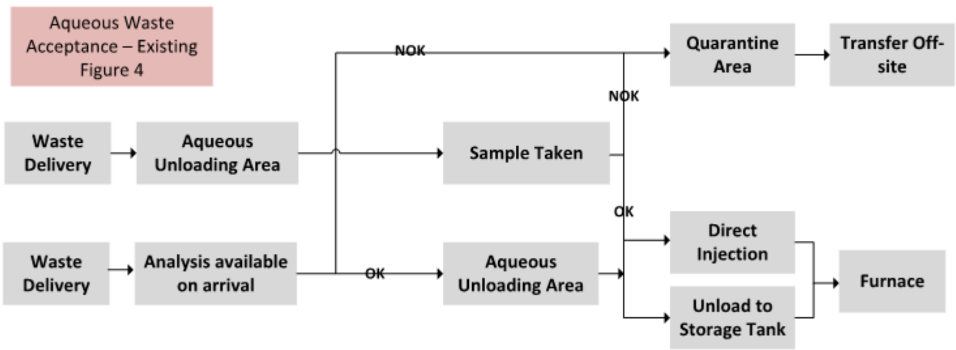

Figure 4 - Aqueous Waste Acceptance Process

Incoming waste to the facility is fed through to the moving grate furnace as shown in Figure **5**.

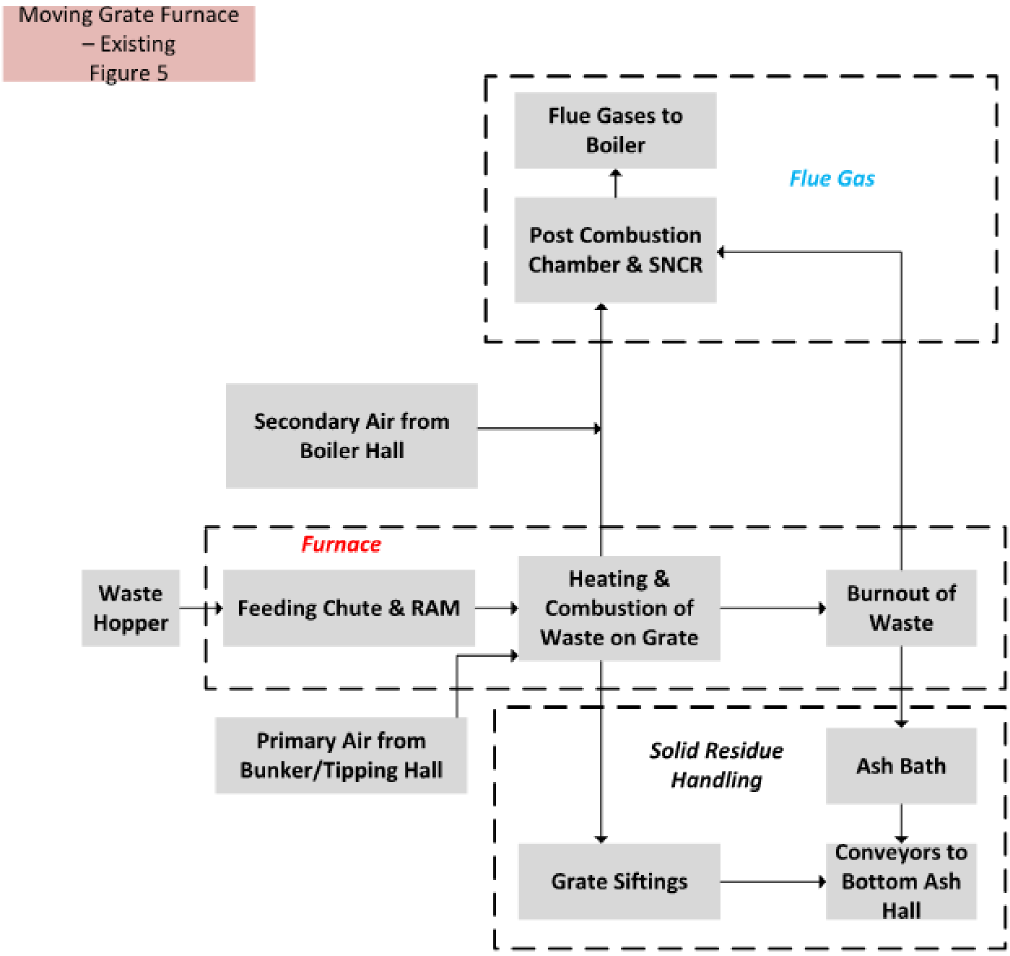

Figure 5 **- Schematic of moving grate furnace**

Energy is recovered from the resulting flue gases in the furnace using a conventional steam boiler. Figure **6** shows a schematic of boiler processes.

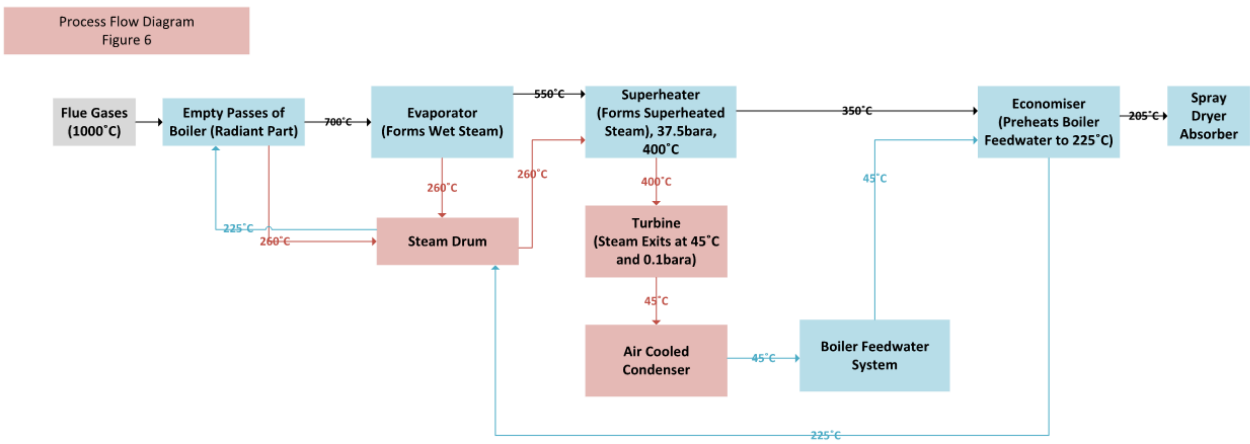

Figure 6 **- Schematic boiler processes**

The resulting steam is fed to a turbine and up to 21.5 megawatts of electricity (MW_e) is generated. Approximately 2.5 MW_e is consumed by the equipment in the plant and the other 19 MW_e is then available for export to the national grid, Figure **7** illustrates this in the form of a flowchart.

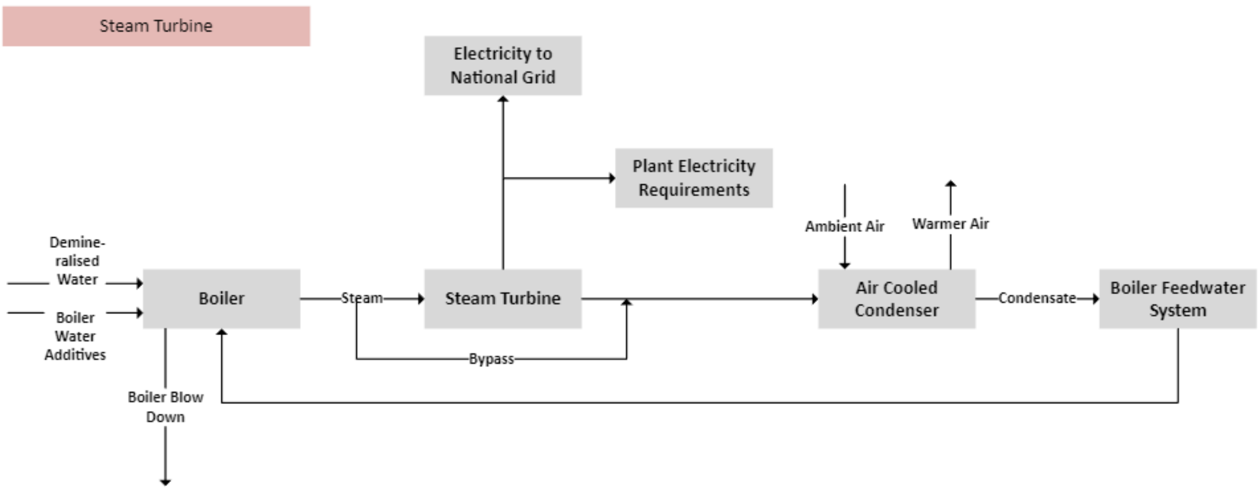

Figure 7 - Schematic of Steam Turbine

Reduction of the oxides of Nitrogen (NO_x) in the flue gases is achieved via injection of aqueous ammonia into the flue gases in the boiler in a process called selective non-catalytic reduction or SNCR. This process is shown is Figure 8.

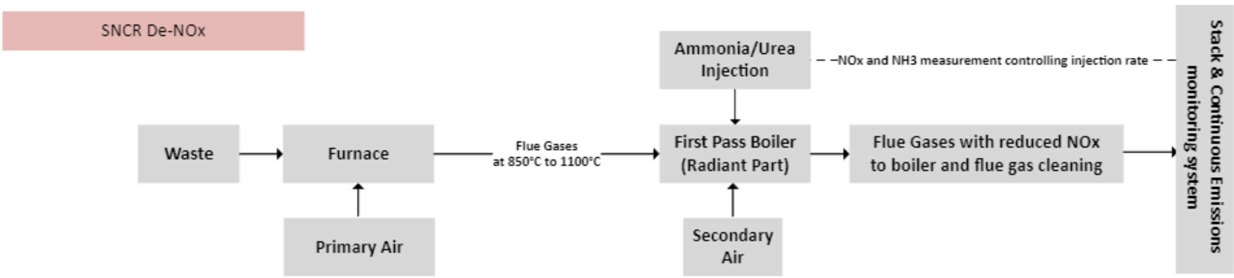

Figure 8 - SNCR De-NOx process

Bottom ash is produced as a residue of the combustion process in the furnace. Once extracted from the furnace via a water quench bath, the bottom ash is transported by conveyor to the bottom ash hall for metal recovery and storage. Ferrous and non-ferrous metals are recovered from the bottom ash using overband magnets and an eddy current separator. The metals and the residual bottom ash are stored in the bottom ash hall prior to sending off-site for recovery.

The bottom ash is sent to landfill for use as daily cover for the landfill cells and also for road construction on the landfill itself, Figure 9 below shows this process. Ferrous metals are sent for recovery in Ireland and non-ferrous metals are sent to mainland Europe for recovery.

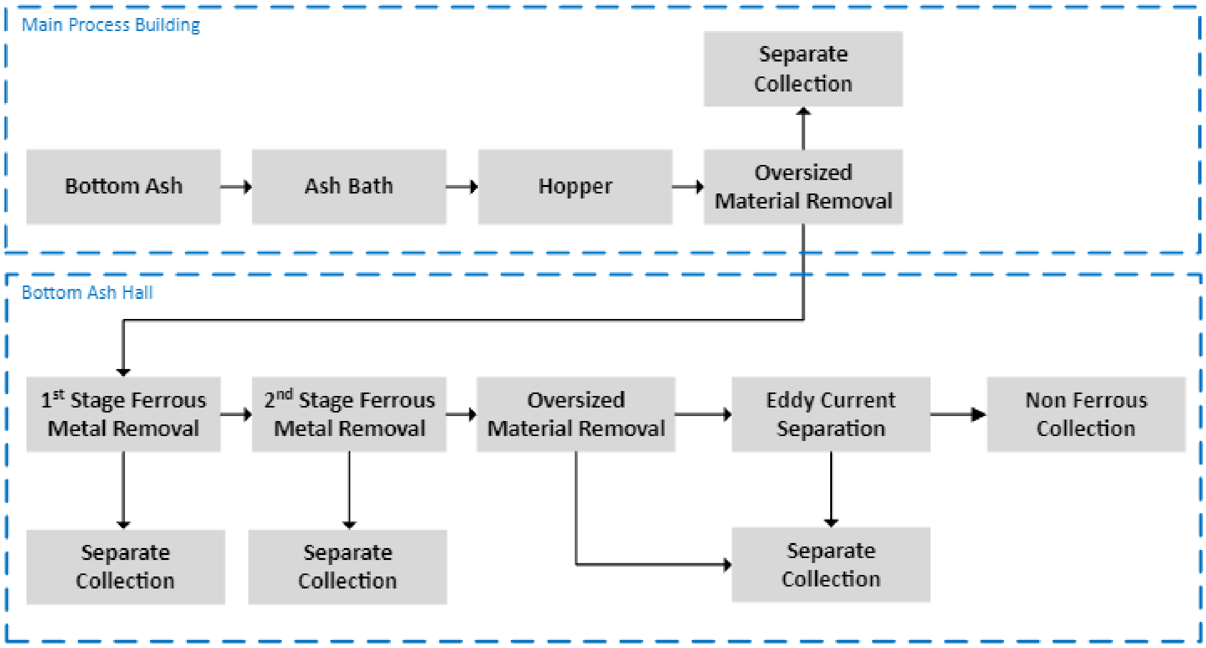

Figure 9 - Schematic of handling residues

2.3 Flue Gas Cleaning Process

After leaving the boiler, the flue gases must be cleaned before they can be discharged through the stack. This is done by the injection of lime and a mixture of activated carbon and expanded clay. Figure **10** shows a simple flowchart of the flue gas cleaning process.

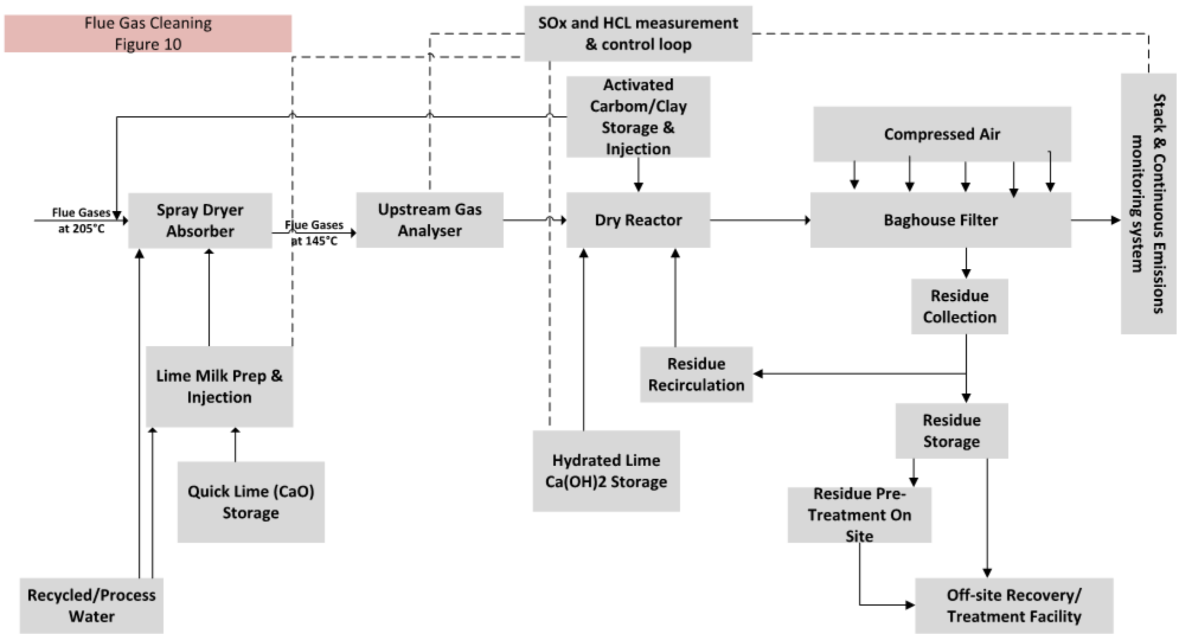

Figure 10 - Flue gas cleaning process flowchart

Lime is introduced to the process in two forms, as a slurry mixed with water and also in dry form to control the acid gas concentration in the flue gases to the levels required in the EPA licence for the site. Separate silos for the storage of quick lime and hydrated lime are provided in the flue gas cleaning part of the main process building.

A mixture of activated carbon and clay is used in the process to control the heavy metals and dioxins.

This is also stored in a silo in the same area as the lime silos. Additional water may be injected to control the temperature of the flue gases entering the baghouse filter. Water for use in the process is abstracted from a groundwater well on site and pumped to the combined firefighting water and process water tank, which is 2,185m^3 in capacity. The top 330m^3 of this tank is reserved for process water.

Residues are also created as a by-product of the flue gas cleaning process. Boiler ash is collected from the on-line cleaning of the boiler and flue gas cleaning residues are generated by the introduction of lime milk, dry lime, activated carbon and clay to clean the resultant flue gases. A baghouse filter is utilised to remove the carbon, clay and lime that has reacted to form the flue gas cleaning residues. The residues are trapped on the surface of the individual sleeves (approximately 2,000 sleeves in total) of the baghouse filter and collected in six hoppers underneath each of the six modules that comprise the baghouse filter unit. Compressed air is used to remove the residues from the sleeves and from the hoppers the residues are transported in enclosed conveyors to one of two residue silos (each of 210m^3 capacity). The residues are either discharged into road tankers for export to recovery at saltmines in Germany or are transferred by enclosed conveyors to the pre-treatment plant on site.

An overview of handling processes for boiler ash, and flue has cleaning residues is shown in Figure 11 and Figure 12 respectively.

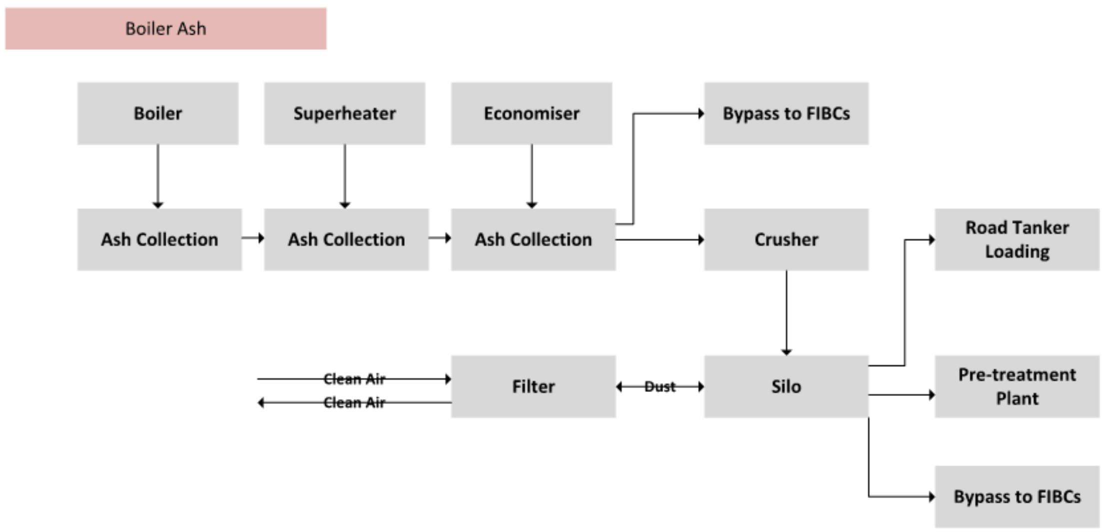

Figure 11 - Boiler Ash handling

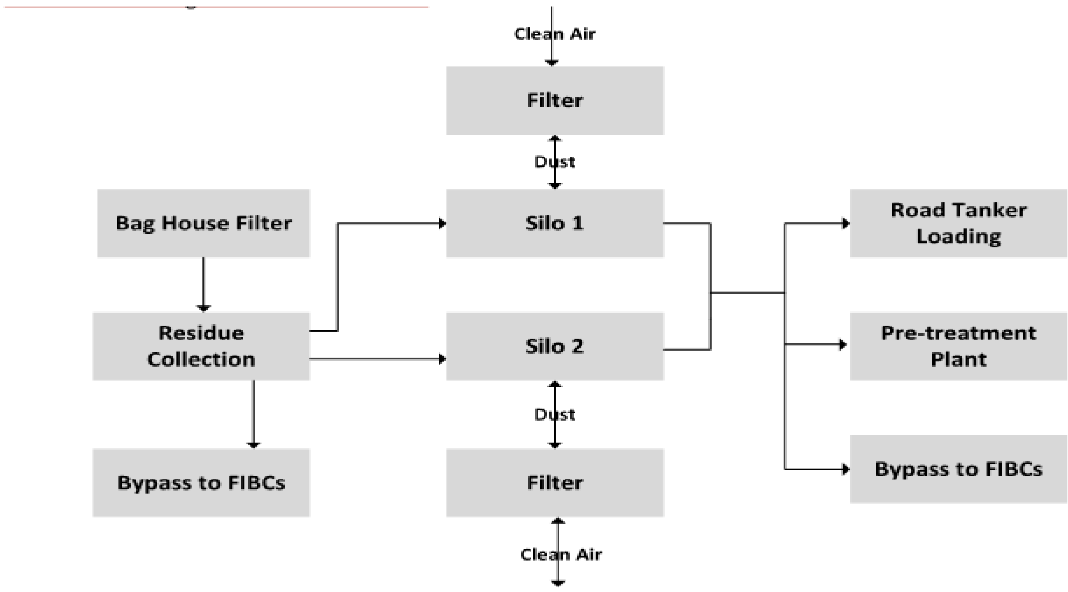

Figure 12 - Flue gas residues handling

At the pre-treatment plant, boiler ash and flue gas cleaning residues are mixed with water and discharged into 1m^3 flexible intermediate bulk container (FIBC) bags and subsequently sent to a saltmine in Northern Ireland for recovery.

The plant also has the facility to bag the flue gas cleaning residues in dry form in FIBC bags also for export for recovery off-site. The Pre-treatment process is shown in Figure 13.

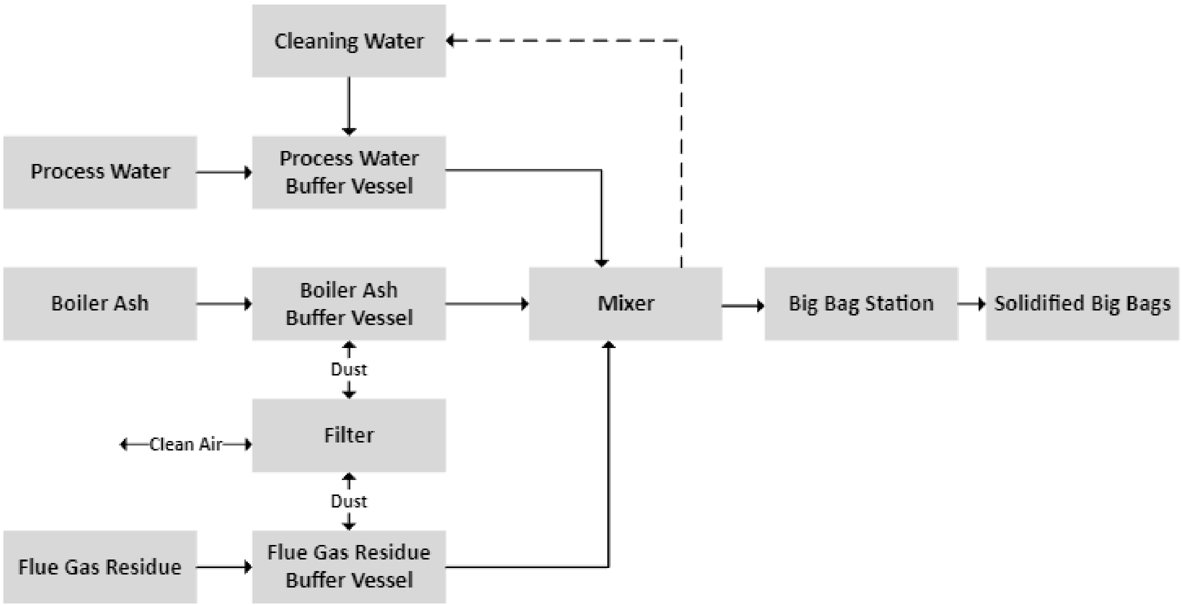

Figure 13 - Pre-Treatment of Residues

An overview of the complete waste to energy process can also be seen below in Figure 14**.**

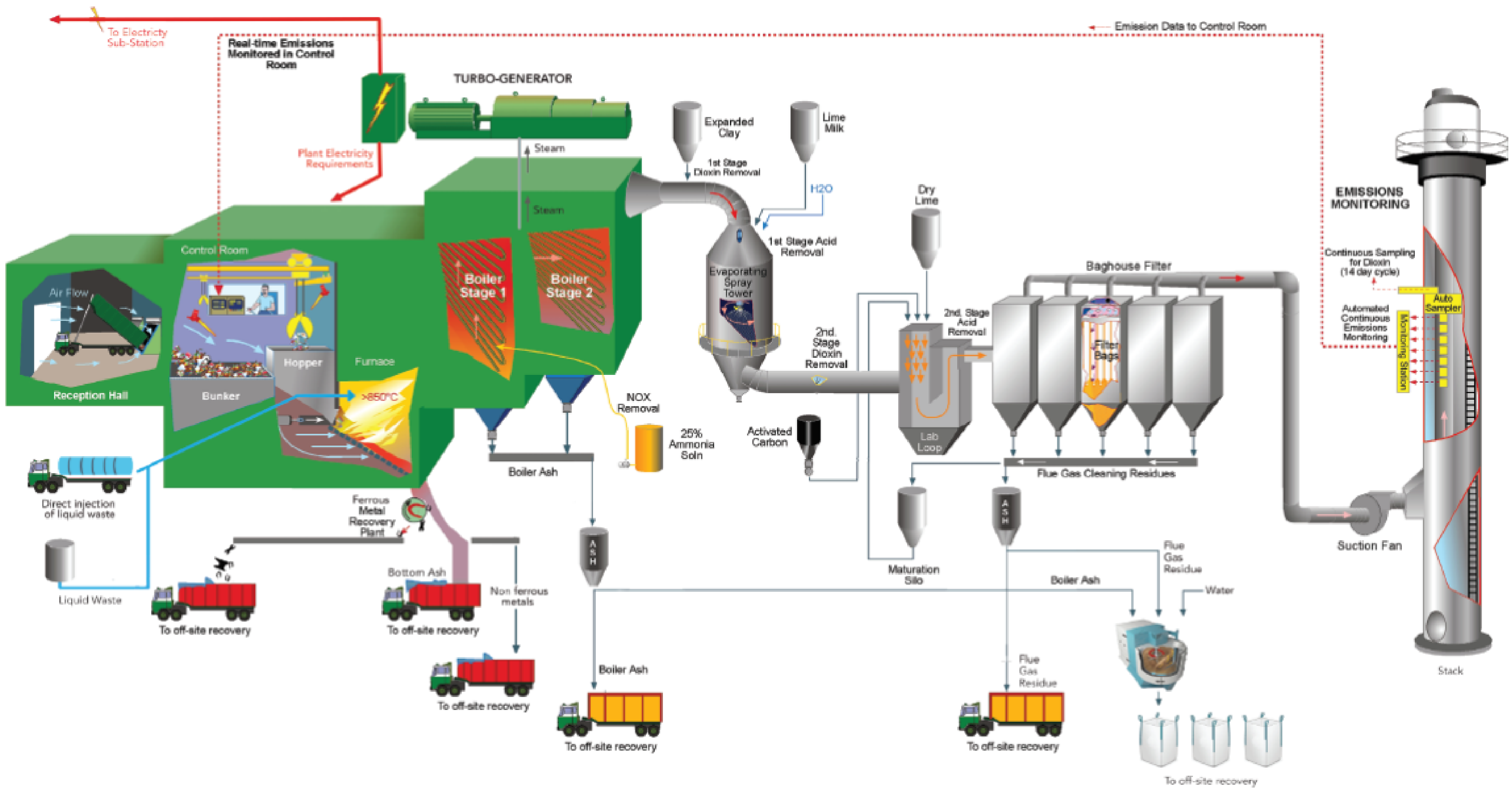

Figure 14 - Schematic of the waste to energy process

2.4 Proposed Unit Operations

The proposed unit operations will comprise the development of an aqueous waste tank farm and unloading area, a hydrogen generation unit, operation of a bottom ash storage building, increase in capacity at the pre-treatment facility, operation of a new warehouse, workshop and emergency response team (ERT)/office building, a new concrete yard and parking area, and re-building of an existing single storey modular office building. The elements of the proposed development outlined will tie in with existing unit operations outlined in the previous section.

2.4.1 Aqueous Waste Tank Farm & Unloading Area

It is proposed to develop a tank farm for the storage and processing of aqueous liquid wastes currently accepted at the facility. The tank farm will include three tanks, each with an operational capacity of 300m^3 which are up to 25.5m in height and 4.5m in diameter. Only two of these tanks will be dedicated to the acceptance and storage of aqueous hazardous waste.

One tank will be utilised for the storage of water during maintenance activities. There will be a further tank of 20m^3 operational capacity which will be used to ensure that any fine solids are constantly kept in suspension before being pumped to the furnace.

All tanks will be single walled and will have an additional jetting prevention shield where necessary. They will be fabricated from mild steel and contained within a concrete bund.

The bund will be approximately 29m by 11m in plan, with a bund wall height of a minimum of 1.2m. The north-facing bund wall will be 2.2m high. It will be designed to the required standards for watertightness and retention capacity. Figure 15 below outlines the layout of this area and the tanks within the bund.

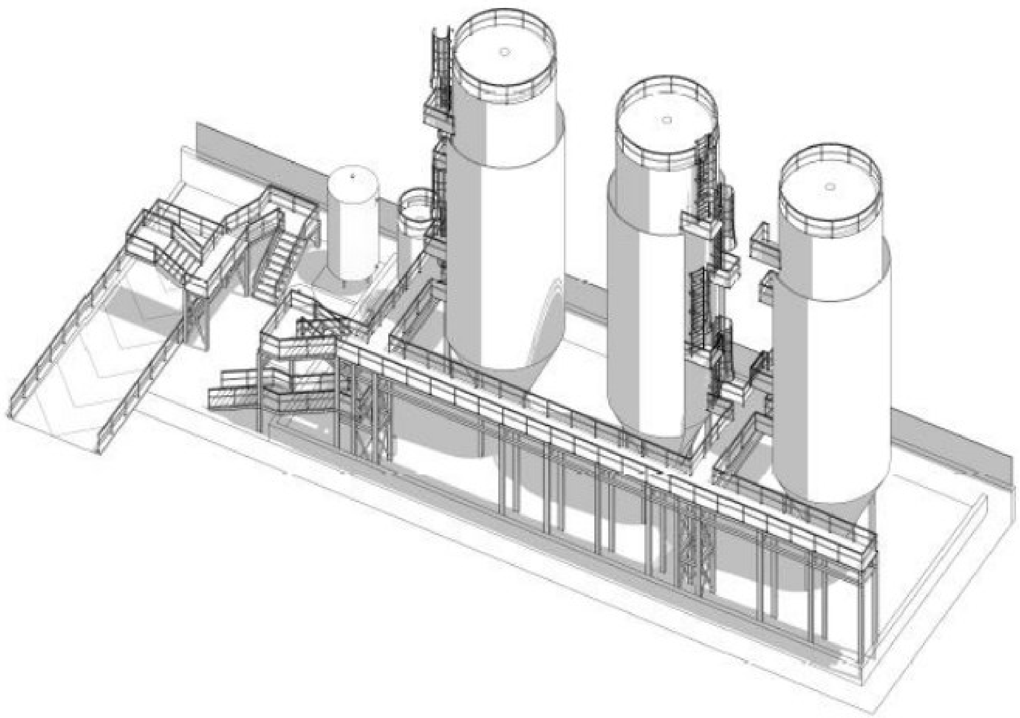

Figure 15 - Tank Farm and Bund

To cater for the possibility of any solvents being present in the aqueous wastes, the tanks will be equipped with a nitrogen blanketing facility to ensure an inert atmosphere in the head space of the tanks. Any possible off-gases and overpressure in the tanks will be vented to the furnace for incineration. A small, activated carbon unit will also be installed for times when the process building is in shutdown to prevent any emissions to atmosphere.

A pipe rack will be provided to link to the existing pipe rack servicing the aqueous ammonia and diesel fuel oil area to the proposed tank farm. Walkways and staircases will provide access in and out of the bund and for access to the tanks and loading area.

An upgrade to the existing tanker unloading area, located south of the main process building is also be undertaken. Such upgrade works will provide space for three tankers at a time for sampling and offloading operations. Containment for the full contents of a tanker (25m^3) will be provided in the event of a spillage. See the proposed layout of this area in Figure 16.

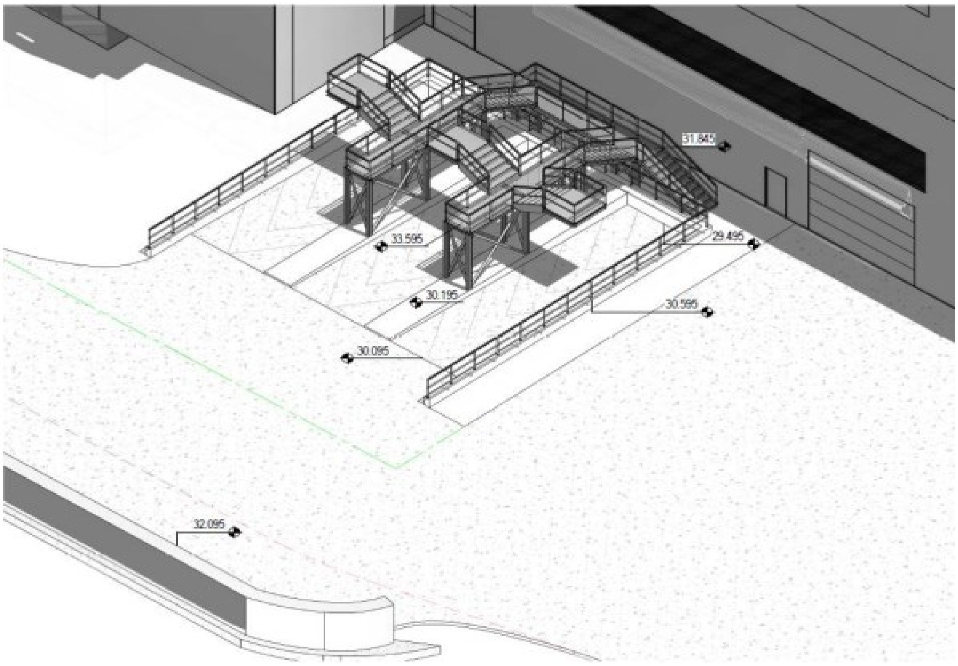

Figure 16 - Proposed Upgrade to Existing Tanker Unloading area

The area will be approximately 15m by 14m in plan and the height to the top of the gantry platforms will be 3.5m.

An additional gantry for accessing the top of tankers will also be provided so that any of the three tanker parking spaces can be safely accessed from above. A wider turning circle for tankers reversing into place will be provided by widening a section of the road to the south of unloading area.

Tankers containing aqueous waste will be directed to the unloading area after waste acceptance and initial weighing operation at the weighbridge. Operators in the tank farm will direct the driver to one of the three unloading bays.

Once in place, the operator will access the top of the tanker to take a sample, when required. The sample will then be analysed for conformity with certain key parameters such as calorific value, pH and chlorine content. This conformity check analysis ensures that the load is within specification. Compatibility testing will also be performed where required to ensure that there will be no adverse reaction with the contents of the tanks.

If the contents are not within specification, then arrangements will be made to send it off-site to an appropriately licensed facility. In this event, the tanker may remain in the unloading area until collected or shunted to the new contained parking area proposed for the northern corner of the site.

In communication with the control room, the operator will decide which of the two 300m^3 tanks to offload into, based on the available volume in the tanks.

Once the connections are made to the tanker, the operator will control the pumping operation locally until the tanker is empty. This takes approximately one hour.

Circulation loops in both 300m^3 tanks will ensure that the contents of the tank are well mixed prior to transfer to the 20m^3 feeding tank.

From the feeding tank the control panel operator in the control room will feed the waste to the furnace at an average rate of approximately 2 tonnes per hour (tph) and up to a maximum of 2.5 tph via two lances in the furnace. The pump will be located in a pump bund local to the tank farm and the line from the pump to the furnace will be carried on an existing overhead pipe rack from the tank farm to the main process building and from there to the furnace. The line will be supported from the structural steel frame of the main process building and on the inside of the building. The line to the furnace will be fully welded with no flanged connections. The same route will also be followed by the line connecting the head spaces of the tanks which will carry nitrogen/vapours from the tank farm for treatment in the furnace.

This transfer of nitrogen/vapours from the two 300m^3 tanks will occur when overpressure is experienced in the headspace of the tanks, either from temperature increases during the normal course of the day or when one or other of the tanks is being filled. When aqueous waste is being pumped out of the tanks, this will generate a slight under-pressure in the tanks and the nitrogen storage vessel adjacent to the tank farm will fill the head space to maintain a constant nitrogen blanket pressure of approximately 10 – 15 mbar.

The updated aqueous waste acceptance process is shown below in Figure 17 showing the additional nitrogen injected into the process.

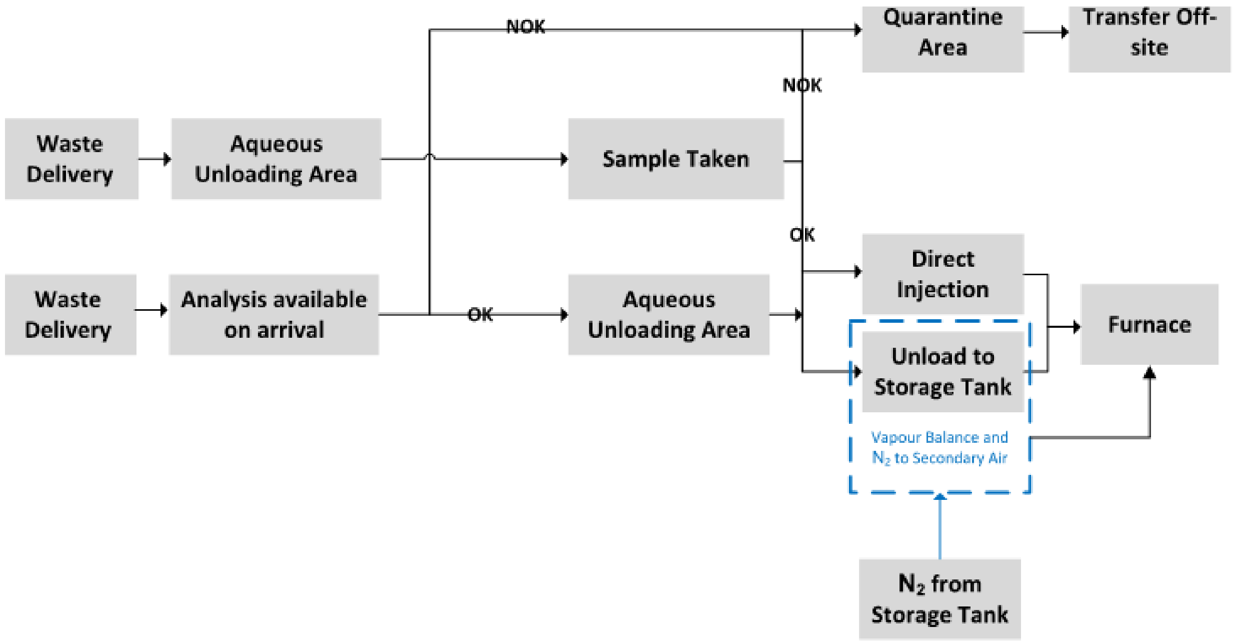

Figure 17 - Proposed Aqueous Acceptance Process

A facility for direct injection from the tanker off-loading area to the furnace will also be provided for certain dedicated waste streams or in the event that the tank farm is out of commission for inspection/maintenance. The direct injection process from a tanker will take approximately 12 hours to complete.

The updated moving grate furnace process with the inclusion of injection of aqueous wastes for the proposed tank farm is shown in Figure 18 below.

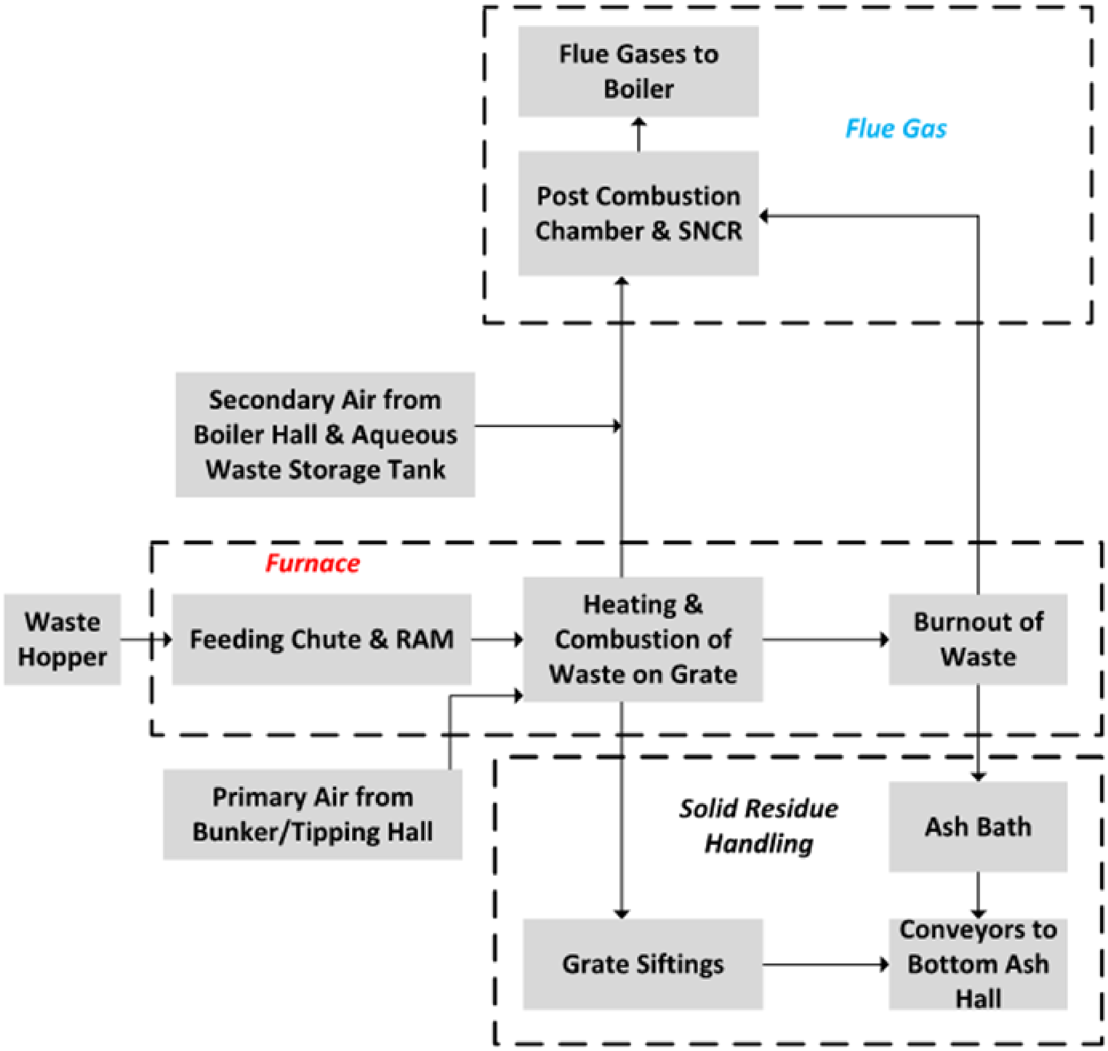

Figure 18 - Proposed Moving Grate Furnace Process

As is currently the case, the tanker unloading area will provide a contained drainage system, and stormwater collected in these areas will only be released into the main drainage network after local assessment confirms that there is no contamination present. The new tank farm will be contained within a bund to comply with standard EPA licence requirements and in line with BS 8007.

The feed rate from the tank farm to the furnace will be controlled in the central control room for the plant. The offloading from road tankers to the tank farm will be controlled locally by the operators in the unloading area. The level on each tank will be controlled using level transmitters and overfill protection will be provided via level switches and interlocks. Overpressure in the tanks is managed by forced ventilation to the secondary air system in the furnace. Pressure transmitters and over/under pressure venting devices will also be installed on each tank.

In the event of a build-up of a solvent top-layer in either of the tanks (which can be verified by samples taken from the tanks), both tanks will have the facility to drain off this solvent layer into a tanker which can park in the area adjacent to the nitrogen storage vessel. This tanker can then be sent off site for treatment when full. This loading area can be seen on the left-hand side of Figure 16. All operations associated with the proposed aqueous waste tank farm will tie in with existing processes illustrated in Section 2.2.

2.4.2 Hydrogen Generation Unit (HGU)

It is proposed to develop a 10MW$_e$ HGU for connection to the natural gas distribution network for mobile hydrogen transport and other potential applications.

The proposed HGU will be an alternative means of generating energy during times of curtailment for export to the national electricity grid.

On average, the existing facility is curtailed or prevented from exporting power generated from the steam turbine on site for approximately one thousand hours per year (or 12.5% of the operational time of the plant) due to lack of demand or excess wind generation capacity. As is currently the case, instead of "dumping" or destroying the steam generated from the combustion of waste over the steam turbine by-pass station and air-cooled condensers, it is proposed to generate electricity in the turbine and divert it to a hydrogen generation unit on site. The hydrogen generated can then be either fed into the natural gas grid or stored on site for fuelling trucks, buses and other transport vehicles that have been either designed or retrofitted to run on hydrogen fuel cells. Hydrogen can also be tankered off-site for industrial use or to fuel distribution centres. When used as a fuel, hydrogen combusts to produce water vapour and hence is a clean fuel.

The building housing the equipment will be approximately 33m by 25m in plan and 11m high at the roof ridge. A rendered view of the building can be seen in Figure 19.

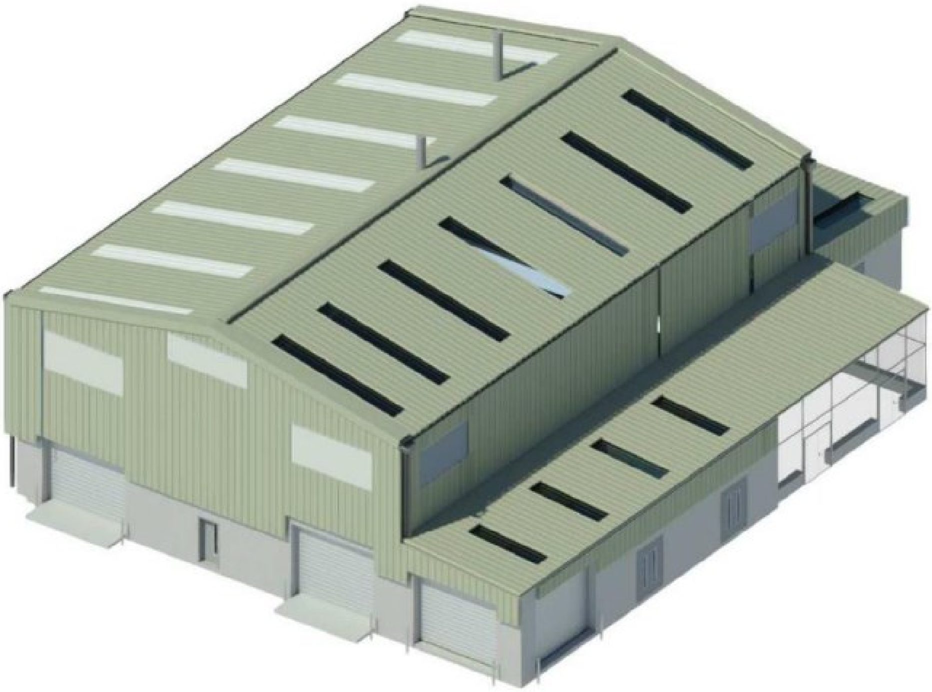

Figure 19 - Hydrogen Generation Unit

The process employed is alkaline water electrolysis which uses water as the feedstock in the presence of an alkaline solution (Potassium Hydroxide (KOH)) to generate hydrogen and oxygen. A schematic of the process is shown in Figure 20. In summary, electrical current is supplied to two electrodes which are submerged in an alkaline – water solution producing hydrogen at the cathode and oxygen at the anode. The oxygen and hydrogen sides of the cell are separated by a diaphragm. The layout of the equipment within the building is shown in Figure 21 and Figure 22.

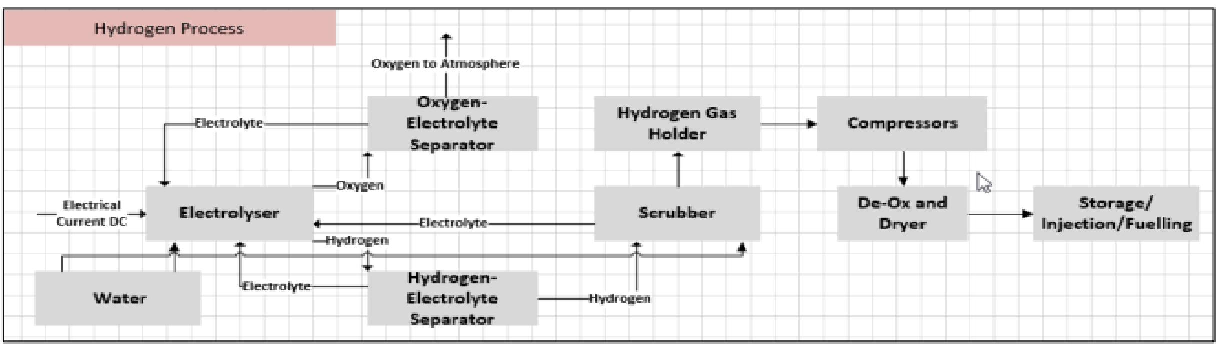

Figure 20 - Schematic of the alkaline water electrolysis process

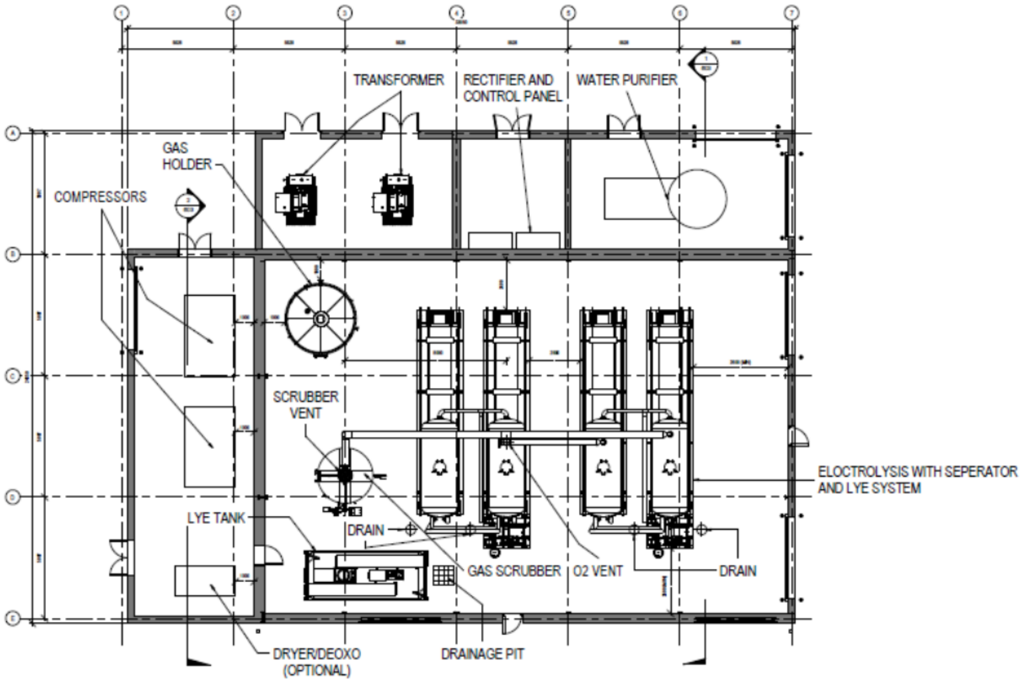

Figure 21 - Schematic of the layout of the Hydrogen Generation Unit building

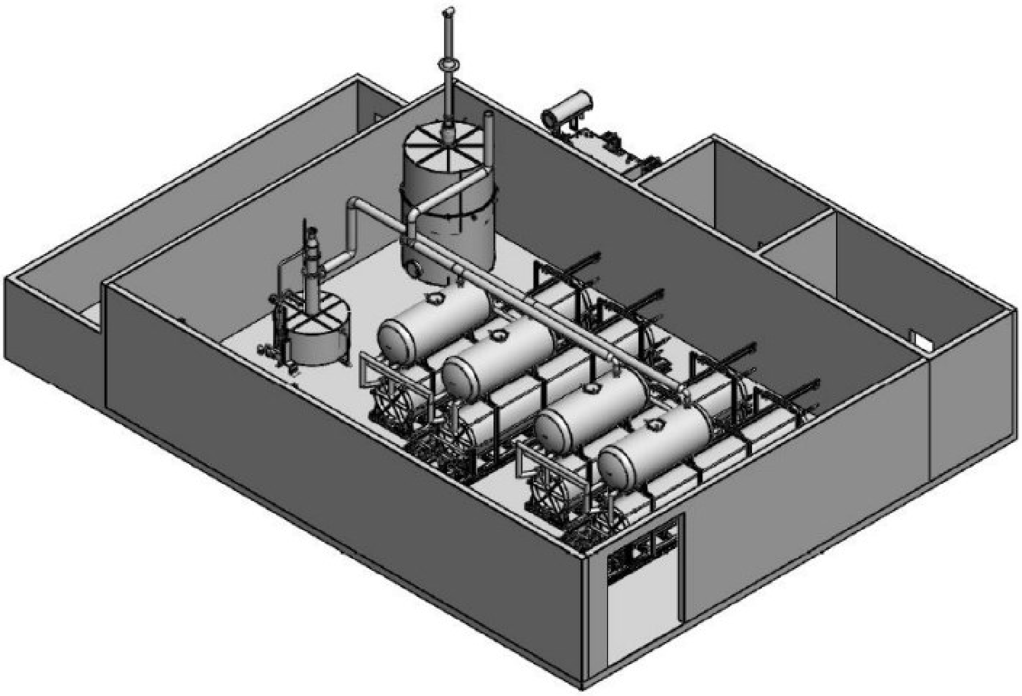

Figure 22 - Layout (3D view) of equipment inside the HGU

2.4.2.1 Electrolysis Unit

DC voltage is applied between the first and last electrode, thereby producing a current flow through the cells and gas is produced. The incoming AC supply from the main incomer is converted to DC via the rectifier unit. The gas from each cell is collected in the hydrogen and oxygen flow ducts which run in parallel along the top of each unit and are fed into the gas/electrolyte separators at the front of the electrolyser.

The oxygen separator discharges the oxygen to atmosphere through a small vent stack (approximately 2.1m high) in the roof at a rate of 1,934 Nm^3 /hr and the hydrogen separator sends the hydrogen to the water scrubber. The electrolyte from both separators is then recycled back into the distribution channels in the bottom of the electrolyser unit. The electrolyte is fed to this system from a $50m^3$ storage tank located in the main plant area. This tank will either be a double skinned tank or contained within a bund and the building. The separators are placed directly on top of the electrolyser units.

A series of four electrolyser units are proposed, all of which will be in the main plant area of the building. Each electrolyser has an electrical consumption of 2.5 MW_e and can produce a total of 1,930 Nm^3 /hr of hydrogen or just under 500 Nm^3 /hr of hydrogen per electrolyser unit. This equates to 1,930,000 Nm^3 or approximately 160 tonnes of hydrogen per annum, assuming that the unit runs for 1,000 hours per year.

Based on a calorific value of 130 MJ/kg for the produced hydrogen fuel, the overall efficiency of the process for the conversion of electrical energy into hydrogen is approximately 60%.

The system uses purified water as a feedstock with a consumption rate of 2.2 m^3 /hr.

Purified water will be supplied from the existing de-mineralised water system on site. In the event that the quality or supply is not suitable from the existing plant on site, a dedicated water purifier will be fed with process water from the existing plant. The water purifier unit, if required will be located in the northernmost corner of the building.

2.4.2.2 Scrubber Unit

Water is also used in the scrubber unit after the hydrogen/electrolyte separator. The scrubber design provides efficient removal of residual KOH droplets from the hydrogen gas to protect downstream equipment from alkali deposits and corrosion. The scrubber is a conventional, packed column type with counter flow scrubbing of the gas. The unit has a water reservoir at the bottom, the packed bed in the middle and a demister at the top. The gas enters under the packed bed and leaves through the demister located at the top of the packing column. The scrubbing water is sprayed evenly on to the top of the packed bed, collected in the bottom reservoir, and circulated back to the top by the scrubber water circulation pump. A heat exchanger is integrated in the circulation loop to cool the gas. Make-up water intake is directly into the bottom water basin.

The scrubber is made from carbon steel and provided with connections for make-up water inlet; drain; flowmeter; level switches and a differential pressure gauge.

The scrubber basin also acts as the feed water reservoir for the electrolyser and since the electrolyser is topped up with feed water from the scrubber basin, recovery of KOH from the gas is ensured.

There is one level transmitter on the scrubber basin to maintain the level in the basin and to provide alarms if the level goes below normal operating range.

2.4.2.3 Gas Holder

The hydrogen from the scrubber passes next into the gas holder which is a $50m^3$ wet, floating-bell type with a central coaxial sliding guide equipped with low friction material. A water seal is fitted immediately downstream of the gas holder and acts as a condensate drain.

The volume of the gas holder is designed to accommodate the approximate equivalent of the maximum volume of hydrogen produced by the electrolyser in 2-3 minutes. If the gas holder should overfill, the hydrogen will automatically be safely vented to atmosphere.

There is one level transmitter and one level switch which monitor how full the gas holder is. The signal from the level transmitter will be used to steer the rectifier current to increase/decrease hydrogen production to maintain the gas holder level at the chosen set point. In addition, the level transmitter is used to provide service alarms (high & low level) and trip alarms (such as HH=rectifier to zero (min)) when the gas holder level reaches various alarm set-points.

2.4.2.4 Compressor

Finally, a compressor is used to compress the hydrogen gas from the gas holder pressure of 0.02 bar up to the pressure required in the on-site storage tank for mobile hydrogen of 350 bar or to supply the above ground installation (AGI) feeding into the natural gas distribution pipeline which is located between the south-eastern site boundary and the R152 regional road. The storage tank is located on the north side of the hydrogen building and will be a horizontal, cylindrical tank of approximately 100m^3 capacity. This tank will be capable of storing up to 2 tonnes of hydrogen at a pressure of 350 bar. The AGI for feeding into the natural gas pipeline will be located to the south of the hydrogen building near the south-eastern site boundary. The AGI will be fenced off with restricted access for authorised personnel only.

The compressor will be fitted with a gas recycle loop which returns some of the hydrogen from the compressor outlet back to the inlet side of the compressor (through the inlet side of the scrubber and gas holder). The hydrogen gas recycle volume is automatically adjusted by a control valve in the gas recycle loop and based on a signal from the level instrument installed on the gas holder.

When the hydrogen gas production rate increases, the gas holder bell will tend to rise and the recycle control valve will close. When the hydrogen volume in the gas holder decreases, the recycle control valve increases the recycle flow, returning some of the hydrogen back to the gas holder.

2.4.2.5 De-Oxidiser & Dryer

Depending on the quality of hydrogen required, a final polishing step may be installed where any residual oxygen or water is reduced to an absolute minimum. Without the polishing step the purity of hydrogen produced is 99% and when installed qualities of 99.99% can be achieved.

The inlet gas to the deoxidiser is saturated and as moisture inhibits the functioning of the catalyst, the gas is electrically pre-heated to a temperature well above dew point. When the deoxidiser reaches the operating temperature, the heater is switched off.

Temperature rise across the deoxidiser gives an accurate measurement of the oxygen content in the hydrogen gas and in case of a high temperature on the outlet of the deoxidiser, which indicates high oxygen content in the hydrogen; the whole plant is automatically shut down.

There are two temperature transmitters on the deoxidiser pre-heater; one to control the temperature, and one to provide high (H) and high-high (HH) temperature alarm functions.

The pre-heated hydrogen then enters the catalytic deoxidiser column. This contains a palladium catalyst which promotes the reaction of hydrogen with residual oxygen in the gas stream. The reaction is exothermic, producing a temperature rise in the gas. There is also a temperature transmitter on the deoxidiser outlet. The increase in temperature from the pre-heater inlet to the deoxidiser outlet is used to calculate the initial oxygen content of the gas. If it is found to be higher than 1% the plant is brought to a stop by an interlock.

The gas is then dried in a twin tower gas dryer where the gas is passed over a bed of water vapour adsorbent. The adsorbent has a limited water adsorption capacity and consequently a twin tower dryer is used. As one tower is drying the gas, the other tower is regenerated.

Drying of the adsorbent is carried out by a small flow of dried gas which is heated by an electric heater. On completion of the regeneration period, the adsorbent is allowed to cool before the regenerated tower is switched back to gas drying mode. The regeneration sequencing and the valve operation of the dryer unit is automatically controlled, and a complete cycle takes approximately 6 hours giving very little wear on valves etc. There is no loss of product gas during the regeneration cycle as the gas used for regeneration is re-circulated internally in the dryer.

2.4.2.6 *Mobile Hydrogen Storage & Transfer*

Hydrogen will be stored for re-fuelling of buses, and HGVs or for bulk transport off-site to fuelling stations. The storage tank will be 100m^3 in capacity and will be horizontal, cylindrical and with dished ends. Normal operating pressure in the tank will be 350 bar and this tank will be capable of storing up to a maximum of 2 tonnes of hydrogen. The tank will be located to the north of the hydrogen building.

A concrete-surfaced re-fuelling area at the western end of the hydrogen unit will be provided to facilitate fuelling of truck, buses and bulk hydrogen transport tankers. This area will be equipped with a pressure reducing station, hoses and connections for fuelling of trucks and buses and with a separate set of hoses and connections for filling high pressure bulk hydrogen transport tankers.

2.4.3 Bottom Ash Storage Building

It is proposed to develop a bottom ash storage building for the storage of up to 5,000 tonnes of bottom ash which is produced on site. Storage of bottom ash on site will be less than 6 months This facility will provide the flexibility to export bottom ash to continental Europe for recovery in the event that there are no bottom ash recycling plants developed in the next five to ten years. It will have the capacity to store up to 5,000 tonnes of bottom ash at a time and can facilitate the export of all of the ash produced in approximately 12 shipments per year out of the Port of Drogheda.

The bottom ash storage building, which will be located in the north-western corner of the site, will be approximately 61m by 25m in plan with a single sloped roof of 14.5m high to accommodate tipping trucks at the highest point to 10m in height at the back of the building. A large concrete yard area to the south-east of the building is also proposed (approximately 55m by 35m in plan) which will allow for circulation of trucks transporting ash to and from the building, access for trucks to the contained parking area and for deliveries to the new warehouse located to the south-east. There are four entrances provided for truck access to the building from the concrete yard area along the length of the front of the building. Inside, on three sides, a reinforced concrete wall to a height of 6m will provide strength and containment for the bottom ash stored. The maximum storage capacity of the building for bottom ash will be approximately 5,000 tonnes. Figure 23 shows the appearance of the building.

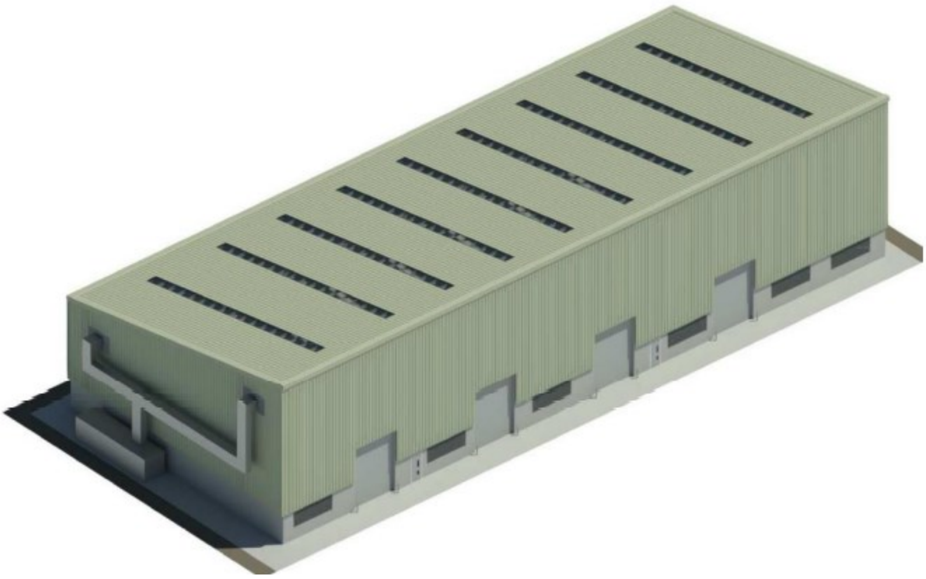

Figure 23 - Bottom Ash Storage Building

Trucks carrying the bottom ash from the ash hall on site will reverse into one of the four doorways and tip the ash onto the concrete floor of the storage building.

A front loader will then move the ash into the ash pile and clear the tipping area for the next truck to arrive. This process will be repeated until the area is full.

Bottom ash shall be stored at dedicated areas within the ash handling building and tipping hall, on concrete hardstanding with contained drainage or other buildings agreed by the agency.

When an export shipment is planned, trucks will be loaded by the loading shovel and sent off site to Drogheda Port where a vessel will be loaded with approximately 3,000 tonnes of bottom ash over a two- or three-day period. All trucks leaving the site for the port will be weighed on the weighbridge. When there are no truck movements in or out of the building, the four access doors will remain shut.

Although the bottom ash is wet when extracted from the furnace, storage of this material for periods of weeks or months will result in the remaining water evaporating, i.e., drying.

Therefore, the entire building will be ventilated by air extraction through a particle filtration system at the southern end and outside the building. Fresh air will enter through vents at the northern end of the building and will be extracted via ducting on the southern end as shown in Figure 23. Any residual water from the storage of the wet bottom ash will remain on the concrete floor of the storage building where it will be contained until evaporated.

This building may also be used for annual waste surveys and detailed waste audits and inspections on incoming deliveries. Waste surveys involve the sampling and sorting of municipal waste and are carried out over a 3 – 5-day period. Detailed inspections may be carried out during an intensified period (1 – 2 weeks) of audits for conformity with incoming municipal waste deliveries. This activity involves tipping a waste load onto the ground and checking for oversized material or nonconforming waste prior to re-loading the truck with a loading shovel or telescopic forklift.

2.4.4 Residue Acceptance & Storage for Pre-Treatment

It is proposed to increase the capacity of the existing ash pre-treatment facility (for the acceptance of third-party boiler ash and flue gas cleaning residues) by 30,000 tonnes per annum. The additional infrastructure proposed for the acceptance of this material and other similar residues from other thermal treatment plants on the island of Ireland will comprise three silos housed within the main process building and an unloading area for tankers delivering this material outside the main process building. The residues will then be processed in the existing pre-treatment plant on site for export for recovery to a salt mine in Northern Ireland.

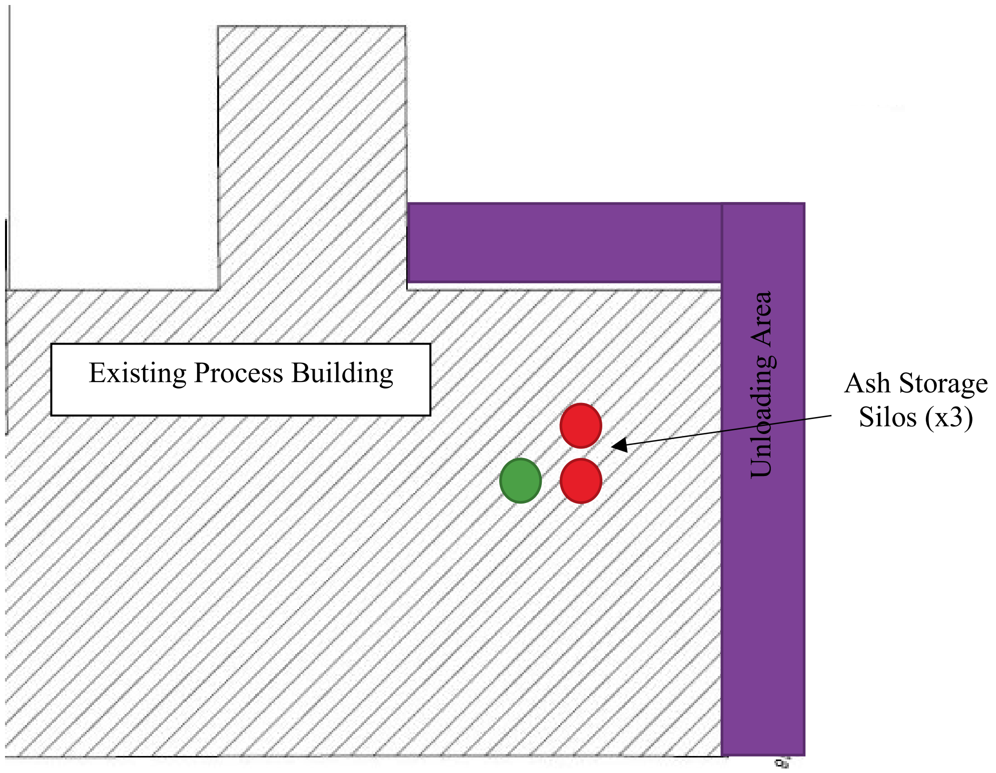

Figure 24 – Unloading area (outside building) and ash storage silos located within the Process Building

Boiler ash (BA), flue gas cleaning residues (FGCR) and similar residues from thermal treatment processes (e.g. kiln dust if available in the market) will be accepted and unloaded to one of three new silos located within the process building. Two silos will be dedicated for FGCR acceptance (approx. 200m^3 each) and one for BA and other residues (approx. 100m^3). The ash will be delivered in enclosed tankers and offloaded to the silos pneumatically. The same method is currently used for unloading consumables. Filtration systems on the silos will control dust emissions during the unloading operation. A new concrete area (300m^2 approx.) will be provided for these unloading operations at the north-eastern end of the main process building.

From the silos, the residues will be transported in enclosed conveyors to the pre-treatment plant and mixed with water in specific proportions in the pre-treatment plant.

Once mixed, the cement-like product will be discharged into 1m^3 flexible intermediate bulk container (FIBC) bags. The bags will then be sent to a salt mine in Carrickfergus, Northern Ireland for recovery (Permit No. P0547/16A).

Proposed third party ash acceptance and pre-treatment processes are illustrated in Figure 25 and Figure 26 respectively.

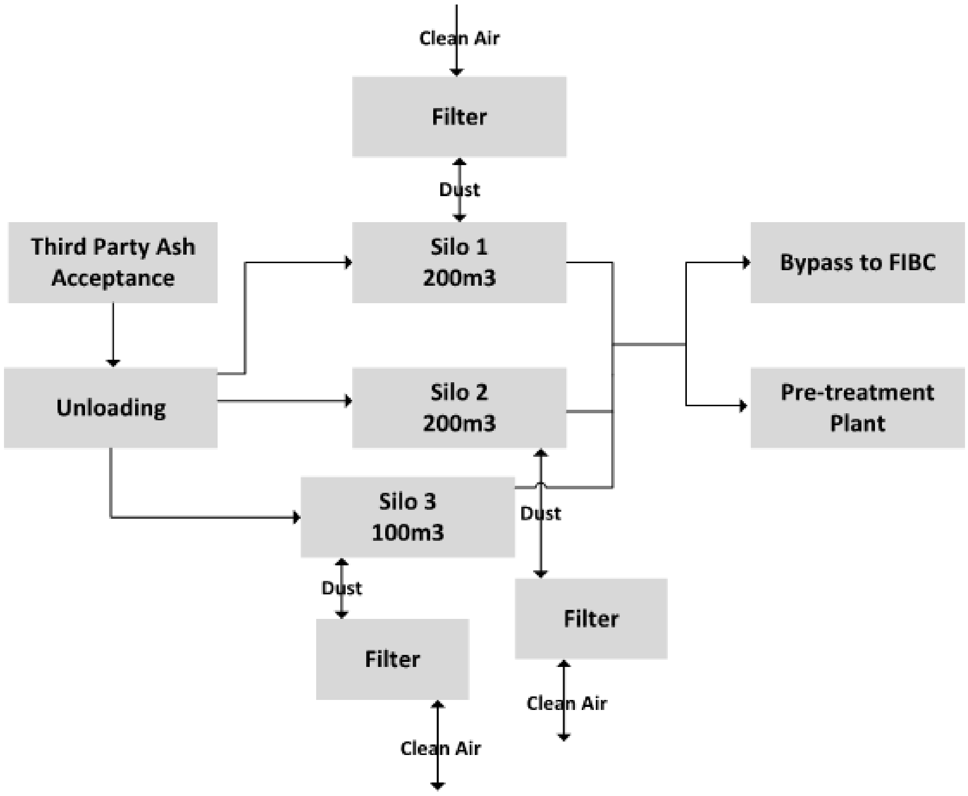

Figure 25 - Third Party Ash Acceptance Process

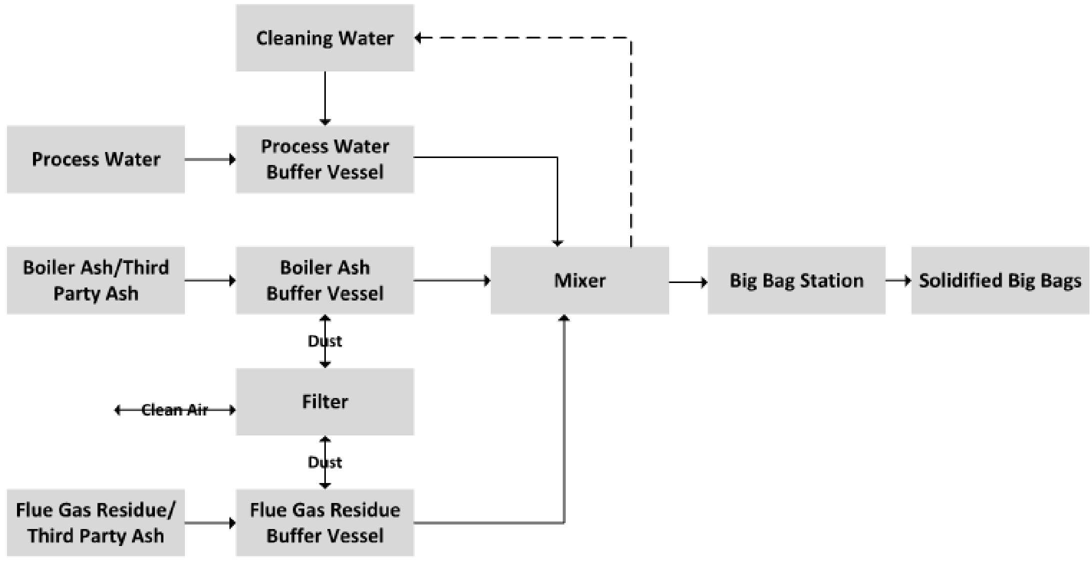

Figure 26 - Proposed Pre-Treatment Process

2.4.5 Warehouse, Workshop & Office/ERT Building

It is proposed that the existing warehouse and workshop building on site will be re-purposed and the warehousing and workshop functions will be re-located to a new two storey building which will also include additional office accommodation for staff on site, Emergency Response Team (ERT) equipment and staff facilities including changing area, toilets and showers.

The building will be split into three separate areas to accommodate the warehouse, workshop and office/ERT functions. The warehouse will comprise a goods-in and -out area, a small office for the warehouse technician and racking/storage spaces for spare parts associated with the operation and maintenance of the entire facility. This area will be approximately 15m by 17m in plan and 10m high.

The workshop is dedicated to the mechanical maintenance team and will house welding equipment, grinders, cutting equipment for use on work benches or in a welding booth all located on the ground floor. A mezzanine office area will be provided for the mechanical maintenance team leader and staff. This part of the building will be approximately 10m by 17m in plan and 10m high.

The ERT area, showers/locker area and the plant room will be on the ground floor.

2.4.6 New concrete yard area and container/trailer/tanker parking area

This proposed area (approximately 70m x 36m) is to facilitate access and vehicular movements in and out of the bottom ash storage building and for deliveries to the warehouse. The yard area will be of a reinforced concrete construction.

Part of this concrete area (approximately 15m x 35m) will be a dedicated spill control zone for the parking of containers, trailers and tankers associated with aqueous waste deliveries and the transport of residues in containers and pre-treated residues in trailers off-site. The design of the concrete will facilitate double stacking of shipping containers if required.

2.4.7 Modular Office Re-construction & Car Park Extension

It is proposed to demolish and re-build an existing single storey modular office building on site with a new permanent single storey office and staff welfare building. This new building will have a slightly increased footprint in place of the old building, and it will accommodate a total of 23 staff (one additional to that already accommodated) and provide a wellness centre, locker room, canteen and meeting facilities.

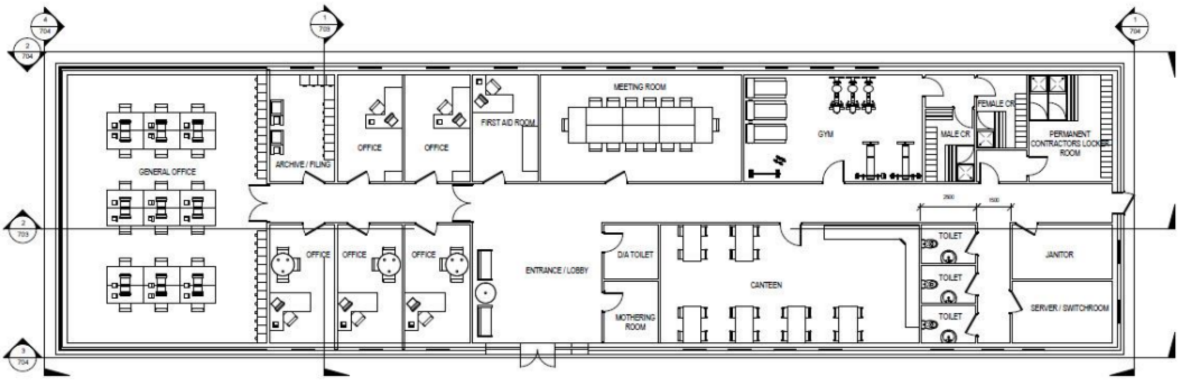

Figure 27 - Proposed office layout

3. Process Control System

3.1 Existing Process Control System

Continuous sampling and monitoring of the flue gases is performed to give real time information to the operators of the plant on the performance of the flue gas cleaning systems relative to the emission limit values specified in the IE licence. The dosing rate of the re-agents is controlled automatically by the plant's computerised control system.

The facility is controlled by an interface computer system (screens, keyboard, and printers) from the Control Room. The system monitors all the parameters and measurements required in order to have a good overview of facility performance. It executes facility control loops, reports low-level and high-level alarms and controls different levels of safety interlocking.

The control room is located above the bunker. From here crane operators can visually inspect the waste and, using a grab and automated transfer system, control waste entering the furnaces from the bunker.

The facility's distributed control system (DCS) is controlled and monitored from the control room. Emissions data from the emissions monitoring station located on the stack and other monitoring locations are also be monitored here.

There are certain conditions that will trigger a plant shutdown. In short, when the corrective actions of the control system and the plant operators cannot keep a required parameter or set of parameters within the appropriate range, a plant shutdown sequence will be initiated. The sequence can be triggered automatically by the control system itself or by a plant operator.

The sequence follows a set of logical steps to stop:

- Stop waste feeding
- Bring on diesel fuel oil burners to maintain minimum temperature of 850°C for as long as there is waste burning on the grate
- Maintain flue gas cleaning systems and ID fan
- Switch off burners
- When flue gases have reached approximately 60°C in the stack, then the flue gas cleaning systems and ID fan can be switched off.

The same sequence is followed when bringing the plant to a stop for annual planned maintenance outages.

3.2 Proposed Process Control System

Once established, the individual units associated with the proposed development will connect into the distributed control system and will be controlled and monitored from the Control Room.

4. Emissions from Site

4.1 Existing Emissions from Site

The IE licence requires monitoring of the following classes of emissions:

- Storm water
- Wastewater
- Air
- Groundwater
- Noise.

4.1.1 Storm water

Storm water is rainwater run-off from roof and non-process areas of a facility, e.g., carparks, and generally will not contain any pollution. Storm water is usually released into a local water body (a drainage ditch which joins to a tributary of the river Nanny). The IE licence requires that storm water is managed to ensure no polluting substances or materials are released into the environment.

Rainwater that falls on the site is channelled into an attenuation pond. It is analysed by an automated analyser at the inlet chamber for compliance with trigger levels for pH, conductivity and Total Organic Carbon (TOC) prior to entering the pond. No water can enter the pond when the readings are outside the trigger levels. Water that is outside of the trigger levels is redirected to an underground storage tank, and is either sent off site for disposal to an appropriately licensed or permitted facility or used in the process. The water is also analysed at the outlet of the pond before it is discharged from the site. No water can be discharged when the readings are outside the trigger levels. The system is monitored 24/7 at the Distributed Control System (DCS) by the operators. The discharge is checked daily.

Stormwater monitoring carried out for 2021 is shown in Table 1.

Table 1 - Summary of Storm Water Monitoring

Parameter measured	No. of Samples	% Compliant
pH	Continuous	100%
Conductivity	Continuous	100%
TOC	Continuous	100%

As reported in the Annual Environmental Reports (2015-2020), no evidence of contamination of storm water have been detected either through daily visual inspection or through continuous TOC monitoring.

4.1.2 Wastewater

There are two types of wastewater that can be produced:

- Process wastewater produced from the activities;
- Sanitary wastewater from toilets, washrooms and canteens.

Wastewater arising from process activities is reused in the process or in rare cases tankered offsite for treatment in an appropriately licensed facility. Domestic wastewater produced onsite (sanitary wastewater from toilets, washrooms and the canteen) is treated onsite by two Puraflo systems which then pass through a percolation area to ground.

All effluent generated from toilets, showers, and utility areas (with the exception of the modular offices and portacabins in the contractors' compound) is collected in a domestic type of effluent collection system, as described above. Wastewater from the modular offices and the contractors compound will drain to a holding tank and subsequently sent off site for treatment in a licensed facility in the Republic of Ireland.

4.1.3 Air

There is one main air emission point (A1-1) on site. This main emission point is monitored continuously by the operations staff at the Control Room.

Each quarter an independent and accredited stack emissions testing company is brought to site to verify the continuous measurements, and also to take measurements of the noncontinuous emission parameters.

A summary of air emissions monitoring for 2021 is shown in Table 2

Table 2 - Summary of Air Emissions Monitoring

Parameter measured	No. of Samples	% Compliant
Carbon Monoxide	Continuous	100%
Chlorine as HCl	Continuous	100%
Dioxins	Continuous	100%
Fluorine as HF	2	100%
Mercury	2	100%
Nitrogen oxides (NO and NO2, expressed as NO2	Continuous	100%
Nitrous oxide (N2O)	Continuous	100%
PM_{10}	4	100%
$PM_{2.5}$	4	100%
SO_2	Continuous	100%
Dust	Continuous	100%
TOC	Continuous	100%
Cd/Tl Other metals etc	2	100%

The current sources of minor emissions on site primarily include passive air extract, breather valves and air filters from silos, firewater diesel pump exhaust, bottom ash vents and air extract, and various other exhaust and air extraction points. The current sources of potential emissions on site primarily involve smoke vents from the tipping hall and bunker, safety valves in the steam line and feed water tank, the turbine exhaust duct and a back-up diesel fired electricity generation plant. Currently sources of fugitive emissions include dust from the ash hall, tipping hall, loading areas and pre-treatment plant, and potential ammonia release from large FIBC bags from the pre-treatment of residues.

Odour monitoring is also completed on the site as part of the Environmental Management System.

As reported in the Annual Environmental Reports (2015-2020), no evidence of exceedances of limits have been detected.

The full list of air emissions, including main, fugitive, minor and potential emissions are outlined in Section 7.4 of this license application.

4.1.4 Groundwater

Groundwater is monitored on site to ensure activities do not cause groundwater pollution. Groundwater is monitored at three monitoring boreholes, one upgradient of the site and two downgradient of the site.

In the past 5 years of monitoring there have been no indications of the presence of groundwater pollution on the site.

4.1.5 Noise

Noise emissions are monitored from the site. Noise monitoring can be conducted at the boundary of the site and/or at locations beyond the boundary referred to as "noise sensitive locations". Schedule B.4 of the IE licence requires that noise produced by the site shall not exceed the noise limit values shown in Table 3 and/or give rise to nuisance.

Table 3 - Operational Noise Limits for the Indaver Duleek facility

Daytime dB(A) $L_{AR,T}$ (30 minutes)	Evening-time dB(A) $L_{AR,T}$ (30 minutes)	Night-time dB(A) LAeq, T (15 - 30 minutes)
55	50	45

As reported in the Annual Environmental Reports (2015-2020), Attachment 7-1-3 Noise Emission Impact Assessment and Attachment 7-5 Noise Emissions, no exceedances of the noise limits have been detected through noise monitoring.

4.2 Potential for Emissions During a Malfunction or Interruption of Services – Existing Development

A wide range of abatement, treatment and recovery systems are employed to minimise air, water and noise emissions on site. The plant also maintains a comprehensive system of alarms, monitors, sprinklers, deluges and fire control equipment throughout the site to monitor and maintain all environmental emissions.

An outline of the procedure followed in the event of an emergency plant shutdown procedure is listed below.

1. Emergency Shutdown Procedure

The emergency shut down will bring the incinerator line to a safe status. The main objectives of the emergency shut down procedure are as follows:

- To shut down the plant safely, avoiding injury to staff or damage to equipment;
- To minimise emissions;
- To protect equipment from damage caused by temperatures which are too high.

An emergency shut down is not a frequent occurrence. In case of failure of electrical power supply, the plant will switch over to island mode and power itself through the turbine. The plant will reduce in load and remain in a stable condition. If the turbine trips in this condition then the motors and equipment required for the emergency shut down will be powered by the emergency generator.

The emergency shut down will be automatically executed in two steps.

Step 1: The waste burn out. As soon as the emergency shut down commences all waste supply will be stopped immediately. The ID-fan will be stopped.

The injection of activated carbon/clay and lime will stop and may be reactivated by the operator, manually, once the reason for the shutdown is known and it is determined that there will be no risk in doing so.

The inertia of the ID-fan will ensure that the flue gases will continue to be evacuated through the flue gas cleaning systems, prior to the start-up of the ID-fan via the auxiliary motor, which will be powered by the emergency generator.

In the grate furnace, air to burn out the residual waste will be drawn into the furnace because the inertia of the ID-fan will maintain under-pressure in the furnace. During this period the flue gas flow will drop quickly to less than 20 % of the normal flow. At this stage the waste in the furnace will be almost completely burned. Only a few bigger waste parts will still be smouldering. The auxiliary motor (with gear box) of the ID-fan will then engage and continue on partial load. The power of this motor will be sufficient to evacuate the remaining flue gas through the flue gas cleaning system.

Step 2: The cooling step. Once there is no more waste in the furnace, the ID fan will continue to pull air through the furnace boiler for a controlled cool down to protect the refractory and boiler from rapid cool down, which could lead to mechanical failure. The ID fan can then be stopped once the plant is below 60° C.

During any emergency shutdown, while there is waste in the furnace all the flue gases pass through the gas cleaning system and are emitted through the stack. As stated above, the ID Fan is kept operating during the shutdown by means of an auxiliary motor and an emergency generator.

In the event of an emergency shutdown and failure of the emergency generator the inertia of the ID Fan would continue to draw the flue gases through the gas cleaning system for an initial period. It is highly unlikely that there would be both an emergency shutdown and a failure of the emergency generator at the same time.

While step 1 of the shutdown sequence is underway, the combustion gases will continue to pass through the flue gas cleaning systems and the bag house filter and particulates will be removed as efficiently as during normal operations. The activated carbon/clay/lime mixture present on the sleeves of the bag house filter will continue to remove heavy metals, dioxins, HCI, HF and SO_2 from the combustion gases.

The fixed installed emissions monitoring equipment located on the stack will continue to monitor the emissions from the stack. In the event of loss of mains power, the monitoring equipment will be supplied with electricity from the Uninterruptible Power Supply (UPS) and emergency generator.

2. Quick stop incineration

During the operation of the plant there can be conditions that force a scenario called quick stop incineration. These conditions are for example when the pressure increases in the furnace. If this occurs, the first stage alarm will indicate to the operator that the pressure is increasing and if no action is taken by the operator, then the second stage alarm will increase the ID fan speed to reduce the pressure. If this does not reduce the pressure then waste feeding will be stopped and the air supplied to the furnace for combustion will be reduced or stopped and the ID fan will reduce to ensure that the waste on the grate is still combusting in a controlled manor. The operator can then resolve the issue that lead to the quick stop incineration conditions and return the plant to normal operating conditions. The fixed installed emissions monitoring equipment located on the stack will continue to monitor the emissions from the stack during this time.

All environmental incidents are dealt with as per the EPA Environmental Incident Investigation and Reporting Procedure.

A Hazard Identification and Risk Assessment (HAZID&RA) report was also prepared in April 2020 where possible Major Accident scenarios were outlined for the existing plant.

4.2.1 Fire Prevention and Emergency Response

During the detailed design phase of the existing plant, hazard and operability (HAZOP) studies were carried out to assess hazards that could arise during both steady and non-steady state operations and identified the necessary mitigation measures required. Based on these studies, a comprehensive set of operating procedures have been drawn up for all aspects of the operation of the plant, to minimise the risk of accident or emergency situations arising.

A Hazard Identification exercise has also been carried out for the entire site, covering the risks presented by the existing activities and the new risk presented by the proposed development, specifically the new bulk storage facility at the site.

A comprehensive Site Emergency Plan has been developed for the existing facility. The plan sets out the response measures to be taken by personnel in the event of an emergency.

Measures have been designed to ensure maximum protection for site employees, visitors and people in other premises near the site to limit damage to property and minimise the impact of site operations on the environment. A dedicated Emergency Response Team have been appointed to respond to any emergency which may arise.

The new elements of the proposed development will be incorporated into a revision of the Site Emergency Plan once operational and a HAZOP will be carried out.

4.2.1.1 Firefighting and firewater retention systems

Fire suppression is provided by an on-site dual-purpose water storage tank. This tank has an overall capacity of 2,185m^3 with an effective fire-fighting storage volume of 1,855m^3 and a process water storage capacity of 330m^3.

The firefighting effort is supported by three diesel fire pumps which are connected to a fire main and hydrant system. In the event of a fire, the process water requirement will not be needed and potentially all 2,185m^3 of process water is available for firefighting.

The greatest potential for fire at the facility arises within the waste bunker where localised heating can occur due to decomposition of organic material. If such a fire occurs, the waste is immediately transferred by the grab crane into the hopper and then covered with another grab of fresh waste. In the event of a larger fire where this is not possible, water cannons are used to douse the fire. Up to the level of the tipping hall, the bunker has a capacity of 5,670m^3 approximately. If a 50% ratio is assumed for the waste, then there would be a retention capacity of 2,835m^3 within the waste bunker. With 2,185m^3 of water available for firefighting, this demonstrates that all of the water will be retained within the bunker even in the most extreme fire event.

If a fire occurred in the turbine area, the firefighting water would be collected in the cellar beneath the turbine which has a capacity of circa 1,000m^3. The waste bunker has been designed conservatively with 1.1m thick walls and 800mm base and secondary containment system. It will therefore retain any fire water generated within the bunker.

4.2.2 Prevention of Accidental Emission or Spillage

All waters produced from wash down etc., and any leaks/spills within the process building are directed to the spill water tank with a capacity of 100m^3. Water from this tank will be used to supplement process water requirements or will be transported off-site for treatment or disposal to an appropriately permitted or licensed facility. There is no process effluent discharged from the facility.

Bulk tanks containing hazardous materials (ammonia, diesel fuel oil) are double skinned and equipped with interstitial leak detection. The tanks are also fitted with level monitoring and overfill protection. Pipe work from the bulk tanks is located over-ground, over paved areas and undergoes regular visual inspection.

There is a designated bulk tanker unloading area for diesel and ammonia which is graded towards a surface drainage channel. Prior to unloading, a diversion valve on the stormwater drainage system is activated which diverts the drainage from the surface drainage channel to a 2m^3 holding tank. This ensures that during tanker unloading any spills/leaks are contained within the unloading area. Any contained spills of hazardous materials will be pumped out and either treated on site (trace contamination) or sent off-site to as appropriately licensed or permitted facility.

All other hazardous materials on site are stored in smaller quantities (e.g. 200L drums, IBCs etc.) in individual bunded areas (e.g. spill pallets, trays, chemical storage cabinets) to contain any spills/leaks.

4.3 Proposed New Emissions from Site

The proposed development includes an increase the annual total waste accepted at the site, the development of an aqueous waste tank, a 10MW$_e$ hydrogen generation unit, a bottom ash storage building, additional waste acceptance capacity and infrastructure, a single storey warehouse, a new concrete yard, demolition and re-building of an existing single storey modular office building and other miscellaneous site upgrades.

A description of the new emissions arising from the proposed development are provided below.

4.3.1 Stormwater

The storm water runoff from the new buildings (warehouse, workshop & ERT/office building, rebuilt office, hydrogen generation unit and bottom ash storage building) will discharge into the existing storm water system on site. Where required, new drainage infrastructure will be provided in order to collect runoff from new hard standing areas.

However due to specific constraints (regarding site levels and discharge rates that prohibit the expansion of the existing stormwater drainage network) it was not possible to extend the stormwater network to the concrete yard. The design solution is to attenuate the surface run-off to a new attenuation tank (146m^3) with a pumping chamber located under the slab area from where it will be pumped to the nearest existing manhole chamber. This proposed attenuation tank will increase the attenuation capacity of the site from 2,887m^3 to 3,033m^3.

Monitoring and control of storm water will continue as currently licensed.

4.3.2 Wastewater

Process wastewater arising from the proposed development will tie into existing infrastructure.

Domestic wastewater arising from the new emergency response team building will drain to the existing treatment system and percolation areas and wastewater from the new office rebuild and contactors facilities will drain to the new treatment system and percolation area.

4.3.3 Air

As part of the proposed development, it is proposed to increase the annual tonnage of waste accepted at the facility to 280,000tpa, of which 250,000tpa will be treated in the waste to energy plant and 30,000tpa will be treated in the ash pre-treatment facility. The waste to energy plant will continue to be the dominant source of air emissions associated with the facility.

The proposed increase in waste treated by the waste to energy plant is driven by the treatment of additional aqueous wastes which, when evaporated, is converted to water vapour in the flue gas flow. As the flue gas flow is corrected (normalised) to standard, dry conditions, the normalised flue gas flowrate will not increase. In any event, the facility will still comply with its licensed emission limit values and thus the increase in waste tonnage proposed will not cause a significant impact to the ambient air quality.

To accommodate fluctuations in the thermal load of the plant and the associated changes in the flue gas flowrate, the maximum average daily flue gas flowrate has increased from 183,700 Nm3/hr to 200,000 Nm3/hr.

Air modelling results, which are provided as Attachment 7-1-2 Air Emissions Impact Assessment, demonstrates that with a volume flow rate of 200,000 Nm3/hr the proposed development will be fully compliant with all relevant ambient air quality standards even when modelled at the maximum emission limit values as per W0167-03. Typically, the plant operates well below these emission limit values and under the new BREF on Waste Incineration, the plant will also be required to perform to new more stringent values during normal operating conditions.

The proposed development will give rise to new minor air emissions points, namely the fume hood from the proposed laboratory, oxygen from the Hydrogen generation unit, and air extract from the bottom ash hall.

Potential air emission sources associated with the proposed development include hydrogen from the hydrogen generation unit, nitrogen and low level vapours from the aqueous waste storage waste, and extracted air from the bottom ash storage building.

Once the operational, the Indaver site will have a total of 1 no. main air emission point, 35 no. minor air emissions points and 40 no. potential air emissions points. The full list, including fugitive, are described in outlined in Section 7.4 of this licence application.

4.3.4 Groundwater

Groundwater is monitored at three monitoring boreholes, one upgradient of the site and two downgradient of the site, as required by Schedule C.6.1 of the IE licence.

Ground water monitoring which is currently undertaken is sufficient and compliance is expected with the addition of the proposed development.

4.3.5 Noise

Once operational, the potential noise sources associated with the proposed development will be from:

- Mechanical and electrical equipment;
- Vehicle movements / activities on site, and
- Additional vehicular traffic to and from the site.

Noise modelling for the proposed development has demonstrated that noise levels arising from the operation of the proposed development will be in accordance with the noise limits currently set in the IE licence.

Noise monitoring will continue to be carried out annually to demonstrate operations of the site does not exceed the noise levels.

4.4 Potential for Emissions During a Malfunction or Interruption of Services (Proposed Development)

Possible areas of accident/malfunction associated with the proposed development with the potential to release emissions include:

- Emergency shutdown of WtE line as per Section 4.2 above. Loss of power to aqueous waste tank farm
- Breakdown of HGU or loss of power or utilities to HGU

The previous scenarios mentioned in Section 4.2 also apply to the proposed development.

In the event of loss of power or utilities to the tank farm or the HGU, there is no potential for emissions as a result. Any over-pressure in the storage tanks will continue to be vented to the furnace or mechanically to the activated carbon unit.

The HGU simply stop running and the any overpressure in the Hydrogen gas holder will vent to atmosphere.

The Hazard Identification and Risk Assessment (HAZID&RA) report prepared in April 2020 outlines any possible Major Accident scenarios for the proposed development.

5. Internal Capacity and Throughput

The existing facility treats up to 235,000 tonnes per annum of residual household, commercial and industrial non-hazardous and hazardous waste and recovers energy. Of the 235,000 tonnes of waste, up to 10,000 tonnes per annum (tpa) of suitable hazardous waste is currently treated at the facility.

The existing facility extracts and recovers valuable material (in the form of ferrous and non-ferrous metals) and energy (in the form of up to 21.5 megawatts of electricity (MW_e)) resources from residual waste. It is important to note that these volumes are indicative maximum current amounts only and the actual volume of waste accepted, and energy produced annually varies. In 2021 approximately 216,935 tonnes of waste were accepted at the facility.

As part of this licence review application the total amount of waste to be accepted at site is 280,000 tpa of which 250,000tpa will be treated in the waste to energy plant and 30,000tpa will be treated in the ash pre-treatment facility.

The proposed development will also give rise to a $10MW_e$ hydrogen generation unit (HGU) for connection to the natural gas distribution network for mobile hydrogen transport and other potential applications.

6. Laboratory Activities

6.1 Existing Laboratory Activities

There is no current requirement for laboratory facilities on site. Where the requirement for laboratory analysis arises for the waste streams (e.g., liquid waste), Indaver's laboratory in the Dublin Port facility or another accredited laboratory is used. Permanent monitoring equipment for the continuous measurement of stack emissions is in place. Non-continuous monitoring and other analysis is carried out by independent and accredited laboratories.

6.2 Proposed Laboratory Activities

The existing warehouse and workshop building will be re-purposed to store FIBC bags ready for shipment from the existing residues pre-treatment plant on site, in advance of shipment off site. The existing office area within this building will be re-purposed as a small laboratory area for sample collection, preparation and testing associated with the pre-treatment plant for residues and the incoming aqueous hazardous waste streams. Activities will include Gas Chromatography-Mass Spectrometry (GCMS) to separate and detect compounds in a sample by using a combination of gas chromatography and mass spectrometry, pH measurement to determine the acidity or basicity of a solution, Karl Fischer titration for determining the amount of water in a sample, X-ray fluorescence (XRF) to determine the elemental composition of a sample. A fume hood will be installed in the laboratory to contain and remove any hazardous fumes and gases generated during experiments.

7. Abatement Systems

7.1 Existing Abatement Systems

There are several existing abatement, treatment and recovery systems in place to minimise the potential for operations at the site to result in impacts to the surrounding environment. A summary of this existing infrastructure is outlined in the following sub-sections.

With this infrastructure in place and associated procedures for treating and managing potential impacts and emissions generated on site, the risk of operations associated with the plant, including those associated with the proposed development, resulting in impacts to the surrounding environment is very low and non-significant.

Schematics and flowcharts of the waste to energy process carried out on site which includes the existing abatement systems can be seen in Section 2.2.

7.1.1 Air Emissions Abatement

The abatement and treatment systems in place associated with the existing air emissions stack on the site are outlined in Table 4.

Table 4 - Abatement and Treatment Techniques for existing air emissions stack

Emission to be treated / abated	Treatment / abatement process
Particulates (dust), Hydrocarbons (expressed as Total Organic Carbon (TOC), pollutants relating to the presence of certain wastes (e.g., chlorine due to presence of PVC).	Abatement: The quality of waste entering the furnace impacts on the completeness of combustion and on the nature of gases released. Waste acceptance and handling procedures are in place to ensure wastes are screened and mixed in the bunker to remove any non-conforming items and provide for complete combustion.

Emission to be treated / abated	Treatment / abatement process
Carbon Monoxide (CO), TOC	Abatement: The temperature and residence time of waste in the furnace affects the completeness of combustion. Regulation of temperature is a critical factor for CO abatement. As the waste travels through the furnace the initial heat (temperature range of 50°C to 100°C) will drive moisture from the waste. The next stage in combustion will be the release of volatiles such as CO. The volatilisation of combustible gases takes place typically at temp range 200°C to 750°C, and then combustion takes place above the waste on the grate at 850°C. To achieve burnout of organics and abate TOC in the flue gasses, a minimum temperature of 850°C will be maintained for at least 2 seconds in the first pass of the boiler.
Poly-Chlorinated Dibenzo Dioxins (PCDD) and Poly-Chlorinated Dibenzo Furans (PCDF)	Abatement: The quality of waste entering the furnace impacts on the completeness of combustion and on the nature of gases released. Residence time in the convective part of the boiler is minimised at temperatures greater than 250°C and less than 450 °C. Waste acceptance and handling procedures are in place to ensure wastes are screened and mixed in the bunker to remove any non-conforming items and provide for complete combustion.
Oxides of Nitrogen (NO_x)	Treatment: A Selective Non-Catalytic Reduction (SNCR) reagent of 24.9% ammonia solution is injected at two levels into the furnace to react with and remove NO_x from the flue gases.
Particulates, PCDD, PCDF, heavy metals	Treatment: Expanded clay and activated carbon are injected in two stages in the flue gas treatment system to trap these components. The clay, carbon and entrained particulates are then removed from the flue gases in the baghouse filter.
Sulphur Dioxide (SO_2), Hydrogen Chloride (HCl), Hydrogen Fluoride (HF)	Treatment: Lime slurry is injected in the spray drier absorber, and, where necessary, fresh hydrated lime in the reaction duct to react with these acid gases. The reaction salts are then removed from the flue gases in the spray drier absorber or in the baghouse filter.
Visible plume	Abatement: The temperature of the emissions exiting the stack is approximately 140°C, which is high enough to mitigate against a visible plume. It is not possible to avoid completely the visible plume as it also depends on the ambient air conditions and in winter months the plume will be visible and less visible in summer months.

7.1.2 Containment of Spills and Leaks

All substances with the potential to cause a negative impact on groundwater or surface waters are stored in appropriate containers within the main process building and/or in bunded areas.

All waste entering the facility (non-hazardous and hazardous LoW codes) is stored in fully contained structures therefore in the unlikely event of a spillage or a particularly wet load of incoming waste, there is no potential for leakage to soils. All waste storage facilities are impervious to the materials stored therein. The waste bunker has a base thickness of 1.1m and a wall thickness underground of 800mm, with a secondary containment system with fully sealed membrane and leak detection system to ensure that at all times the bunker remains watertight. The leak detection system is checked on a monthly basis. In the event that any liquid is encountered in this leak detection system the source of the liquid will be investigated and mitigation works completed as and when required.

All other concrete bunding structures (for storage of fuels and other raw materials) have been constructed as watertight structures in accordance with the requirements of relevant Codes of Practice such as BS8007 British Standard for Design and Construction of Aqueous Liquid Retaining Structures. These structures will be integrity tested in accordance with the requirements of the facility licence and guidelines given in the Code of Practice for leakage to confirm that they are watertight.

All storage, treatment and handling of residues and consumables and any plant cleaning operations, with the exception of fuel and ammonia solution storage, takes place within the main process building. The fuel tank and ammonia storage tank in the service yard are double skinned. Materials stored within the main process building will also be provided with bunding where necessary. Any spills or wash water is contained within the building and directed to the spill tank for recirculation.

These measures ensure that there are no uncontrolled emissions to groundwater.

7.1.3 Existing stormwater control and management

Existing abatement measures regarding the process building, site drainage, firefighting and firewater retention systems, and sanitary effluent and treatment systems are outlined in detail in Section 9.1.

7.2 Proposed Abatement Systems

The existing abatement systems, which are in operation at the plant will also be adopted for the proposed development, where appropriate. Therefore, the description of abatement systems provided in the previous section should be referred to as an overview of the general abatement associated with the waste to energy process.

Additional abatement systems associated with the proposed development are required for the proposed aqueous waste tank farm and hydrogen generation process.

Aqueous Waste Tank Farm

To cater for the possibility of any solvents being present in the aqueous wastes, the tanks will be equipped with a nitrogen blanketing facility to ensure an inert atmosphere in the head space of the tanks. Any possible off-gases and overpressure in the tanks will be vented to the furnace for incineration. A small activated carbon unit will also be installed for times when the process building is in shutdown to prevent any emissions to atmosphere. A pipe rack will be provided to link to the existing pipe rack servicing the aqueous ammonia and diesel fuel oil area to the proposed tank farm.

The feed rate from the tank farm to the furnace will be controlled in the central control room for the plant. The offloading from road tankers to the tank farm will be controlled locally by the operators in the unloading area. The level on each tank will be controlled using level transmitters and overfill protection will be provided via level switches and interlocks. Overpressure in the tanks is managed by forced ventilation to the secondary air system in the furnace. Pressure transmitters and over/under pressure venting devices will also be installed on each tank.

Hydrogen Generation Process

Hydrogen/Oxygen electrolyte separators:

The gas from each cell is collected in the hydrogen and oxygen flow ducts which run in parallel along the top of each unit and are fed into the gas/electrolyte separators at the front of the electrolyser. The oxygen separator discharges the oxygen to atmosphere through a small vent stack and the hydrogen separator sends the hydrogen to the water scrubber. The electrolyte from both separators is then recycled back into the distribution channels in the bottom of the electrolyser unit.

Scrubber Unit:

Water is used in the scrubber unit after the hydrogen/electrolyte separator. The scrubber design provides efficient removal of residual electrolyte (potassium hydroxide solution – KOH) droplets from the hydrogen gas to protect downstream equipment from alkali deposits and corrosion. The scrubber is made from carbon steel and provided with connections for make-up water inlet; drain; flowmeter; level switches and a differential pressure gauge. There is one level transmitter on the scrubber basin to maintain the level in the basin and to provide alarms if the level goes below normal operating range.

Gas holder:

The hydrogen from the scrubber passes next into the gas holder which is a 50m^3 wet, floating-bell type with a central coaxial sliding guide equipped with low friction material. A water seal is fitted immediately downstream of the gas holder and acts as a condensate drain. The volume of the gas holder is designed to accommodate the approximate equivalent of the maximum volume of hydrogen produced by the electrolyser in 2-3 minutes. If the gas holder should overfill, the hydrogen will automatically be safely vented to atmosphere.

There is one level transmitter and one level switch which monitor how full the gas holder is. The signal from the level transmitter will be used to steer the rectifier current to increase/decrease hydrogen production to maintain the gas holder level at the chosen set point.

In addition, the level transmitter is used to provide service alarms (high & low level) and trip alarms (such as HH=rectifier to zero (min)) when the gas holder level reaches various alarm set-points.

8. Raw Materials, Intermediates and Products

8.1 Raw Materials Usage

In addition to lime, activated carbon/clay and water for flue gas cleaning, water is also used on site for boiler water, general site cleaning, and firefighting activities. Diesel fuel oil is consumed in the burners primarily for start-up and shutdown activities. Aqueous ammonia is used in the Selective Non-Catalytic Reduction (SNCR) process for the reduction of nitrogen oxides. Table 5 below summarises the annual raw materials usage for 2021.

Table 5 - Raw materials consumed for 2021

Raw materials	Total Consumption 2021 Usage
Quicklime (CaO)	3,863 Tonnes
Dry Hydrated Lime (Ca(OH)2)	855 Tonnes
Activated Clay+Carbon	327 Tonnes
Aqueous Ammonia	448 Tonnes
Water	74,778 Litres
Diesel Fuel Oil	234 Tonnes

A full list of raw materials, intermediates and products consumed at the facility is detailed in Attachment 4-6-2 of this licence review application.

8.2 Existing Storage Conditions, Locations, Segregation and Transfer Systems

Raw materials, intermediates and products are stored at the following locations.

8.2.1 Waste to Energy Process Building

Separate silos for the storage of quick lime, hydrated lime, activated carbon and clay are provided in the flue gas cleaning part of the main process building. A baghouse filter is utilised to remove the carbon, clay and lime that has reacted to form the flue gas cleaning residues. The residues are trapped on the surface of the individual sleeves (approximately 2,000 sleeves in total) of the baghouse filter and collected in six hoppers underneath each of the six modules that comprise the baghouse filter unit.

Bottom ash is produced as a residue of the combustion process in the furnace. Once extracted from the furnace via a water quench bath, the bottom ash is transported by conveyor to the bottom ash hall for metal recovery and storage. Ferrous and non-ferrous metals are recovered from the bottom ash using overband magnets and an eddy current separator. The metals and the residual bottom ash are stored in the bottom ash hall prior to sending off-site for recovery.

Boiler ash, flue gas cleaning residues and water are mixed together and discharged into $1m^3$ flexible intermediate bulk container (FIBC) bags. The bottom ash is sent to landfill via covered trucks for use as cover for the landfill cells and also for road construction on the landfill itself.

The FIBC bags containing boiler ash, flue gas cleaning residues and water are then loaded onto curtain-sided trailers and sent to a saltmine in Northern Ireland for recovery. This process avoids the need to export these residues in bulk powder form to saltmines in Germany where a similar pre-treatment process is applied prior to recovery in the mine. For operational reasons, the ability to use both routes for export is maintained.

Table 6 shows the residues produced in the waste to energy process in 2021.

Table 6 - Residue/Re-agents Produced from the WtE Process 2021

Residue/Re-agent	Tonnes per annum
Bottom Ash	34,779
Pre-treated Boiler Ash	10,184
Boiler Ash exported as is	112
FGC Residues	5,090
Ferrous Metals	3,314
Non-Ferrous Metals	662

8.2.2 Aqueous Waste Storage and Unloading Area

Aqueous waste is unloaded to the temporary mobile storage tank (70m^3 capacity) on site, located at the southern part of the main process building, from where is it pumped to the furnace for treatment. Alternatively, the aqueous waste can be pumped directly from an incoming tanker for treatment in the furnace.

8.2.3 Diesel Fuel oil/Ammonia tanks

Located at the northern boundary of the site are a 44m^3 diesel fuel oil tank for fuelling the burners used for start-up and maintaining the minimum temperature of 850°C in the furnace when required, and a 60m^3 aqueous ammonia tank which is used for NO_x reduction in the flue gases.

Both tanks are double skinned and equipped with interstitial leak detection. The tanks are also fitted with level monitoring and overfill protection. Pipe work from the bulk tanks is located over-ground, over paved areas and undergoes regular visual inspection.

There is a designated bulk tanker unloading area for diesel and ammonia which is graded towards a surface drainage channel. Prior to unloading, a diversion valve on the stormwater drainage system is activated which diverts the drainage from the surface drainage channel to a small 2m^3 holding tank. This ensures that during tanker unloading any spills/leaks are contained within the unloading area. Any contained spills of hazardous materials will be pumped out and either treated on site (trace contamination) or sent off-site to appropriately licensed or permitted facility. All other hazardous materials on site are stored in smaller quantities (e.g., 200L drums, IBCs etc.) in individual bunded areas (e.g., spill pallets, trays, chemical storage cabinets) to contain any spills/leaks.

8.3 Proposed Storage Conditions, Locations, Segregation and Transfer Systems

The proposed development includes the following aspects in relation to the storage conditions, locations, segregation, and transfer systems of raw materials:

- Development of an aqueous waste tank farm and tanker loading area for the storage of aqueous wastes;
- Development of a bottom ash storage building, for the storage of bottom ash;
- Development of three new silos in the main process building for the acceptance and storage of third-party residues and construction of a concrete area for tanker unloading of third party ash for pre-treatment;
- The re-purposing of the existing warehouse and workshop building on site will and re-location of warehousing and workshop functions to a new two storey building.

There will be a small increase in the use of other raw materials consumed in the waste to energy process. These increases are very small, and the raw materials listed are not in short supply. In reality, the increases will be far less as the greater proportion of the 15,000 tonnes of additional hazardous waste processed will be contaminated water (aqueous waste). Hence, the impact of this increased raw materials usage is not considered significant.

The HGU also requires potassium hydroxide as the electrolyte for the electrolysis of water to hydrogen and oxygen, but this is not consumed in the process. The electrolyte may be topped up or changed out from time to time, but this is not a regular occurrence. From the initial charge of approximately 100 tonnes of a 15% Potassium Hydroxide solution or Potassium Hydroxide pallets mixed with demineralised water of equivalent amount, usage thereafter is not considered significant.

Based on the assumption outlined above that all of the additional waste processed in the waste to energy plant is solid waste, and more re-agents are required for use in the flue gas treatment process, correspondingly the amount of residues produced should also increase. The calculated increases are set out in Table 7 below.

Table 7 - Increase in residue production from waste to energy process

Residue/Re-agent	% per tonne waste input	Additional Tonnes per annum
Additional Bottom Ash	15.0%	2,250
Additional Boiler Ash	0.7%	105
Additional FGC Residues	4.0%	600
Ferrous Metals	1.2%	180
Non-Ferrous Metals	0.2%	30

As a result of treating an additional 30,000 tonnes per annum of boiler ash, flue gas cleaning residues and similar residues accepted from third parties, 39,000 tonnes per annum of treated residues will be sent off-site for recovery.

An additional c.210 tonnes per annum of ferrous and non-ferrous metals will be recovered for recycling at an appropriately licensed or permitted facility. The same facilities that are currently utilised by the existing plant will be utilised for this additional material. The recovery or recycling of the ferrous and non-ferrous metals is expected to have a minor positive effect on the environment.

8.3.1 Aqueous Waste Storage and Unloading Area

The tank farm will contain three principal tanks, two of which will be dedicated to the acceptance and storage of aqueous hazardous waste. The third tank will be utilised for the storage of water during maintenance activities. There will be a further tank of $20m^3$ operational capacity which will be used to ensure that any fine solids are constantly kept in suspension before being pumped to the furnace.

All tanks will be single walled but with an additional jetting prevention shield where necessary and will be fabricated from mild steel and contained within a concrete bund.

An upgrade to the existing tanker unloading area, located south of the main process building is also be undertaken. Containment for the full contents of a tanker ($25m^3$) will be provided in the event of a spillage.

Tankers containing aqueous waste will be directed to the unloading area after waste acceptance and initial weighing operation at the weighbridge. Operators in the tank farm will direct the driver to one of the three unloading bays.

Once in place, the operator will access the top of the tanker to take a sample, which is then analysed for conformity with certain key parameters such as calorific value, pH and chlorine content. This conformity check analysis ensures that the load is within specification.

If the contents are not within specification, then arrangements will be made to send it off-site to an appropriately licensed facility in Ireland or abroad.

8.3.2 Residue Acceptance & Storage for Pre-Treatment

Three silos housed within the main process building and an unloading area for tankers delivering this material outside the main process building are proposed to facilitate the increase in acceptance capacity of third-party boiler ash and flue gas cleaning residues.

Boiler ash, flue gas cleaning residues (FGCR) and similar residues from thermal treatment processes (e.g., kiln dust if available in the market) will be accepted and unloaded to one of three new silos located within the process building.

Two silos will be dedicated for FGCR acceptance (approx. 200m^3 each) and one for boiler ash (BA) and other residues (approx. 100m^3). The ash will be delivered in enclosed tankers and are offloaded to the silos pneumatically. The same method is currently used for unloading consumables.

Filtration systems on the silos will mitigate against dust emissions during the unloading operation. A new concrete area (300m^2 approx.) will be provided for these unloading operations at the north-eastern end of the main process building.

From the silos, the residues will be transported in enclosed conveyors to the pre-treatment plant and mixed with water in specific proportions in the pre-treatment plant. Once mixed, the cement-like product will be discharged into 1m^3 flexible intermediate bulk container (FIBC) bags. The bags are then sent to a salt mine in Carrickfergus, Northern Ireland for recovery (Permit No. P0547/16A).

9. Wastewater and Surface Water Drainage

9.1 Existing Wastewater and Surface Water Drainage

9.1.1 Wastewater

All effluent generated from toilets, showers, and utility areas (with the exception of the modular offices and portacabins in the contractors' compound) is collected in a domestic type of effluent collection system. All effluent is passed through a treatment system (Puraflo) before being discharged to the percolation area. The wastewater treatment area is located on the northern boundary of the site. A second smaller effluent collection and discharge system is provided at the gatehouse building.

One effluent holding tank is also utilised on site for the modular offices in the contractors' compound and the temporary portacabins which are used during the annual maintenance shutdown. The contents of this holding tank is transported off site for treatment as required.

Wastewater arising from process activities is reused in the process or tankered offsite for treatment in a licensed facility in the Republic of Ireland.

9.1.2 Surface Water Drainage

Rainwater from roofs, roads and hardstanding areas passed through an underground oil interceptor before draining into the attenuation pond. Prior to entering the pond the rainwater is analysed by an automated analyser at the inlet chamber for compliance with pH, conductivity and Total Organic Carbon (TOC). The water is subsequently monitored at outlet chamber before being released into a drainage ditch which joins to a tributary of the river Nanny. In the event trigger levels are exceeded water is redirected to an underground fire retention tank and is either sent off-site for disposal or used in the process.

9.1.2.1 Process Building & Tanker Unloading Bay

All waters arising from wash down etc. within the waste processing building are directed to an underground spill water tank (100m^3) located to the east of the bunker building. Water from this spill tank is used to supplement process water requirements. There is no process effluent from the facility.

Rainwater from the tanker unloading bay is analysed and depending on the results is either sent off-site for disposal or drains into the underground spill water tank.

The existing site drainage system is illustrated in Figure 28.

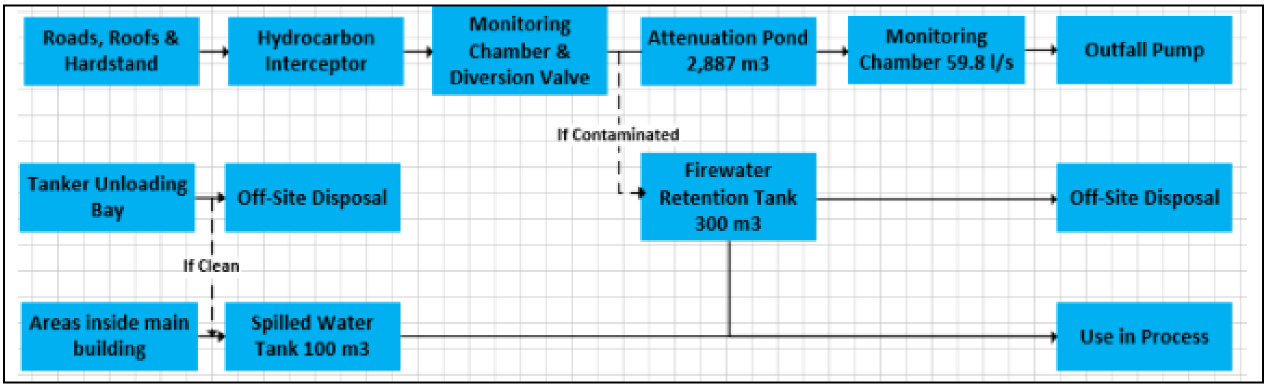

Figure 28 - Existing Drainage System Flow Diagram

9.1.3 Fire Water

Contaminated run-off arising from firefighting operations will be contained by collection in the stormwater drainage system and draining to both the underground contaminated water tank (approx. $300m^3$) and by overflow when full to the attenuation pond (approx. $2,887m^3$).

Firewater will be stored for removal from site for disposal or for transfer to the tank farm for treatment in the furnace. Adequate capacity is available on site to store both the firefighting water and rainfall that may occur during a fire.

A schematic of the current Firewater management system is shown in Figure 29

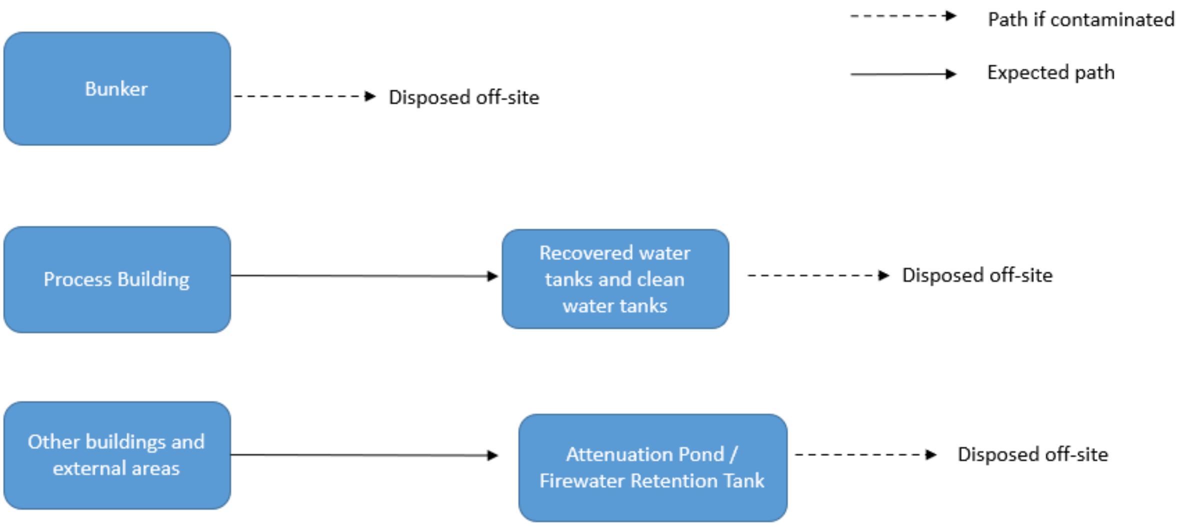

Figure 29 - Schematic of the current Firewater management system

9.2 Proposed Wastewater and Surface Water Drainage

9.2.1 Wastewater

Domestic wastewater arising from the new emergency response team building will drain to the existing treatment system and percolation areas and wastewater from the new office rebuild and contactors facilities will drain to the new treatment system and percolation area.

Wastewater arising from process activities will tie into the existing infrastructure.

9.2.2 Surface Water Drainage

Rainwater from the new areas will discharge into the existing stormwater system on site. The current system is attenuated at the point of discharge to the watercourse located at the northwest corner of the site.

Any spills or wash waters generated within the hydrogen generation unit building will be contained and directed to the existing spilled water tank on site.

Rainwater from the new concrete yard will drain to a new attenuation tank (146m^3) before connecting into the site wide drainage infrastructure.

The existing infrastructure has the capacity to attenuate the additional run-off.

The proposed drainage system is illustrated in Figure 30 with the new elements highlighted in green.

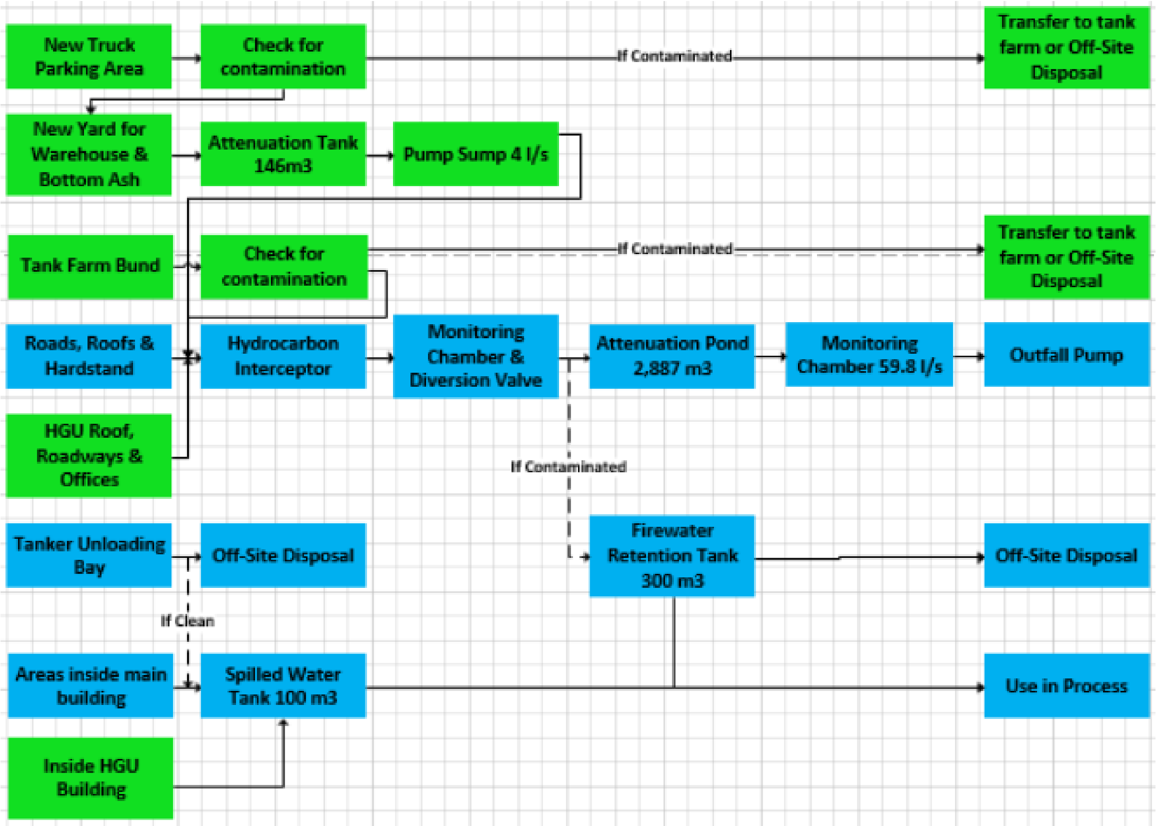

Figure 30- Proposed Stormwater Drainage System Flow Diagram.

9.2.3 Fire Water

Contaminated run-off arising from firefighting operations associated with the proposed development will be managed as per existing fire water drainage infrastructure.

10. Waste Activities

10.1 Existing Waste Activities

Indaver currently manage, store and record hazardous, non-hazardous and inert waste generated at the facility. It is ensured that this waste is subsequently treated or disposed of in accordance with the relevant waste regulations.

The facility is licensed to carry out the following activities:

Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants *(a) for non-hazardous waste with a capacity exceeding 3 tonnes per hour, and*

(b) for hazardous waste with a capacity exceeding 10 tonnes per day.

Waste arriving at the facility must be checked in at the gatehouse and pass over the weighbridge before being directed to the tipping hall which consists of 6 separate loading bays (solid waste deliveries) or to the tanker unloading area (aqueous waste deliveries). Acceptance checks are performed at both acceptance points to ensure that the waste delivered meets the required specifications. Additional controls for the acceptance of hazardous waste are included in the site's IE licence.

Solid waste is unloaded from trucks to the waste bunker from the tipping hall where two waste cranes mix the waste prior to feeding towards the waste hopper and feeding chute prior to introduction to the furnace.

Aqueous waste is unloaded to the temporary mobile storage tank (70m^3 capacity) on site, located at the southern part of the main process building, and either pumped from the tank or directly from an incoming tanker for treatment in the furnace.

Figure 31 below illustrates the current waste workflow procedure on site.

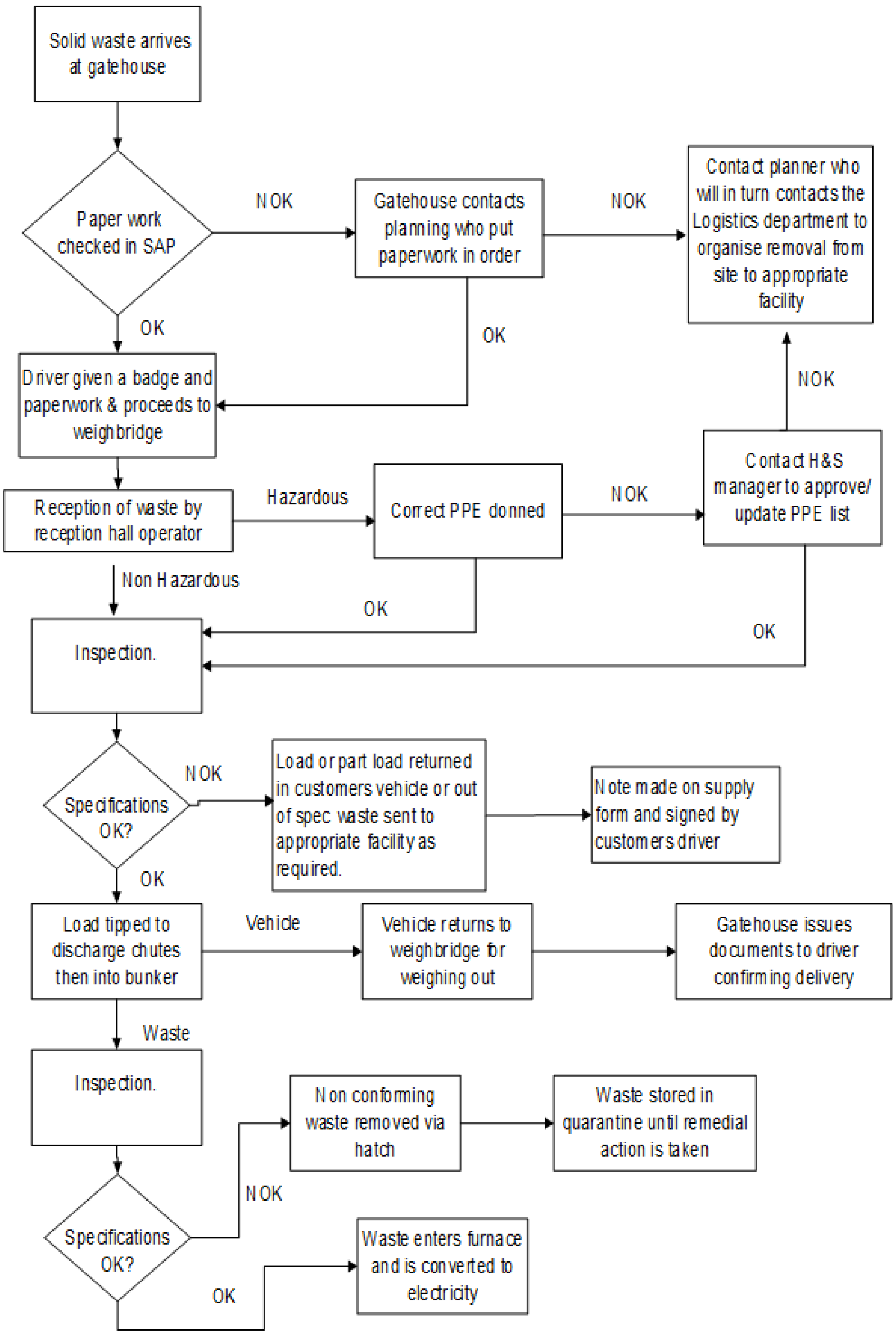

Figure 31 - Current waste activity workflow

Reception of waste truck.

Waste is only accepted if it is planned and scheduled in the SAP system and in accordance with the requirements of the licence and in conformance with Indaver's waste acceptance criteria (WAC). The vehicle parks in a designated bay and driver visits reception and the following procedure is followed:

- Document check - The security personnel checks that the paperwork supplied with the vehicle matches what is available on the SAP system. Reception grants the driver access to the reception hall and a badge to activate the weighbridge
- Weighing in - The vehicle drives to the 'in' weighbridge where they use the badge to activate the weighing of the load. On receiving a green light the driver moves the vehicle towards the reception hall.

- Reception hall - Entry to the reception hall is controlled by the Tipping Hall Operator. If materials meet the acceptance criteria, the vehicle driver is directed to the appropriate discharge chute. Bulk Liquids loads are sent for direct injection.

Inspections

There are various options for waste inspections. For every load received checklist ENV 02.02 is completed by the person inspecting the waste:

- Visual on discharge - As the load is being tipped into the reception chutes the Tipping Hall Operator watches for any non-conformance to the waste acceptance criteria.
- Visual in truck – Carried out if non-compliance is expected by the tipping hall operator. CCTV cameras are in place at the weighbridge and waste can be inspected using this e.g. tipper trucks where the cover has been pulled back.
- Detailed inspections - These will be carried out periodically as required to ensure that customers do not supply waste outside the WAC. As a minimum one random inspection per week will be carried out.
- Camera inspection - There is a camera in the bunker/hopper area of the plant. The monitor for this camera is in the control room where a crane operator can ensure that only acceptable waste loaded into the hopper.
- Inspection by crane operator - As the crane operator mixes and transfers the waste they must always be vigilant for any waste that does not conform to the waste acceptance criteria.

Weighing out

- The Vehicle follows the one-way route, observing the speed limit, and exits via the 'out' weighbridge. The security guard stamps/signs the paperwork for the driver and issues a recovery certificate.

10.1.1 Waste Accepted

The EPA licence requires that waste is accepted in a manner that does not cause environmental pollution. All incoming and outgoing hazardous, non-hazardous and inert waste is managed stored and recorded, and subsequently treated, recovered, disposed or stored at the facility depending on the licence requirements.

Indaver are currently licensed to accept up to 235,000tpa[1] total waste for treatment in the waste to energy facility, of which up to 10,000tpa[2] of hazardous waste can be accepted.

Table 8 shows a summary of waste accepted in 2021 and the percentage increase or decrease on the previous year. The percentage recovery is the amount of total waste accepted that was reused, recycled or recovered.

Table 8 - Summary of Waste Accepted in 2021

Type	Quantity (Tonnes)	% Increase/ decrease on previous year	% Recovery
Hazardous	8,878.739	21.6% increase	100%
Non-Hazardous	208,056.089	1% decrease	100%
Inert	0	N/A	N/A
Total Tonnes	216,934.829	0.2% decrease	100%

From 2017 to 2020, an average of over 7,200 tonnes per annum of aqueous hazardous waste were accepted and treated at the facility.

[1] As part of this licence review application the total amount of waste to be accepted at site is 280,000 tpa of which 250,000tpa will be treated in the waste to energy plant and 30,000tpa will be treated in the ash pre-treatment facility.

[2] As part of this licence review application there will be an increase in the amount of hazardous waste accepted at the facility to 25,000 tpa

10.1.2 Waste Generated

A summary of the waste generated in 2021 and the percentage increase or decrease on the previous year is shown in Table 9. The percentage recovery is the amount of total waste generated that was reused, recycled or recovered.

Table 9 - Waste Generated 2021

Type	Quantity (Tonnes)	% Increase/ decrease on previous year	% Recovery
Hazardous	15,595.64	5.8% increase	99.4%
Non-Hazardous	38,923.23	10% decrease	10.2%
Inert	0	0	N/A
Total Tonnes	54,518.87	5.9% decrease	35.9%

The quantity of hazardous waste generated increased from 2020 to 2021 as an increasing majority of the hazardous residues are being pre-treated in the Pre-treatment plant. The pre-treatment process involves mixing the flue residues and the boiler ash with water to create monolithic blocks. The amount of residues being produced in the thermal treatment of waste has not increased, it is the addition of water which increases the overall weight of the pre-treated residues. When pre-treated, the residues remain on the island of Ireland and are used as an alternative backfilling material in an appropriately licensed facility.

Currently the main waste residues produced at the facility are of bottom ash, boiler ash, flue gas treatment residues and ferrous and non-ferrous metals. The usage, handling and storage, and disposal methods of these residues are detailed in Section 8.2**.**

Other wastes arising from the facility will include minor quantities of waste from facility operations and staff and visitor facilities. A full list of waste generated on site, as well as relevant EWC codes and descriptions is detailed in Attachment 8-1 of this licence review application.

10.2 Proposed Waste Activities

The proposed development includes the following aspects in relation to the waste activities:

- Increase in the amount of hazardous waste accepted at the facility for treatment in the waste to energy plant from the current permitted 10,000 tonnes per annum (tpa) up to a maximum of 25,000 tpa.
- Increase the annual total waste accepted at the site for treatment in the waste to energy facility from the currently permitted 235,000 tpa to 250,000 tpa.
- Development of an aqueous waste tank farm (up to $625m^2$) and unloading area (up to $310m^2$) including: 1 x $20m^3$ (up to 8m high above ground) and 3 x $300m^3$ storage tanks (up to 25.5m high above ground) in a bund (up to $320m^2$), a single-bay tanker loading area, ancillary equipment area complete with paved areas, gantries, piperacks and stairs; and an upgrade of the existing unloading area to a three-bay tanker unloading area complete with gantries, piperacks and stairs.
- Development of a bottom ash storage building up to $1,525m^2$ and 14.5m high above ground, for the storage of up to 5,000 tonnes of bottom ash currently produced on site.
- Additional waste acceptance capacity and infrastructure (2 x $200m^3$ & 1 x $100m^3$ tanks located inside the existing main process building and a concrete area for tanker unloading of up to $300m^2$ located outside) to accept up to 30,000 tpa (bringing the site total to 280,000 tpa) of third-party boiler ash and flue gas cleaning residues and other similar residues for treatment in the existing ash pre-treatment facility on site.

As is the case with the existing facility as outlined in Section 8.2, adequate provision will be made for the separation of waste at source for the various elements of the proposed development. Office and canteen waste generated on site will be recycled where appropriate or treated on-site in the waste-to-energy facility. The proposed development will have a beneficial impact as it will reduce the quantity of hazardous waste being exported to Europe for disposal.

Wastes arising on site, for example from the administration building and maintenance activities, will be sent off site to be recycled where practical, and treated in the Waste-to-Energy facility if not. A beneficial reuse will be sought for the bottom ash. Metals will be recovered from the bottom ash. The additional boiler ash and flue gas residues accepted and produced at the site will be pre-treated for recovery off-site.

10.2.1 Proposed Treatment of Generated Waste

Bottom Ash

Bottom ash is currently sent to three main landfill outlets for recovery as daily cover or as a road construction material on the landfill itself. This will continue for the additional bottom ash produced as a result of the proposed development.

It is the intention of Indaver to continue to identify potential uses for bottom ash. The reuse of this material would assist in Ireland's envisaged transition to a circular economy as laid down in stated European and national policy positions as all wastes including those that are unavoidable such as residues are regarded as being capable of being transformed into useful and valuable resources. Such reuse is also compatible with the principle of self-sufficiency as laid down in the Waste Framework Directive.

The manner in which this material may be treated and transported is dependent upon how this material is classified and characterised which may be hazardous or non-hazardous. The bottom ash residues from the plant are currently characterised as non-hazardous.

Boiler Ash and Flue Gas Cleaning Residues

Circa 105 tonnes of additional boiler ash and 600 tonnes of additional flue gas cleaning residues will be produced annually from the waste-to-energy plant operations as part of the proposed development.

When pre-treated (after mixing with water) these residues will amount to a total of approximately 917 tonnes per annum. More significantly, an additional 39,000 tonnes per annum of pre-treated residues will be produced by the existing on-site pre-treatment facility. It is expected that the 30,000 tonnes of boiler ash, flue gas cleaning residues and similar material from third party facilities that is accepted as part of the proposed development for pre-treatment will be similar in composition to the boiler ash and flue gas cleaning residues from the existing facility. The total amount of additional pre-treated residues from both waste to energy plant and that accepted from third parties will be sent for recovery to salt mines licensed to accept this type of waste.

Salt mines are suitable environments for containing boiler ash and flue gas cleaning residues. The absence of water in the underground salt mine's environment removes any risk of leaching of, for example, heavy metals from residues. Hence the recovery of this material by backfilling in the saltmines is not likely to have significant negative effect on the environment.

Boiler ash and flue gas cleaning residues from the existing facility are currently shipped (un-treated) to the Hattorf and Wintershall Reutilisation Facility, which is an underground salt mine in Germany. The facility has been approved for the reutilisation by the relevant authorities in Germany. In 2017 a similar salt mine facility in Northern Ireland attained planning consent and an environmental permit to operate as a recovery facility for hazardous residues from waste to energy facilities. At times when this recovery facility may not available, for example, during a maintenance outage, the un-treated flue gas cleaning residues will be exported for treatment and final recovery to German salt mines in specialised road tank vehicles.

Ferrous and Non-Ferrous Metal Recovery

An additional 210 tonnes per annum of ferrous and non-ferrous metals will be recovered for recycling at an appropriately licensed or permitted facility. The same facilities that are currently utilised by the existing plant will be utilised for this additional material.

11. Alternatives

A number of alternatives have been considered by Indaver Ireland Limited during the design process of the proposed developments primarily relating to alternative processes and designs.

11.1 Alternative Processes

11.1.1 Hazardous Waste Treatment (Waste to Energy)

No changes are required to the existing waste to energy treatment process itself to facilitate the treatment of an additional 15,000 tonnes per annum. A permanent storage facility is however required for aqueous waste prior to treatment and the alternatives considered are outlined in Section 11.2.1 below. The current process is working successfully with regard to the treatment of hazardous and aqueous wastes, and this is largely attributable to the advanced screening of the waste (profiled prior to acceptance, and further determined at collection and delivery) prior to treatment in the waste-to-energy plant.

11.1.2 Alternative Processes relating to the Hydrogen Generation Unit

Alternative processes were explored for the utilisation of waste steam or the resultant waste electricity when power is not required by the grid. Several options were investigated over the past five to seven years including those listed below:

- Fly-wheel technology for energy storage;
- Electric battery storage;
- Users for steam off-take;
- Use of the electricity for Hydrogen generation.

With the exception of hydrogen generation, none of the other options provided a viable technical or economic case for further investigation. Fly wheel or battery storage are more efficient ways to store electricity for re-use but the energy they store cannot be released back onto the electricity grid when grid restrictions released as the size of the export line and rated MEC (Maximum Export Capacity) for the site cannot facilitate this.

The use of steam instead of producing electricity is environmentally more desirable and more energy efficient but requires constant heat demand within close proximity to the site from either an industrial source or high density of population. No such usage demand exists in this area.

Although the energy efficiency associated with an alkaline electrolysis unit to generate Hydrogen is lower than the storage solutions mentioned above, the case for this clean, non-carbon based fuel in the context of climate change policy and sustainability is very compelling.

Alkaline electrolysis is 60% efficient at converting the electricity input from the waste to energy plant into a hydrogen fuel and is the only power to hydrogen gas process which is proven and has operating plants at the scale required ($10MW_e$) for this development. Hence there is no reasonable alternative process to alkaline electrolysis for hydrogen generation taking into account the characteristics of this project.

11.1.3 Bottom ash storage for off-site treatment

The only alternative process that could be considered on site to the storage of bottom ash prior to off-site treatment is the full treatment of bottom ash to recover remaining residual metals and to produce an aggregate material for onward sale to the construction industry. With only 40,000 tonnes per annum of bottom ash currently produced on site, the scale of investment would not be economical and in addition, the amount of space required would be significant and could not be accommodated on the existing site.

Thus, no reasonable alternative exists.

11.2 Alternative Designs

11.2.1 Aqueous Waste Storage

Some alternatives were considered with regards to the type and size of tanks to be utilised for the unloading, storage, mixing of aqueous waste prior to transfer to the furnace for treatment. These alternatives would be considered standard in process engineering terms and would also be in accordance with the applicable BAT guidelines. They are summarised in Table 10. Some environmental factors were also considered during this process (such as material assets and visual impacts) as summarised in Table 10.

Based on the above considerations in the case of this application, avoiding quality issues with fabrication on site and the space required to fabricate wider diameter tanks (>5m), it was decided to utilise tall and thin tanks. Although there was a potential for increased visual impact, the location chosen on site ensured that this did not arise.

Table 10 - Factors considered for alternative aqueous waste storage tank design

Design Consideration	Pros	Cons
Single Skin in bund	Cheaper tank costs	Bund and additional civil works costs required Higher impact on material assets
Double skinned with no bund	No bund required. Lower impact on material assets.	Higher tank costs Bottom discharge from tank not possible.
Tall and thin tanks	Can be fabricated off site to a higher quality standard and installed quickly on site.	Increased visual impact potential. Fabrication on site requires a large area, process is slow and quality can be an issue.
Short and fat tanks	Lower visual impact potential.	
Small number of larger tanks	Lower investment cost per m^3 storage.	Limited ability to segregate different wastes.
Large number of smaller tanks	High degree of waste segregation possible.	Higher investment cost per m^3.
Conical bottom	Excellent solids extraction.	Double Skin not possible.
Flat bottom	Double skin possible.	Solids build-up in tank.

Conical bottoms were also chosen to ensure that any solids could be easily extracted from the tanks in the waste and pumped to the furnace. Choice of a conical bottom excluded the possibility for a double skinned tank, so single skinned tanks within a bund was required.

Two larger tanks (each 300m^3 capacity) were chosen instead of many smaller tanks as there is no significant need for the segregation of aqueous wastes due to the high-water content.

11.2.2 Hydrogen Generation Unit

As the layout of the equipment is standard for such a plant and the visual impact is not significant, no alternative designs were considered. Colour finishes for the exterior cladding have been chosen to match the existing on site.

11.2.3 Bottom Ash Storage

Apart from the pitch of the roof (based on the orientation of ash trucks within the building when tipping) no other alternative designs were considered. Colour finishes for the exterior cladding were chosen to match the existing on site.

12. References

- Arup (2020) Environmental Impact Assessment Report for Meath Waste-to-Energy Site Sustainability Project 2020, Indaver Ireland Limited.
- Byrne Ó Cléirigh Limited (2020) Hazard Identification and Risk Assessment at Duleek for the Site Sustainability project at Indaver Ireland Limited
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