# Caulmert Limited

Engineering, Environmental & Planning Consultancy Services

**Deerplay Landfill Site**

**WRG Environmental Limited**

**Environmental Permit Variation Application**

**Operating Techniques and BAT Review**

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**APPROVAL RECORD**

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**DISCLAIMER**

**Operating Techniques and BAT Review**

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# 1.0 INTRODUCTION

## 1.1 Overview

1.1.1 WRG Environmental Limited ('the Operator') (a subsidiary of FCC Environment (UK) Limited) have appointed Caulmert Limited to prepare a bespoke environmental permit variation application to install a new Reverse Osmosis (RO) Plant at Deerplay Landfill Site, Bacup Road, Cliviger, in Lancashire.

1.1.2 The Operator proposes to install the Reverse Osmosis (RO) Plant within a compound (the existing gas compound to be repurposed) adjacent to the landfill, within the existing permit boundary. The RO Plant will treat the non-hazardous landfill leachate at the site prior to disposal to sewer. The existing discharge point to sewer is situated on Bacup Road, which ultimately discharges into the Burnley Wastewater Treatment Works.

1.1.3 This permit variation consists of adding a new listed activity to Table S1.1 of the permit for the physico-chemical treatment of more than 50 tonnes per day of non-hazardous leachate. Only non-hazardous leachate from Deerplay Landfill will be treated at the RO Plant. It is this activity to which this 'Operating Techniques & BAT Review' report relates.

## 1.2 Proposed Operation

1.2.1 The Operator proposes to install a new RO Plant to treat leachate extracted from the adjacent Deerplay Landfill Site only. The RO Plant will take the raw non-hazardous landfill leachate and treat it via a series of filters, and with the addition of reagents, to produce a permeate which can be discharged to sewer. The RO Plant will be a 3-stage process and will be capable of achieving clean and consistent water quality for the treated leachate which will be suitable for discharge to sewer.

1.2.2 Discharge to sewer will be via an existing sewer connection situated on Bacup Road, which ultimately discharges into the Burnley Wastewater Treatment Works, and the discharge is already consented under existing Trade Effluent Discharge Consent (TEDC) ref. 716T4-2-148 (dated 26th February 2024) issued by United Utilities (see Appendix 5 of Supporting Document ref. 5987-CAU-XX-XX-RP-V-0301).

1.2.3 A 'H1 Surface Water Pollution Risk Assessment' (document ref. 5987-CAU-XX-XX-RP-O-0300) has been undertaken as part of this permit application and concluded that the risks to the receiving water body via the wastewater treatment works from the discharged treated leachate will be 'low' to 'negligible'.

1.2.4 From the RO Plant, a concentrate will also be produced, which is the waste product of the RO process, consisting of a liquid of concentrated substances that are removed from the leachate during cleaning. The concentrate will be collected and stored within a suitably specified bunded tank on-site pending removal off-site by a licenced tanker to a suitable disposal facility.

1.2.5 Non-hazardous raw leachate will be piped directly from Deerplay Landfill Site to the existing but relocated 54.5m$^3$ self-bunded raw leachate reception tank. The leachate generated from the landfill site will be collected via a series of sealed pipes which converge at the leachate tank located to the west of the compound. The tank will be connected to the RO Plant via sealed hoses and the leachate is then passed through the reverse osmosis process. The leachate will be separated into approximately 75% clean water (permeate), to be discharged to sewer and 25% highly concentrated reject to be tankered off site for further treatment.

1.2.6 The RO Plant will consist of a unit with two rooms, the electrical cabinet (switchboard) and an engineering room. There will also be two tanks sited externally for the storage of reagents: sulphuric acid (15m$^3$) and caustic soda (30m$^3$), and another tank for the storage of concentrate (110m$^3$) prior to export from site, all within a fully bunded concreted area capable of holding 110% volume of the largest tank (see drawing ref. WR7979/01/04).

1.2.7 The overall site layout of the proposed RO Plant and tanks within the existing permit boundary is shown on drawing ref. WR7979/01/03 'Proposed Site Layout'. The RO Plant and associated infrastructure will be installed within a compound with impermeable concrete surfacing, in the old gas compound adjacent to the landfill.

1.2.8 The RO Plant would be capable of treating circa 200m³ of leachate per day. This would represent the equivalent of circa 8 tanker loads of leachate which would otherwise have to be removed from the landfill site by road. The leachate concentrate (reject) will be taken off-site in circa 3 daily tankers for further treatment at a specialised wastewater treatment plant. The use of the RO Plant for treating the leachate at the Site therefore reduces the daily vehicle movements by 8 tankers per day not leaving the Site. This is clearly a significant benefit as the RO Plant will reduce the number of vehicle movements required to manage leachate at the Site, which consequently will reduce carbon emissions.

1.2.9 As part of this permit variation application, it is proposed to add the following activity to Table S1.1 of the landfill permit for the RO Plant:

- *Section 5.4 A(1)(a)(ii) 'Disposal of non-hazardous waste with a capacity exceeding 50 tonnes per day involving physico-chemical treatment (D8)'.*

1.2.10 A general process description for the treatment activities is provided in Section 3 of this report.

### 1.3 Report Context

1.3.1 This report comprises an integrated approach of the 'Activities & Operational Techniques' requirements from application form Part B3, and also an assessment of compliance for the proposed RO Plant to ensure compliance with 'Best Available Techniques' (BAT). Activities are required to conform to BAT to show that operations at the site demonstrate that no significant pollution will be caused from the activity as a whole.

1.3.2 The Part B3 form requests information about the activities the application relates to and the operating techniques that will apply to them, which includes:

a) Types of activities;

b) Types of waste to be accepted;

c) Emissions (to air, water, sewers, land etc.);

d) Operating Techniques including technical standards;

e) General requirements in relation to managing emissions (substances, odour, noise & vibration);

f) Types and amounts of raw materials; and,

g) Monitoring of point source emissions.

1.3.3 A review of the proposed activities against Industrial Emissions Directive 2010/75/EU 'Establishing Best Available Techniques (BAT) Conclusions for Waste Treatment' (2018) is included within this report, in Section 6.0.

### 1.4 Site Location and Surrounding Land Use

1.4.1 Deerplay Landfill Site is located at postcode BB11 3RL in a very rural location and is approximately 4.4km southeast of Burnley and 1.5km southwest of the village of Cliviger, in Lancashire. The location of the proposed RO Plant is centred on National Grid Reference SD 85873 28410.

1.4.2 The closest residential receptors to the proposed RO Plant are Long Shay Cottage located 390m southwest, Stone House Cote Farm (farm buildings) 400m east-northeast and Cow Side 525m southeast. Further northeast is Stone House Fold 680m away and Dyneley Farm approximately 860m north-northeast.

1.4.3 The closest watercourse to the RO Plant is the Easden Clough located 175m to the southeast. The bedrock below the site is designated as a Secondary A Aquifer. The site is not located within a Source Protection Zone (SPZ).

1.4.4 Access to the site is from The A671 Bacup Road, which runs along the south-eastern boundary of the landfill site. The site location is shown below in Figure 1:


**Figure 1 - Site Location Plan**

## 1.5 Site Plans

1.5.1 The following site plans have been included in the following application documents:

Operating Techniques and BAT Review report:

- WR7979/01/01 'Site Location'
- WR7979/01/02 'Existing Site Layout'
- WR7979/01/03 'Proposed RO Plant Site Layout'
- WR7979/01/04 'Proposed RO Plant Elevations'
- WR7979/02/07 R2 'Pipe and Cable Runs'

Environmental Risk Assessment:

- 5987-CAU-XX-XX-DR-V-1800 Sensitive Receptor Plan

## 2.0 ACTIVITIES & OPERATING TECHNIQUES – PART B3 FORM

### 2.1 Q1a. What activities are you applying for

2.1.1 It is proposed to install a Reverse Osmosis (RO) treatment plant with a treatment capacity of 50 or more tonnes per day for the purpose of the physico-chemical treatment of non-hazardous leachate for disposal. The treated leachate (permeate) produced by the RO Plant will be discharged to sewer via an existing sewer connection on Bacup Road, which ultimately discharges into the Burnley Wastewater Treatment Works.

2.1.2 As part of this permit variation application, it is proposed to add the following activity to Table S1.1 of the landfill permit for the RO Plant:

- *Section 5.4 A(1)(a)(ii) 'Disposal of non-hazardous waste with a capacity exceeding 50 tonnes per day involving physico-chemical treatment (D8)'.*

2.1.3 The RO Plant will treat up to 200 tonnes per day of non-hazardous leachate. See Table 1 below for the proposed activity to be added to Table S1.1 of the permit.

2.1.4 The new activity will be for physico-chemical treatment of leachate in a new Reverse Osmosis (RO) Plant to be installed adjacent to the landfill site.

2.1.5 The Directly Associated Activity (DAA) for the discharge of treated leachate from the landfill to sewer is already included within the permit for the existing Leachate Treatment Plant (LTP).

2.1.6 An additional DAA will be added to the landfill permit for the '*discharge of treated leachate to sewer from the reverse osmosis plant*'. In addition, a DAA for the '*temporary storage of leachate prior to disposal off-site*' is also required to be added to Table S1.1 of the landfill permit to cover the storage of raw leachate prior to treatment and concentrate prior to tankering off-site for disposal.

**Table 1 – Proposed Specified Activities**

| **Additional Schedule 1 listed activities to be added to permit** | | | | | |
|---|---|---|---|---|---|
| **Installation name** | **Schedule 1 or other references** | **Description of the Activity** | **Activity capacity** | **Annex I (D codes) and Annex II (R codes) and description** | **Non-hazardous waste treatment capacity** |
| Deerplay Reverse Osmosis (RO) Plant | Section 5.4 Part A(1)(a)(ii) | *"Disposal of non-hazardous waste with a capacity exceeding 50 tonnes per day (or 100 tonnes per day if the only waste treatment* | 200t/d | ***D 9** Physico-chemical treatment which results in final compounds or mixtures which are discarded by means of any of the operations numbered D 1 to D 8 and D 10 to D 12* | 200 t/d |

| Additional Schedule 1 listed activities to be added to permit | | | | | |
|---|---|---|---|---|---|
| **Installation name** | **Schedule 1 or other references** | **Description of the Activity** | **Activity capacity** | **Annex I (D codes) and Annex II (R codes) and description** | **Non-hazardous waste treatment capacity** |
| | | *activity is anaerobic digestion) involving one or more of the following activities, and excluding activities covered by Council Directive 91/271/EEC concerning urban waste-water treatment—*<br>*(ii) physico chemical treatment"* | | | |

| Additional Directly associated activities to be added to Permit | |
|---|---|
| **Name of DAA** | **Description of the DAA (including which Schedule 1 activity it serves)** |
| Temporary storage of leachate | Storage of non-hazardous leachate prior to treatment and storage of concentrate prior to disposal. |
| Release to water body except seas/oceans | Discharge of treated leachate to sewer from the reverse osmosis plant. |
| **For installations that take waste – for additional activity** | |
| Total storage capacity: | Non-hazardous leachate tank prior to treatment: 54.5m$^3$<br>Concentrate storage tank post-treatment: 110m$^3$ |
| Annual throughput (tonnes per year): | Leachate treatment: 73,000 tonnes per year. |

## 2.2 Q1b. Table 1b. Types of Waste Accepted

2.2.1 It is not proposed to change the permitted waste types as part of this permit variation. Only leachate derived from Deerplay Landfill Site will be stored and treated, no other leachate will be imported from off-site.

## 2.3 Q2. Point Source Emissions to Air

2.3.1 There will be no point source emissions to air as part of the activities at the site. The RO Plant will be an enclosed unit, with no point source releases to atmosphere.

## 2.4 Q2. Point Source Emissions to Water (Other than Sewers)

2.4.1 There will be no point source emissions to water as part of the proposed activities at the site.

## 2.5 Q2. Point Source Emissions to Sewers, Effluent Treatment Plants or Other Transfers Off-Site

2.5.1 The Operator proposes to install a new RO Plant to treat leachate extracted from the adjacent Deerplay Landfill Site only. The RO Plant will take the raw non-hazardous landfill leachate and treat it via a series of filters, and with the addition of reagents, to produce a permeate which can be discharged to sewer. The RO Plant will be a 3-stage process and will be capable of achieving clean and consistent water quality for the treated leachate which will be suitable for discharge to sewer.

2.5.2 Discharge to sewer will be via an existing sewer connection situated on Bacup Road, which ultimately discharges into the Burnley Wastewater Treatment Works, and is already consented under existing Trade Effluent Discharge Consent (TEDC) ref. 716T4-2-148 (dated 26th February 2024) issued by United Utilities (see Appendix 5 of Supporting Document ref. 5987-CAU-XX-XX-RP-V-0301).

2.5.3 A 'H1 Surface Water Pollution Risk Assessment' (document ref. 5987-CAU-XX-XX-RP-O-0300) has been undertaken as part of this permit application and concluded that the risks to the receiving water body via the wastewater treatment works from the discharged treated leachate will be 'low' to 'negligible'.

2.5.4 From the RO Plant, a concentrate will also be produced, which is the waste product of the RO process, consisting of a liquid of concentrated substances that are removed from the leachate during cleaning. The concentrate will be collected and stored within a specialist 110$m^3$ bunded tank on-site pending removal off-site by a licenced tanker, to a suitable facility such as Davyhulme Waste Water Treatment Works (United Utilities) or FCC Knostrop.

2.5.5 The route the permeate takes to final discharge to sewer is shown on drawing ref. WR7979/02/07/R2, along with the location the permeate leaves the RO Plant at the Sampling Point 'SP'. The connection to the discharge point will comprise a 150mm diameter HDPE twin-wall pipeline from the RO Plant permeate discharge point (Sampling Point) to the existing effluent balance tank on-site before entering the existing foul sewer line. A flow-meter ('FM') will be present where the permeate leaves the RO Plant, through which all permeate will flow, together with a sampling tap at the Sampling Point 'SP', as shown on drawing ref. WR7979/02/07/R2. An existing magnetic inductive flow meter with continuous logging is already installed on the sewer line after the effluent balance tank, as part of the existing biological leachate treatment plant discharge on site.

## 2.6 Q2. Point Source Emissions to Land

2.6.1 There will be no point source emissions to land as part of the activities at the site.

## 2.7 Q3a. Technical Standards

2.7.1 As part of this permit variation application, the following guidance and reference material was used:

- Environment Agency guidance 'Control and monitor emissions for your environmental permit' last updated 24th November 2022;
- Environment Agency guidance 'Risk assessment for your environmental permit' last updated 21st November 2023;
- Best Available Techniques (BAT) reference document for waste treatment, IED 2010/75/EU (Integrated Pollution Prevention and Control) (last updated October 2018).
- Environment Agency guidance 'Surface water pollution risk assessment for your environmental permit', last updated 25th February 2022;
- FCC Environment (UK) Limited (of which WRG Environmental Ltd is a subsidiary) Integrated Management System & Waste Acceptance Procedures;
- Environmental Risk Assessment report ref. 5987-CAU-XX-XX-RP-V-0303;
- Operating Techniques & BAT Review report ref. 5987-CAU-XX-XX-RP-V-0302 (this report);
- H1 Surface Water Pollution Risk Assessment report ref. 5987-CAU-XX-XX-RP-O-0300.

2.7.2 The European BAT reference document (BREFs) 'Best Available Techniques (BAT) reference document for waste treatment' IED 2010/75/EU (Integrated Pollution Prevention and Control) sets out in detail the 'best available techniques' (BAT) standards for how to carry out waste treatment activities and are intended to ensure European consistency in the understanding of what is BAT for a certain sector.

## 2.8 Q3b. General Requirements

2.8.1 An 'Environmental Risk Assessment' is provided as report ref. 5987-CAU-XX-XX-RP-V-0303. Risks from dust, odour, noise, other fugitive emissions, accidents and fire are considered to be low from the proposed site activities. The RO Plant will be an enclosed operation and will be situated together with associated storage tanks and pipework, within a fully bunded area with impermeable concrete surfacing and sealed drainage, providing at least 110% containment of the largest storage tank.

2.8.2 The risks of significant noise, odour and dust from the proposed RO Plant is considered low to negligible and therefore management plans for noise, odour and dust are not required for this application.

2.8.3 As part of Daily Site Inspections, fugitive emissions monitoring will be undertaken for dust, odour, noise, vibration and other possible fugitive emissions. Any emissions detected to be

having an impact beyond the site permit boundary are to be reported, recorded and investigated by site management, particularly if complaints are made, with remedial actions taken as per the site's Environmental Management System.

## 2.9 Types and amounts of raw materials

2.9.1 As part of the treatment process within the RO Plant, there is a requirement to add reagent chemicals, which include caustic soda and sulphuric acid to be stored in $30m^3$ and $15m^3$ tanks respectively. These chemicals are to be stored on site and each chemical is listed below:

Raw materials other than water

2.9.2 The raw materials to be used consist primarily of the following substances:

- Sulphuric Acid
- Caustic Soda (NaOH)
- Membrane Acidic Cleaner (Citric Acid)
- Alkaline Cleaner (P3-ultrasil 11)
- Descaling Chemicals

2.9.3 The Operator will select the least harmful products to use in the operation wherever possible.

2.9.4 The Operator will keep Material Safety Data Sheets (MSDS) for all products used and will monitor the quantity of materials used. This will provide data for regular reviews of raw materials usage.

2.9.5 All product documentation will be checked against the order prior to acceptance.

2.9.6 Any incorrect labelling will be removed/corrected prior to placing the material in storage. Product storage tanks and containers will be appropriately labelled with regards to the contents and any hazards associated with the product.

2.9.7 All vessels and tanks used for storage of process/raw materials will be above-ground with secondary containment of materials that are appropriate to the chemical nature of the materials being stored. Drums will be placed within a designated area.

Water use

2.9.8 Water usage will be small in volume and limited to cleaning of the RO Plant.

## 2.10 Q4. Monitoring

Emissions to air

2.10.1 There will be no point source emissions to air outside of the RO Plant and so monitoring is not proposed.

Emissions to sewers, effluent treatment plants or other transfers off site

2.10.2 It is proposed that the RO plant will treat up to 200 tonnes per day of non-hazardous leachate from Deerplay Landfill.

2.10.3 The route the permeate takes to final discharge to sewer is shown on drawing ref. WR7979/02/07/R2, along with the location the permeate leaves the RO Plant at the Sampling Point 'SP'.

2.10.4 The connection to the discharge point will comprise a 150mm diameter HDPE twin-wall pipeline from the RO Plant permeate discharge point (located at the 'Sampling Point') to the existing effluent balance tank on-site before entering the existing foul sewer line.

2.10.5 A flow-meter ('FM') will be present where the permeate leaves the RO Plant, through which all permeate will flow, together with a sampling tap at the Sampling Point 'SP', as shown on drawing ref. WR7979/02/07/R2. The flow-meter will continuously record the flow of effluent (permeate) discharged from the RO Plant to sewer.

2.10.6 The RO Plant will have continuous monitoring of temperature, conductivity and pH within the process which will be constantly monitoring output and will shut down the plant if the permeate quality exceed set limits.

2.10.7 An existing magnetic inductive flow meter with continuous logging is already installed on the sewer line after the effluent balance tank, as part of the existing biological leachate treatment plant discharge on site.

2.10.8 Concentrate from the RO process will be stored securely in a specialised bunded 110m$^3$ tank on-site prior to removal off-site by tanker to a suitable disposal facility. Concentrate will not be discharged to surface water or sewer by the Operator and will be kept strictly separate from the permeate prior to collection. The Operator will send concentrate to Davyhulme Waste Water Treatment Works (United Utilities) or FCC Knostrop.

2.10.9 The monitoring that will be carried out relevant to the new activities has been summarised in Table 2 below:

**Table 2 – Proposed Monitoring of Discharge**

| Monitoring point ref | Parameter | Frequency | Monitoring standard or method |
|---|---|---|---|
| Permeate Sampling Point 'SP' | Ammoniacal nitrogen<br>Arsenic<br>Chemical oxygen demand<br>Chloride<br>Chromium<br>Copper<br>Nickel<br>pH<br>Sodium | Monthly | In accordance with LFTGN02 'Monitoring of landfill leachate, groundwater and surface water'<br><br>and |

| | | | |
|---|---|---|---|
| | Sulphate<br>Total suspended solids<br>Zinc | | BAT Conclusion 7 (Section 1.2 of 'establishing best available techniques (BAT conclusions for waste treatment'). |
| | Flow rate<br>Temperature<br>Electrical Conductivity<br>pH | Continuously | |

2.10.10 The monitoring of the permeate prior to discharge to sewer will be undertaken by the Operator or authorised contractor employed for the purpose. Testing of the permeate quality will be undertaken by an accredited laboratory and in accordance with the permit. This will ensure the permeate remains within the compliance limits for parameters set within the permit.

Emissions to water (other than sewers)

2.10.11 There are no proposed point source emissions to water as part of this permit variation, so monitoring is not proposed

Emissions to land

2.10.12 There will be no point source emissions to land, so monitoring is not proposed.

# 3.0 PROCESS DESCRIPTION

## 3.1 Context

3.1.1 It is proposed to install a reverse osmosis (RO) treatment plant at Deerplay Landfill Site, to treat non-hazardous leachate from the landfill.

3.1.2 The new RO process will facilitate the treatment of non-hazardous leachate to remove organic and inorganic contaminants. The RO Plant will be a 3-stage process deemed as being sufficient to meet the effluent quality required for discharge to sewer, based upon the expected contamination levels to be dealt with and minimising electricity and reagent use. Therefore, the RO Plant will be capable of achieving clean and consistent aqueous permeate quality which will be suitable for discharge to sewer via an existing sewer connection on Bacup Road. A small volume of aqueous concentrate produced from the process will be removed by tanker for off-site treatment/disposal.

3.1.3 The RO Plant, tanks and pipework will be situated adjacent to the landfill within a fully bunded area, with impermeable concrete surfacing. The proposed RO Plant site layout is shown in attached drawing ref. WR7979/01/03 'Proposed RO Plant Site Layout' and the pipework and permeate discharge connections to sewer are shown on drawing ref. WR7979/02/07/R2.

## 3.2 Approach to the selection of RO Treatment Plant

3.2.1 The attached 'Technical Proposal' in Appendix 1 is provided as an indicative Reverse Osmosis (RO) Plant only and the proposed scheme may be this, or similar.

3.2.2 The selection of waste water management options by the Operator has, in accordance with the principles outlined in BAT Reference document for Waste Treatment, IED, 2010/75/EU IPPC (updated October 2018), been based on thorough characterisation of the non-hazardous leachate and assessment of the most appropriate treatment option for the leachate, taking into consideration leachate quality data to-date, water balance calculations that provide predictions for future waste water production, the site setting, physical constraints on the site, costs, and the proposed receiving sewer for the permeate discharge.

3.2.3 Reverse Osmosis (RO) is regarded in BAT Reference document for Waste Treatment, IED, 2010.75/EU IPPC (updated October 2018) and the SGN5.06 Guidance document as:

*"the finest physical separation method known in contract to normal filtration where solids are eliminated from a liquid, reverse osmosis succeeds in removing solutes"*.

3.2.4 The RO plant is a state-of-the-art membrane plant for leachate treatment and is characterized by a high degree of automatization. As a technology, RO is well established in wastewater treatment applications where the RO membranes can retain more than 98% of large molecules dissolved in waste waters and are frequently used in waste and potable water desalination operations.

3.2.5 The plant has been designed to treat and discharge up to 200 tonnes per day (equivalent to 200$m^3$) per day of non-hazardous leachate and will operate continuously for 24hours at an expected annual throughput of 73,000 tonnes per year.

Leachate Characterisation

3.2.6 The leachate at Deerplay Landfill Site is well characterised and has been extracted, stored and treated on-site for many years by an existing biological leachate treatment plant (LTP).

3.2.7 Quality data for the raw leachate has been collected for Deerplay Landfill Site and the removal rates within the RO Plant (based on the treatment capabilities within a similar sized RO Plant at FCC-operated Calvert Landfill) have been applied to the data within the H1 Assessment (document ref. 5987-CAU-XX-XX-RP-O-0300) to determine if the treated leachate (permeate) from Deerplay Landfill Site could be discharged to sewer.

3.2.8 As part of the H1 Assessment, a number of parameters were screened out following treatment at the RO plant, prior to the surface water screening assessment, as concentrations were below the relevant EQS values prior to discharge to sewer. All other parameters passed the surface water assessment and therefore this assessment has demonstrated that concentrations within the discharge are acceptable with respect to the Surface Water Pollution Assessment methodology.

## 3.3 Principles of the reverse osmosis treatment process

3.3.1 Reverse osmosis (RO) is a technique well-established in wastewater treatment applications which aims to extract clean water from aqueous solution of organic and inorganic contaminants found in waste waters.

3.3.2 The process is designed around the natural osmosis principles that facilitate movement of dilute solutions across a semi-permeable membrane into a higher concentrated solution on the opposite side of the membrane until both solutions display the same concentration.

3.3.3 In reverse osmosis, pressure is applied to the run-off against a semi-permeable membrane forcing water molecules through the membrane to form a clean ‘permeate’ solution. The solutes or contaminants that are retained are collected as a ‘concentrate’ for disposal.

## 3.4 Plant design selection

3.4.1 The specific technology proposed is focused on the efficient treatment of the non-hazardous leachate to achieve a cleaned permeate that can be discharged to sewer.

3.4.2 The Operator is proposing to install a well-proven reverse osmosis system and they have similar plants successfully operating on other FCC sites.

## 3.5 Plant size calculations

3.5.1 The RO Plant has been designed on the treatment of predicted non-hazardous leachate from the Deerplay Landfill Site to produce a permeate that can be discharged to sewer.

3.5.2 The plant has been designed for a treatment capacity of up to 200 tonnes per day (equivalent to approximately 200m$^3$ per day), and a maximum operating pressure of 80 bar. The RO plant will treat non-hazardous leachate primarily to reduce chloride and ammoniacal nitrogen and also metals which are present at much lower levels.

3.5.3 In light of the Deerplay Landfill Site leachate strength/composition and destination of the permeate (sewer), the manufacturer of the RO plant has specified that a 3-stage RO plant will be required, with three purification stages to treat the leachate and guarantee a high permeate quality for discharge to sewer.

## 3.6 RO Plant Design Details

3.6.1 The RO Plant will treat the waste leachate from Deerplay Landfill Site. An example flow diagram of the reverse osmosis process (based on attached indicative proposal in Appendix 1) is detailed in Figure 2 below.

3.6.2 The RO plant is a state-of-the-art membrane plant for wastewater treatment and characterized by a high degree of automatization. Control systems such as control of the booster modules and membranes of the 1$^{st}$ stage are also installed to enable optimum operation of the plant.

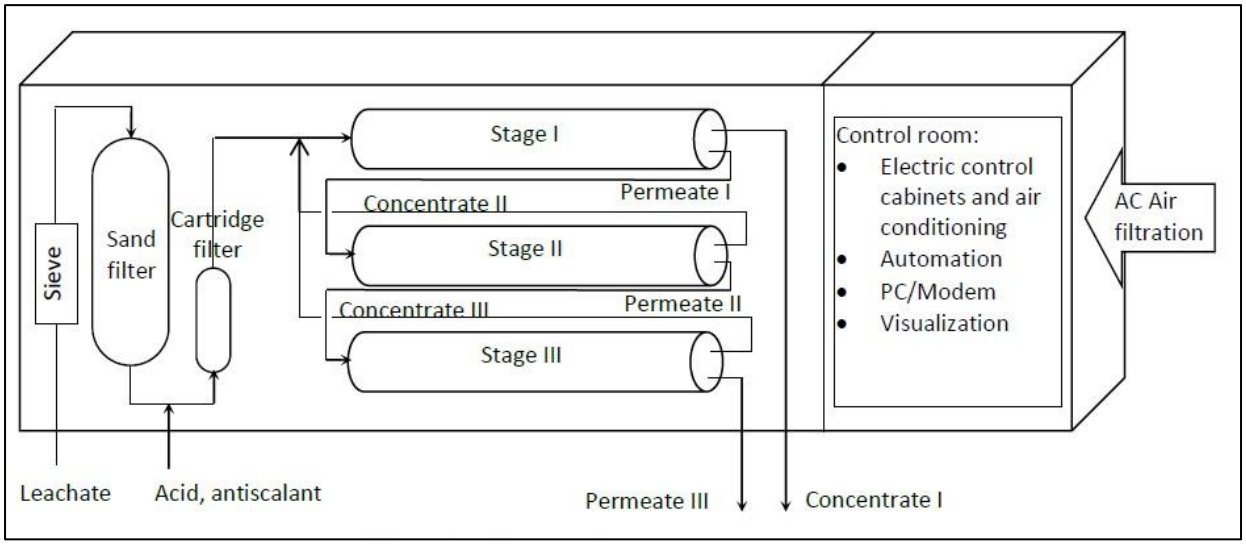


**Figure 2 – Schematic of a 3-stage Containerised Reverse Osmosis System**

***Treatment Stages***

3.6.3 The main treatment stages which are integrated in the RO Plant container are the following:

- Sieve with a 1.5mm mesh

- Pre-filtration by a pressurised sand filter
- Control of pH by dosing of sulphuric acid
- Addition of antiscalant
- Pre-filtration by microfiltration 10µm (1-10µm)
- 1st stage of Reverse Osmosis
- 2nd Stage of Reverse Osmosis
- 3rd Stage of Reverse Osmosis

3.6.4 To control the quality of permeate at the outlet, the conductivity value is measured inline. The permeate can be discharged to the environment, or alternatively be used for irrigation or as process water, etc.

***Pre-Filtration***

3.6.5 Based on the indicative proposal in Appendix 1, as a pre-treatment and for the protection of the pumps and membranes there will be a sieve with a 1.5mm mesh, a sand filtration stage and two microfiltration stations. Sand filtration is carried out in pressurized filters. The sand filters are cleaned by applying a liquid (automatism included), the cleaning liquid is leachate. The frequency of cleaning of the filters depends on the content of suspended solids in the leachate and is usually weekly.

3.6.6 After the sand filtration, there are two filtration stations with 10µm cartridge (microfiltration, porosity adjustable to the sort of leachate between 20 to 1µm) to avoid the entry of small particles which may damage the membranes. Each station takes various filtrating cartridges adapted on the size of the plant. In the case of blockage, a message appears on the system's screen. Replacement of cartridges is fast, simple, and economical and due to the parallel system, it can be executed during operation.

***Chemical Dosing System***

3.6.7 The chemicals used in the process are used to increase the solubility of the salts and to reduce the precipitation of less volatile salts are:

- pH adjustment with acid
- Antiscalant

3.6.8 Acidification is done with 96-98% concentrated sulphuric acid, which is usually the cheapest commercialized acid. The transportation and dosage pump are integrated in the container. For safety reasons, the acid injecting system is completely sealed in a chemically resistant box and equipped with a overfill sensor that switches the system off, in case of a spillage.

3.6.9 The pH of the leachate is controlled by the sulphuric acid dosage system, before passing through the membranes. The acid is injected directly into the piping with a dosing valve. The advantage of this solution is injection in a closed and pressurized system allows avoidance of production of foaming and strong odours.

3.6.10 Also, antiscalant and dispersant is added inline at a dosing station. Depending on the leachate composition there are suitable products which are added to the process, to improve the performance of the plant in terms of treatment, washing cycles and lifetime of the membranes.

3.6.11 The pre-treatment system is equipped with pressure, flow, conductivity, temperature, and pH sensors used for control and monitoring of the process.

***Membrane System***

3.6.12 The three stages of the Reverse Osmosis (RO) system are equipped with pressure sensors for process control. In case of a malfunction (under- or over-pressure), the process shuts down automatically. In addition, there is an over-pressure safety valve in the first stage to avoid damage to the system. The stages are as follows:

1st Stage

- Downstream the filtration stage, a piston pump increases the pressure according to the operating parameters (which depend on the characteristics of the leachate).
- Several membrane modules are installed in a high-pressure tube, forming a block. In addition, each block is equipped with a recirculation pump which maintains the velocity at a high level, and thus, a turbulent flow over the membrane surface, to reduce the effects of "scaling and fouling." The high-pressure pump and a pneumatic pressure control valve create and control the pressure inside the blocks. The flow of the final concentrate is measured by an electromagnetic flow meter and controlled according to the adjusted efficiency by a special anti-cavitation pneumatic control valve with highly resistant satellite components. Depending on the type of operation, the plant can be controlled also by the pressure. Each block can be switched off separately (by-passed), to adapt the plant to different operating conditions.
- The concentrate that results from the first stage can be sent to a specific area (to be defined), at the remaining pressure of the modules (max. 5bar).

2nd and 3rd Stage

- To ensure a proper treatment of the leachate and to guarantee the compliance of the limit values of discharge/permit, the Osmosis system is equipped with a second and a third treatment stage. Permeate of the 1st stage follows directly to this 2nd stage without buffer tank.
- The operation of the process of the 2nd stage is identical to the 1st stage, only the pressure is naturally reduced due to the lower osmotic pressure (max. 35bar) in this 2nd stage. This allows a simplification of the membrane system and equipment which is executed in only one block.

- The concentrate of the 2nd stage is recirculated and sent to the inlet tank of the leachate in the inside of the container. This concentrate is treated together with the leachate.

- To ensure that there is no problem with the membrane system the permeate is monitored at the outlet by the conductivity value.

***RO Plant Infrastructure***

3.6.13 The overall RO plant will consist of the RO unit itself, a raw leachate storage tank, a sulphuric acid tank, a caustic soda tank with dosing infrastructure and a concentrate storage tank with associated pipework, bunding and sealed drainage/sump. Further detail is provided below:

- ISO container for the RO Plant – 40ft marine type container measuring 12.3m in length, 2.4m in width and 2.9m in height (30sqm) finished in green. This will house the reverse osmosis system and associated equipment and instrumentation (see Appendix 1 for example).

- An emergency shower – cubical dimensions of which would be 0.8m by 0.8m by 3m.

- Sulphuric acid storage tank (self-bunded) – 15m$^3$ volume, with a maximum radius of 2.8m, with an overall height of 2.3m (for example see Appendix 2).

- Caustic soda storage tank (self-bunded) – 30m$^3$ volume, with a maximum radius of 4.0m, and an overall height of 2.4m (for example see Appendix 2).

- Raw leachate reception tank (self-bunded) – 54.5m$^3$ volume, measuring 12.3m long, 3.3m wide and 3.5m tall. The tank is a bunded single skin tank made of mild steel and mounted on a skid (re-purposed existing leachate tank – see attached in Appendix 3).

- Concentrate storage tank – 110m$^3$ volume self-bunded tank, measuring 16.5m long, 3.3m wide and 3.2m high, finished in green (see drawing ref. WR7979/01/01 for proposed location).

- Bunded area (repurposed old gas compound area) for all the above container, tanks, pipework and manifolds – minimum 110% of largest tank capacity with impermeable concrete surfacing (a kerbed concrete slab). Bunding and storage will comply with CIRIA C736.

- The plant is designed for a minimum operational life of 20 years.

- All tanks and vessels will be appropriately labelled and clearly signed as to their contents and capacity, each given a unique identifier. Labelling of tanks and process pipework will differentiate between wastewater and raw process waters including direction of flow.

***Technical Description of the RO System***

3.6.14 The RO technology works with semi permeable membranes and high pressure to separate the substances from the water. The pressure of the system must be higher than the osmotic pressure caused by the total dissolved salts (TDS) in the leachate in order for the purified water to pass through the membrane. The higher the salt content, the higher the osmotic pressure is required with respect to the trans-membrane pressure of the system in order to achieve a high flux rate.

3.6.15 While water can pass through the membrane, organic substances and even small ions can't pass through and will be rejected. The leachate will be separated into cleaned water (permeate) and a highly concentrated reject aqueous solution (concentrate).

3.6.16 The raw leachate will be pumped from the on-site storage tank to a small pH adjust tank, which will be used for the injection of sulphuric acid. From the pH adjustment tank, the run-off is fed to a sand filter stage to remove suspended solids that may be present in the surface run-off. From this process the surface run-off is then put through a reverse osmosis process which means each litre of wastewater is filtered by a reverse osmosis membrane.

3.6.17 The RO Plant will be completely automated with security system capable of switching off the system in case of problems arising and all aspects of the process, including process parameters, able to be monitored and controlled. All data is registered by the on-board software.

3.6.18 In summary, the proposed system of Reverse Osmosis integrates a three-stage treatment process to ensure a high quality of the treated effluent and with a higher operating pressure, up to 80 bar, to optimize the permeate flow. The system is equipped with "wide spacer" spiral membranes. The three-stage purification process proposed has the advantage of being able to treat heavy loads of leachate and be more adaptable to future situations in terms of variations of flow and quality of the leachate effluent.

3.6.19 The feeding of the system consists of an external pump, placed inside the leachate reception tank and controlled by the Reverse Osmosis module. The leachate is pumped to the container by the external supply pump. The pump is controlled by the level signal of the leachate reception tank in the Osmosis. The leachate enters the container, passes a sieve, and flows into the leachate reception tank which is equipped with two level-sensors: one sensor for controlling the feed pump and the other sensor to avoid spillages.

***Cross-flow Filtration***

3.6.20 Modern membrane processes are based on the "cross-flow" dynamic filtration, instead of the ordinary "dead-end" statistic filtration (see Figure 3). During the "cross-flow" filtration, there is a high flow (volume) of the liquid that passes through the filtering membrane, to avoid the accumulation of particles on the membrane surface. The cross-flow filtration is a process that separates the liquid flow at the entrance into two types of effluent: permeate and

concentrate. The relation between the two flows is the result of the concentration factor, one of the indicators of the separation efficiency.

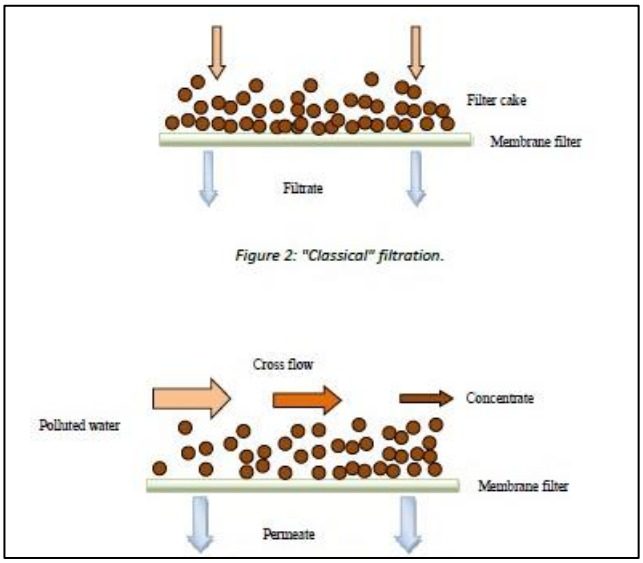


**Figure 3 – Cross-flow Filtration**

***Diffusion and osmosis***

3.6.21 The phenomenon of diffusion is defined as being a process in which different concentrations have the tendency to equilibrate and homogenize/mix together, because of the random movement of its components: atoms, molecules, or ions. If there is a separation of two liquids through one semi-permeable membrane with the selection only for the molecules of the solvent, the result is a unidirectional diffusion of the solvent through this semi-permeable membrane. The movement of the solvent molecules takes place through the membrane, in the direction of the more concentrated solution. The resulting pressure on the membrane is called osmotic pressure. When a high pressure is applied on the solution, with high concentration, the solvent diffuses through the membrane, starting from the more concentrated solution to the more diluted. This process is called reverse osmosis. The membrane process by cross-flow filtration, based on this effect of the Reverse Osmosis, allows the separation of nearly 100% of molecules with a molecular weight higher than 100g/mol and around 95-99% of salt retention. Individual effects are depending on the form and charge of the molecules.

***Types of Membranes***

3.6.22 Membranes used in the Reverse Osmosis systems have a high selectivity, as they should retain nearly all dissolved substances, allowing only the diffusion of water molecules and a very small fraction of these substances. The retention amount depends on the type of substance, varying between 85-100%. The membranes normally used in leachate treatment are tubular, disk or spiral-type membranes.

3.6.23 Structurally, the spiral of the membrane is constructed by "gluing" the membrane sheets in the form of an envelope inserting the open side into a central tube. The permeate enters the space in the envelope-like form where it is conducted until the central tube. The channels in between the membrane sheets are created by the utilization of "spacers". The spiral membranes of "wide-spacer" type which are used in the proposed system show the best relation of price/handling/space/performance in the leachate treatment and are, for these reasons, selected for this RO system. The active material in the membrane surface is polyamide with a high mechanical and chemical resistance. There are several types of membrane surfaces which influence, specifically, the higher or lower salt passage. The used membranes are of the "high rejection" type (of salts) to improve the permeate quality.

3.6.24 Main characteristics and advantages of applied "wide-spacer" spiral membranes, compared to other current types include:

- Considerably lower replacement costs.
- Lower maintenance costs, due to the easy accessibility - fast control and change.
- Optimization of space, due to the good relation of membrane area/volume.
- Optimized hydraulic characteristics with a tangential flow at high velocity on the membrane surface, resulting in a turbulent flow.
- Reduction of the blocking risk (phenomena of "Fouling and Scaling"), resulting in a lower washing frequency and the increase of lifetime.
- The membrane type is a high rejection membrane to allow a better quality of the permeate.
- TFC (Thin film composite) - type with an active surface of polyamide, resistant to a wide temperature and pH range.

## 3.7 Flow

3.7.1 The RO Plant ensures an adequate treatment with a constant entry flow at the plant of 200$m^3$ per day (constant 24 hours per day) of leachate with or without pre-treatment. For the balance of the masses, the system is calculated based on leachate with 21,500 µS/cm conductivity. The annual capacity of the system must be calculated by the availability which is typically 90%. The complete system is assembled in a 40-foot container. The plant can also accept leachate with different conductivity values, with adapted operating parameters.

## 3.8 Raw materials

3.8.1 Raw materials will be required as part of the RO plant treatment process. The types and quantities of raw materials are detailed in Table 3 below.

3.8.2 The Operator will select the least harmful products to use in the operation wherever possible.

3.8.3 The Operator will keep Material Safety Data Sheets (MSDS) for all products used and will monitor the quantity of materials used. This will provide data for regular reviews of raw materials usage.

**Table 3 - Types and quantities of raw materials**

| Substance | Storage Arrangements |
|---|---|
| Sulphuric Acid | Stored in 15m$^3$ self-bunded tank.<br>All chemical containers will be sited within a bund. Sulphuric acid is stored in an acid resistant tank. |
| Caustic Soda | Stored in 30m$^3$ self-bunded tank.<br>All chemical containers will be sited within a bund. |
| Membrane Acidic Cleaner (citric acid) | Delivered in 25kg bags which will be stored in a bund of sufficient size to contain it.<br>All vessels and tanks used for storage of process materials will be above ground with secondary containment of materials that are appropriate to the chemical nature of the materials being stored. |
| Alkaline cleaner | Delivered in 25kg bags which will be stored in a bund of sufficient size to contain it.<br>All vessels and tanks used for storage of process materials will be above ground with secondary containment of materials that are appropriate to the chemical nature of the materials being stored. |
| De-scaling chemicals | Delivered in 25kg drums which will be stored in a bund of sufficient size to contain it.<br>All vessels and tanks used for storage of process materials will be above ground with secondary containment of materials that are appropriate to the chemical nature of the materials being stored. |

# 4.0 EMISSIONS MANAGEMENT

## 4.1 Overview

4.1.1 This section provides evidence of the provision of relevant emissions controls and abatement that have sufficient capacity to allow the effective management and control of the installation to the standard indicated by BAT for waste treatment, IED 2010/75/EU (Updated October 2018) and BAT Conclusions for Waste 'Establishing best available techniques (BAT) conclusions for waste treatment, Directive 2010/75/EU (updated August 2018).

4.1.2 An 'Environmental Risk Assessment' covering risks from dust, odour, noise, other fugitive emissions, accidents and fire, and site-specific control measures for the proposed operation has been undertaken as part of this permit application, included as document ref. 5987-CAU-XX-XX-RP-V-0303.

## 4.2 BAT Justification for Emissions Control and Abatement

4.2.1 Provision is made for the monitoring of site activities to ensure no detriment to the environment. Specifically:

- Point source releases to air, water and sewer; and,
- Fugitive releases to air, water and sewer.

4.2.2 It is believed that sufficient evidence has been provided below and within other sections of this report to demonstrate BAT considerations defined in BAT for waste treatment, IED 2010/75/EU (Updated October 2018).

## 4.3 Point Source Releases to Air

4.3.1 Introduction of the reverse osmosis treatment process will not introduce any new point source emissions to air. The RO Plant will be an enclosed unit, with no point source releases to atmosphere.

## 4.4 Point Source Releases to Water (Other than Sewer)

4.4.1 There will be no point source emissions to water.

## 4.5 Point Source Emissions to Sewers, Effluent Treatment Plants or Other Transfers Off-Site

4.5.1 See Section 2.5 of this report for more detail.

4.5.2 The permeate (treated leachate) will be discharged to sewer via existing sewer connection under existing Trade Effluent Discharge Consent (TEDC) ref. 716T4-2-148 (dated 26th February 2024) issued by United Utilities (see Appendix 5 of Supporting Document ref. 5987-CAU-XX-XX-RP-V-0301). It is proposed that the RO Plant will treat and discharge up to 200 tonnes (200$m^3$) per day.

4.5.3 The route the permeate takes to final discharge to sewer is shown on drawing ref. WR7979/02/07/R2, along with the location the permeate leaves the RO Plant at the Sampling Point 'SP'.

4.5.4 A 'H1 Surface Water Pollution Risk Assessment' has been undertaken as part of this permit variation application, for the receiving waters. This is included within this application as document ref. 5987-CAU-XX-XX-RP-O-0300.

4.5.5 Concentrate from the RO process will be stored securely in a specialised bunded 110m$^3$ tank on-site prior to removal off-site by tanker to a suitable disposal facility. Concentrate will not be discharged to surface water or sewer by the Operator and will be kept strictly separate from the permeate prior to collection. The Operator will send concentrate to Davyhulme Waste Water Treatment Works (United Utilities) or FCC Knostrop.

4.5.6 The discharge to sewer will be monitored continuously and sampled monthly at the Sampling Point 'SP' shown on drawing ref. WR7979/02/07/R2 and tested for the suites as per Table 2 of Section 2.10 of this report.

## 4.6 Fugitive Releases to Air

4.6.1 It is not anticipated that there will be any odours released from the RO treatment plant. The RO plant will be fully enclosed which will prevent odours from leaving the plant.

## 4.7 Fugitive Releases to Surface Water, Sewer and Groundwater

4.7.1 In relation to the RO treatment plant, fugitive emissions to water would be primarily associated with surface run off from the treatment/storage area. Potential emissions are mitigated as follows:

- The RO Plant, storage tanks and pipework will be situated within a fully bunded area with impermeable concrete site surfacing, sealed drainage and leachate drip collection sump.

- The RO container is built with a customised steel floor designed like an oil pan. In case of an emergency this will prevent any liquids (surface run-off, chemicals) from leaking out of the container.

- An flow meter will on the permeate discharge line at the RO Plant to continuously record the flow of effluent (permeate) discharged to sewer. The RO Plant will have continuous monitoring of temperature, conductivity and pH within the process which will be constantly monitoring output and will shut down the plant if the permeate quality exceed set limits.

- Concrete surfacing, bunding, tanks and pipework will be subject to routine inspection and maintenance to ensure integrity is maintained.

- Storage tanks for raw leachate, concentrate, permeate and reagents will be fully contained, bunded and equipped with online level monitoring.

- Spillages of liquids or rainwater collected within the bunded area will be collected within a sump and pumped out and disposed of regularly by tanker to the appropriate treatment works.

- Tanker collections of concentrate will be undertaken within the fully bunded tanker parking area, with impermeable concrete surfacing and kerbing. Spillages will be reported immediately and cleaned up using spill kits available on site.

- Daily site inspections by site operatives to check the site, RO Plant and associated infrastructure for any damage, vandalism, leaks or other issues which may give rise to fugitive emissions. Any issues will be reported immediately to site management and dealt with in accordance with procedures set out within the site's Environmental Management System.

- All plant, storage tanks, pipework and other equipment will be serviced regularly and maintained in accordance with a planned preventive maintenance programme (PPMP) and as per manufacturer's instructions to prevent malfunction or breakage of equipment which may give rise to fugitive emissions. Operations and maintenance manuals are supplied by the technology provider who will also provide, for the first 12 months minimum, maintenance and emergency callouts. The plant is designed for a minimum operational life of 20 years.

# 5.0 NOISE & VIBRATION MANAGEMENT

## 5.1 Context

5.1.1 This section of the report overviews the assessment of the impact of noise/vibration from the RO treatment plant on potential noise-sensitive receptors and defines the techniques for monitoring and control of noise at the installation.

5.1.2 Noise emissions, controls and mitigation is also detailed in the 'Environmental Risk Assessment' document ref. 5987-CAU-XX-XX-RP-V-0303.

## 5.2 BAT Justification

5.2.1 With respect to the BAT guidance, it is felt that the general BAT principles are met with respect to:

- Employment of basic good practice measures for noise control.
- Provision of adequate plant maintenance.

## 5.3 Sources of Noise

5.3.1 Sources of noise associated with the RO treatment process will include:

- Pumps associated with the RO plant.
- Vehicle movements including reversing and loading operations.

## 5.4 Reverse Osmosis Treatment Plant Design Considerations

5.4.1 In designing the RO treatment plant consideration has been given to the following mitigation measures:

- Pumps, motors and drives associated with the RO plant will be selected to minimise potential noise emissions.
- Plant and services will be enclosed as far as practicable to minimise the emission of significant noise levels.
- The manufacturers have stated that the maximum sound level at 1m distance from the container is 80 db(A).

## 5.5 Operational Considerations

5.5.1 During plant commissioning, staff training will include raising employee awareness with respect to normal plant operational noise levels and actions to be taken to rectify any faults.

- RO plant doors and hatches will be kept closed when access not required.
- During these periods of downtime, all plant will be switched off.

- RO plant will be maintained in line with manufacturer's recommendations this includes checking for deterioration of plant condition (e.g. bearings becoming worn). Repairs will be undertaken as appropriate to rectify any identified defects.

## 5.6 Noise Monitoring

5.6.1 Noise levels from the RO process will be evaluated during the commissioning period and if necessary further consideration of noise abatement or attenuation will be completed at this stage.

5.6.2 The complaint procedure for the site will record any noise complaints associated with the site including the RO process - should complaints be received consideration will be given to boundary monitoring as appropriate.

# 6.0 ODOUR MANAGEMENT

## 6.1 Context

6.1.1 This section of the report reviews the assessment of the impact of odour from the RO plant on potential odour sensitive locations and defines the techniques for monitoring and control of potential odour generation at the installation.

6.1.2 Odours are not anticipated and therefore it is unlikely that there will be any odours directly associated with treatment operation of the RO plant. The RO plant will be an enclosed system with sealed pipes to minimise the potential for odour release. A planned preventive maintenance programme (PPMP) will be in place for the RO plant, which will also include regular maintenance of equipment and monitoring of processes to ensure odours are minimised.

6.1.3 Staff will be trained in employee awareness of normal plant operational odour levels and abnormal odour levels, and what action to take to minimise odour release. Staff will respond in accordance with the company's management procedures for dealing with odour emissions and complaints should they arise, which will extend to cover operations at the RO Plant.

## 6.2 BAT Justification

6.2.1 With respect to the guidelines outlined in BAT for waste treatment, IED 2010/75/EU (Updated October 2018) and BAT Conclusions for Waste 'Establishing best available techniques (BAT) conclusions for waste treatment, Directive 2010/75/EU (updated August 2018), it is felt that the general BAT principles are met with respect to:

- Employment of basic good practice measures for odour control.
- Provision of odour abatement on the main treatment process.

## 6.3 RO Plant Design Considerations

6.3.1 In designing the RO plant, consideration has been given to the following mitigation measures:

- Enclosure of the RO treatment plant will minimise the potential for odour release.

## 6.4 Operational Considerations

6.4.1 During plant commissioning, staff training will include raising employee awareness with respect to normal plant operational odour levels and actions to be taken to rectify any faults.

- RO plant doors and hatches will be kept closed when access not required.
- Ensuring the RO process operation is optimised in relation to the treatment process and associated abatement processes.

6.4.2 It should be noted that there are existing leachate storage tanks on-site, which are sealed units with no point source emissions to air. These are managed in accordance with the existing management system procedures for the landfill.

# 7.0 REVIEW AGAINST BAT CONCLUSIONS

## 7.1 Overview

7.1.1 This section (Table 4) is a review against 'Establishing Best Available Techniques (BAT) Conclusions for Waste Treatment, under Directive 2010/75/EU of the European Parliament and of the Council' (2018).

7.1.2 In addition, Sector Guidance Note (SGN IPPC 5.06) 'Guidance for the Recovery and Disposal of Hazardous and Non-Hazardous Waste' has also been used as reference for this BAT review.

**Table 4 - Review Against BAT Conclusions**

| BAT Conclusion Number | Description | Applicable to RO Plant | Reference |
|---|---|---|---|
| | **Overall Environmental Performance** | | |
| **1.** | **In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features (I – XV as per BAT Conclusions for Waste Treatment)** | Yes | • The Operator has developed a company-wide Integrated Management System (IMS) accredited to ISO14001 and a Quality Management System accredited to ISO9001. The IMS defines the sites management structure, roles and responsibilities of staff, practices, procedures and resources for achieving, reviewing and maintaining the company's commitment to environmental protection. The IMS also includes the Environmental Policy, Health and Safety Procedures and acts as an operational guidance manual which includes process plant operating procedures for both normal and emergency conditions. A copy of the IMS certificate and summary is contained within Appendix 4 of the Supporting Document of this permit application. The operation of an IMS is an assurance to the regulator, neighbouring businesses, stakeholders, and others alike that the operations at the facility are undertaken in strict compliance with the regulations in force and with the management seeking continual improvements. It requires the company to work in a transparent way, to maintain and improve the confidence of regulators and neighbours, and to have a proactive approach to environmental improvement. The Operator will develop documented management procedures and written work instructions which incorporate environmental considerations into the construction and operation of the facility.<br>• An 'Environmental Risk Assessment' (ERA) has been carried out for the purpose of this application which assesses the environmental risks and potential emissions from the activities proposed to be covered by the permit (document ref. 5987-CAU-XX-XX-RP-V-0303).<br>• A 'H1 Surface Water Pollution Risk Assessment' covering the proposed site activities is also included (document ref. 5987-CAU-XX-XX-RP-O-0300). |

| | | | |
|---|---|---|---|
| | | | • All the above risk assessments for the proposed activities at the site include control measures and procedures to prevent environmental pollution and nuisance to sensitive receptors from potential emissions from the site. These will be incorporated into the EMS for the site. |
| **2.** | **In order to improve the overall environmental performance of the plant, BAT is to use all of the techniques given below (a – g as per BAT Conclusions for Waste Treatment).** | Yes | • Only non-hazardous leachate is to be treated by the RO Plant and the leachate is well characterised. The RO Plant will be adaptable to varying leachate quality throughout the year.<br>• The Operator has a suitably competent person who is qualified as per the company CMS for existing leachate treatment activities at the site. The roles of site staff are clearly defined within the procedures in the Integrated Management System (IMS) and staff will only undertake activities for which they have received suitable training.<br>• All staff undertaking inspection, maintenance and servicing of the RO Plant, tanks, pipework, site surfacing and associated equipment will receive suitable training in the relevant health and safety and environmental procedures in place and reporting of defects/issues with environmental protection measures in place. |
| **3.** | **In order to facilitate the reduction of emissions to water and air, BAT is to establish and to maintain an inventory of waste water and waste gas streams, as part of the environmental management system (see BAT 1), that incorporates all of the following features** | Yes | • The RO Plant, storage tanks for raw leachate, concentrate and process chemicals (sulphuric acid and caustic soda) will be sat within a fully bunded area, which will comply with CIRIA C736, providing secondary containment 110% of the largest container (as a minimum) and a sump will be present to allow the pumping out of any contaminated liquids due to spillages or leaks, or the collection of rainwater. Spill kits will be available on site and staff will be trained in their correct use and disposal.<br>• The tanker parking area for concentrate collection will be fully bunded with a leachate spill collection sump, impermeable concrete surfacing and kerbing at the entrance/exit. Any spills or leaks in this area will be cleaned up immediately using available spill kits by trained site operatives, prior to the tanker leaving to prevent any drag-out of substances onto the road.<br>• The treated permeate produced by the filtration processes in the RO Plant will be discharged to sewer and monitored at the Sampling Point 'SP' as shown in attached drawing ref. WR7979/02/07/R2, within the parameter limits of the TEDC. The connection to the discharge |

| | | | |
|---|---|---|---|
| | **(i. – iii. as per BAT Conclusions for Waste Treatment).** | | point will comprise a 150mm diameter HDPE twin-wall pipeline from the RO Plant to the existing effluent balance tank of the leachate treatment plant on-site, before discharging to the existing sewer line. A flow-meter ('FM' on drawing ref. WR7979/02/07/R2) will be present on the permeate line from the RO Plant, through which all permeate will flow prior to discharge, together with a sampling tap at the Sampling Point 'SP'. The permeate discharge has been assessed in 'H1 Surface Water Pollution Risk Assessment' ref. 5987-CAU-XX-XX-RP-O-0300, included within the application.<br>• Volumes of permeate discharged to sewer will be recorded daily as per the EMS procedures and will be restricted by the RO Plant processing capabilities (200$m^3$ per day).<br>• Any site surface run-off within the bunded area will be contained by bund walls and collected in the sump before being pumped out and disposed of off-site at the appropriate licensed waste water treatment facility.<br>• There will be no waste gas streams at the site. |
| **4.** | **In order to reduce the environmental risk associated with the storage of waste, BAT is to use all of the techniques given below (a – d as per BAT Conclusions for Waste Treatment).** | Yes | • Raw leachate from Deerplay Landfill Site will be stored in a fully bunded 54.5$m^3$ raw leachate reception tank prior to treatment in the RO Plant. The concentrate (post-treatment) will be stored in a fully bunded 110$m^3$ tank. All tanks, pipework and RO Plant container will sit within a fully bunded impermeable concrete surfaced area, constructed to CIRIA C736.<br>• The connection to the discharge point will comprise a 150mm diameter HDPE twin-wall pipeline from the RO Plant to the existing effluent balance tank of the leachate treatment plant on-site, before discharging to the existing sewer line. A flow-meter ('FM' on drawing ref. WR7979/02/07/R2) will be present on the permeate line from the RO Plant, through which all permeate will flow prior to discharge, together with a sampling tap at the Sampling Point 'SP'. Bunding and storage will comply with CIRIA C736.<br>• The plant is designed for a minimum operational life of 20 years.<br>• A planned preventive maintenance programme (PPMP) for all elements of the plant will be put in place which will include regular inspection of storage vessels. Operations and |

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| | | | maintenance manuals are supplied by the technology provider who will also provide, for the first 12 months minimum, maintenance and emergency callouts.<br>• It is proposed that the plant will operate continuously, treating and discharging up to 200 m³ (200 tonnes) per day of permeate.<br>• All tanks and vessels will be appropriately labelled and clearly signed as to their contents and capacity, each given a unique identifier.<br>• Written records will be held for all tanks including the above and:<br>- Capacity<br>- Construction (including materials)<br>- Maintenance schedules and inspection results<br>- Fittings (including joints and gaskets etc)<br>- Waste types that may be stored and or treated in the vessel including flash point limit.<br>• Labelling of tanks and process pipework will differentiate between wastewater and raw process waters including direction of flow. |
| **5.** | **In order to reduce the environmental risk associated with the handling and transfer of waste, BAT is to set up and implement handling and transfer procedures** | Yes | • Handling and transfer of leachate, concentrate and raw materials will be undertaken in accordance with procedures and control measures as set out in the site's Integrated Management System (IMS) and 'Environmental Risk Assessment' ref. 5987-CAU-XX-XX-RP-V-0303, in order to reduce odour, noise and other emissions and to ensure the site is kept clean and tidy for practicality and safety of site operatives.<br>• The Operator has a suitably competent person who is qualified as per the company CMS for existing leachate treatment activities at the site. The roles of site staff are clearly defined within the procedures in the Integrated Management System (IMS) and staff will only undertake activities for which they have received suitable training.<br>• All staff will receive suitable training in leachate waste and raw materials/substances handling and the relevant health and safety and environmental procedures in place. |

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| | | | • All staff to be involved with the operation of the RO treatment plant will receive training relevant to the tasks that they will be carrying out. This will include safe handling, use and disposal of process chemicals.<br>• All staff will receive training and refresher training on correct handling and transfer of waste around site, as part of training programmes included within the EMS. Operations will be undertaken during normal site operational hours.<br>• The risks from spillages of potentially polluting substances or waste is assessed in the 'Environmental Risk Assessment' report ref. 5987-CAU-XX-XX-RP-V-0303. |
| | **Monitoring** | | |
| **6.** | **Monitoring – for relevant emissions to water as identified by the inventory of waste water streams (see BAT 3), BAT is to monitor key process parameters at key locations** | No | • There will be no discharge to surface water or groundwater.<br>• Permeate will be discharged to sewer. A 'H1 Surface Water Pollution Risk Assessment' ref. 5987-CAU-XX-XX-RP-O-0300 has been undertaken as part of this permit application. The concentrate produced by the process will be tankered off-site to a suitable treatment facility. A dedicated concentrate tank will ensure adequate, bunded storage prior to disposal off site.<br>• Emissions to sewer monitoring will comprise of continuous flow monitoring and monthly permeate sampling and testing for the parameters/suites listed in Table 2, Section 2.10 of this report.<br>• The RO plant discharge can be isolated should there be a breach in permitted compliance limits for effluent samples, and all non-compliances will be recorded and the site manager notified. |
| **7.** | **BAT is to monitor emissions to water with at least the frequency given below and in accordance with EN standards.** | No | • See above response to BAT 6 - There will be no point source emissions to surface water or groundwater. |

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| **8.** | **BAT is to monitor channelled emissions to air with at least the frequency given below and in accordance with EN standards.** | No | • Introduction of the new reverse osmosis leachate treatment process will not introduce any new point source emissions to air. The RO Plant will be an enclosed unit, with no point source releases to atmosphere. |
| **9.** | **Bat is to monitor diffuse emissions of organic compounds to air from the regeneration of spent solvents, the decontamination of equipment containing POPs with solvents, and the physico-chemical treatment of solvents for the recovery of their calorific value, at least once per year using one or a combination of the techniques given below (a – c as per BAT Conclusions for Waste Treatment).** | No | Not applicable to this application. |
| **10.** | **BAT is to periodically monitor odour emissions.** | Yes | • Odour risk from the RO Plant and storage of raw leachate and concentrate is addressed in the 'Environmental Risk Assessment' report ref. 5987-CAU-XX-XX-RP-V-0303 and considered a low risk to receptors if control measures implemented. As part of daily site inspections, odour will |

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| | | | be checked for, along with other potential fugitive emissions, and staff will be trained to detect and report any abnormal odour issues on-site to site management immediately. |
| **11.** | **BAT is to monitor the annual consumption of water, energy and raw materials as well as the annual generation of residues and waste water, with a frequency of at least once per year.** | Yes | • An inventory of the annual consumption of water and raw materials, and the annual volumes of concentrate produced/sent off-site and permeate discharged to sewer will be recorded, in accordance with the environmental permit and procedures set out in the Integrated Management System (IMS) for the site.<br>• The raw materials to be used consist primarily of the following substances:<br>  • Sulphuric acid<br>  • Caustic Soda (NaOH)<br>  • Membrane Acidic cleaner (Citric Acid)<br>  • Alkaline cleaner (P3-ultrasil 11)<br>  • Descaling Chemicals<br>• The Operator will select the least harmful products to use in the operation wherever possible.<br>• The Operator will keep Material Safety Data Sheets (MSDS) for all products used and will monitor the quantity of materials used. This will provide data for regular reviews of raw materials usage. All product documentation will be checked against the order prior to acceptance.<br>• Any incorrect labelling will be removed/corrected prior to placing the material in storage. Product storage tanks and containers will be appropriately labelled with regards to the contents and any hazards associated with the product.<br>• All vessels and tanks used for storage of process/raw materials will be above ground with secondary containment of materials that are appropriate to the chemical nature of the materials being stored. Drums will be placed within a designated area.<br>• Water usage will be small in volume and limited to cleaning of the RO Plant. |

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| | **Emissions to Air** | | |
| **12.** | **In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements (a – d as per BAT Conclusions for Waste Treatment).** | Yes | • See response to BAT 10.<br>• An Odour Management Plan (OMP) is not considered necessary for the proposed RO Plant, as it is a sealed plant with sealed pipework and with no point source emissions to air, and therefore the risk to receptors is considered to be low, with control measures in place (see 'Environmental Risk Assessment' ref. 5987-CAU-XX-XX-RP-V-0303).<br>• Any odour complaints received directly by the Site or via the Regulatory Bodies, including the EA and Local Authority, will be recorded on the FCC EcoOnline database. Investigation will then be undertaken via olfactory monitoring at the location of the complaint and on-site to substantiate the extent and location of the plume and to identify the source of the odour.<br>• If necessary, odour monitoring will also be carried out at the nearest sensitive receptors to the site and the monitoring results recorded.<br>• Further olfactory monitoring will be carried out upon close of the complaint to ensure the issue has been addressed and to monitor the effectiveness of any control measures undertaken.<br>• All information is recorded digitally and maintained within a digital database. All information can be accessed via computer within the Site Office and will be made available to the Environment Agency on request. This record keeping already forms part of the Site's Integrated Management System. |
| **13.** | **In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to use one or a combination of the techniques given below** | Yes | • See response to BAT 10 and 12 above. |

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| | **(a – c as per BAT Conclusions for Waste Treatment).** | | |
| **14.** | **In order to prevent or, where that is not practicable, to reduce emissions to air, in particular of dust, organic compounds and odour. BAT is to use an appropriate combination of the techniques given (a – h as per BAT Conclusions for Waste Treatment).** | Yes | • See response to BAT 10, 12 and 13.<br>• The risks of emissions such as odour and dust from the proposed operations have been assessed in the 'Environmental Risk Assessment' report ref. 5987-CAU-XX-XX-RP-V-0303. |
| **15.** | **BAT is to use flaring only for safety reasons or for non-routine operation conditions (e.g. start-ups, shut downs) by using techniques (a – b as per BAT Conclusions for Waste Treatment).** | No | Not applicable to this application. |
| **16.** | **In order to reduce emissions to air from flares when flaring is unavoidable, BAT** | No | Not applicable to this application. |

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| | **is to use the techniques detailed (a – b as per BAT Conclusions for Waste Treatment).** | | |
| | **Noise and Vibrations** | | |
| **17.** | **In order to prevent, or where that is not practicable, to reduce noise and vibration emissions, BAT is to set up, implement and regularly review a noise and vibration management plan as part of the environmental management system.** | Yes | • Noise and vibrations have been considered in the 'Environmental Risk Assessment' document ref. 5987-CAU-XX-XX-RP-V-0303, which concludes that noise and vibration impacts are likely to be of very low impact to sensitive receptors with control measures in place. Therefore, a Noise Management Plan is not considered necessary for this site.<br>• A planned preventative maintenance programme (PPMP) will be in place for all parts of the plant and will include routine maintenance and servicing of parts that could give rise to increases in noise and vibrations and as part of the routine site checks, noise and vibration emissions will be checked.<br>• In designing the RO treatment plant consideration has been given to the following mitigation measures:<br>- Pumps, motors and drives associated with the RO plant will be selected to minimise potential noise emissions.<br>- Plant and services will be enclosed as far as practicable to minimise the emission of significant noise levels.<br>- During plant commissioning, staff training will include raising employee awareness with respect to normal plant operational noise levels and actions to be taken to rectify any faults.<br>- RO plant doors and hatches will be kept closed when access not required.<br>- During these periods of downtime, all plant will be switched off. |

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| | | | - RO plant will be maintained in line with manufacturer's recommendations this includes checking for deterioration of plant condition (e.g. bearings becoming worn). Repairs will be undertaken as appropriate to rectify any identified defects.<br>• As the location of the plant is not within a sensitive location it is not proposed to undertake a noise assessment or that any specific abatement measures are employed.<br>• Noise levels from the RO process will be evaluated during the commissioning period and if necessary further consideration of noise abatement or attenuation will be completed at this stage.<br>• The complaint procedure for the site will record any noise complaints associated with the site as a whole including the RO process – should complaints be received consideration will be given to boundary monitoring as appropriate. |
| **18.** | **In order to prevent or where that is not practicable, to reduce noise and vibration emissions, BAT is to use of or a combination of the techniques given (a – e as per BAT Conclusions for Waste Treatment).** | Yes | • See response to BAT 17. |
| | **Emissions to Water** | | |
| **19.** | **In order to optimise water consumption, to reduce the volume of waste water generated and to prevent or, where that it not** | No | • See responses to BAT 3 and BAT 6.<br>• The site will benefit from an impermeable concrete surface, that will be inspected daily for cracks or damage and made-good as soon as practicable. The RO Plant, storage tanks and |

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| | **practicable, to reduce emissions to soil and water, BAT is to use an appropriate combination of the techniques given (a – l as per BAT Conclusions for Waste Treatment).** | | pipework will be fully bunded. This will ensure the surrounding surface water and ground water environment are protected from accidental release of pollution from the site. |
| **20.** | **In order to reduce emissions to water, BAT is to treat waste water using an appropriate combination of techniques (a – r as per BAT Conclusions for Waste Treatment).** | No | • There will be no point source emissions to surface water or groundwater from the proposed RO Plant treatment process. Permeate will be discharged to sewer which will ultimately end up at the Burnley Wastewater Treatment Works.<br>• See Section 1.2 of this report for information on the proposed Reverse Osmosis Plant to be installed to treat non-hazardous leachate from Deerplay Landfill Site which is well-characterised. This treatment activity is a type of physico-chemical treatment of leachate.<br>• The RO Plant will take raw leachate and treat it via a series of filters in 3-stages, with the addition of reagents to produce a permeate which can be discharged directly to sewer.<br>• The RO Plant will be capable of achieving clean and consistent water quality for the treated leachate for discharge to sewer.<br>• As deemed best practice, a 'H1 Surface Water Pollution Risk Assessment' (ref. 5987-CAU-XX-XX-RP-O-0300) has been undertaken as part of this permit application. |
| | **Emissions from Accidents and Incidents** | | |
| **21.** | **In order to prevent or limit the environmental consequences of accidents and incidents, BAT is to use all for the techniques given** | Yes | • An 'Environmental Risk Assessment' is provided as report ref. 5987-CAU-XX-XX-RP-V-0303. Risks from dust, odour, noise, other fugitive emissions, accidents and fire are considered to be 'low' from the proposed site activities.<br>• The company Integrated Management System will include an 'Accident Management Plan' for the site, with written procedures for handling, investigating, communicating and reporting environmental complaints and implementation of appropriate actions. |

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| | **below, as part of the accident management plan (a – c as per BAT Conclusions for Waste Treatment).** | | |
| | **Material Efficiency** | | |
| **22.** | **In order to use materials efficiently, BAT is to substitute materials with waste.** | No | • Not applicable – specific raw materials i.e. caustic soda, sulphuric acid etc. will be required in the RO treatment process and stored in suitable containers and under cover to avoid spoiling. |
| | **Energy Efficiency** | | |
| **23.** | **In order to use energy efficiently, BAT is to use both of the techniques given below:**<br>**a) Energy Efficiency plan**<br>**b) Energy balance record** | Yes | • Housekeeping measures including maintenance and operational procedures are in place for all areas of the site where the breakdown of machinery could lead to an impact upon the environment or compromise the Operator's ability to undertake normal site activities. A planned preventive maintenance programme (PPMP) will be in place covering all equipment with significant impact on the plant's energy consumption or energy conservation.<br>• Energy consumption information will be collated and reported on in accordance with the permit. The main energy use at the plant will be from the high-pressure pumps associated with the filtration process, which will operate 365 days per year. A number of process/discharge/dosing pumps that will operate intermittently throughout the process. The control panel will record periods when particular equipment is in use and the power consumption of each unit is known. This will provide the ability to accurately monitor and report on the use of energy from different parts of the operation within the plant. This information can be used for periodic reviews of energy use in order to identify potential energy reduction opportunities.<br>• Processes will be controlled by electronic automated control systems. The control room for the plant will be within the RO plant container but will not be manned other than during daily |

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| | | | checks and inspections. There will be no requirement to heat the control room except for a frost heater, and so electricity use will be minimal.<br>• This is a new plant that has been designed with energy minimisation in mind. Energy efficiency measures identified at design stage have been incorporated as part of the design.<br>• These measures will be reviewed every year to determine if additional energy savings could be made and will include: -<br>  • Switching off equipment when not in use;<br>  • Careful operation and maintenance of plant & equipment; and,<br>  • Regular cleaning of plant & equipment.<br>• See response to BAT 11. |
| | **Re-Use of Packaging** | | |
| **24.** | **In order to reduce the quantity of waste sent for disposal, BAT is to maximum the reuse of packaging, as part of the residues management plan.** | | • Any packaging e.g. pallets etc. will be returned to the supplier for efficient recycling and re-use where appropriate. The Operator will (where applicable) re-use clean packaging and/or recycle at a suitable facility to reduce the quantity of waste sent for disposal.<br>• Containers and drums will be sent to the appropriate recycling or disposal facility. |
| | **General BAT conclusions for the mechanical treatment of waste** | | |
| **25.** | **In order to reduce emissions to air of dust, and of particulate-bound metals, PCDD/F and dioxin-like PCBs, BAT is to apply BAT 14d and to use one or a combination of the techniques given below.** | No | Not applicable to this application. |

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| | **BAT conclusions for the mechanical treatment in shredders of metal waste** | | |
| **26.** | **In order to improve the overall environmental performance, and to prevent emissions due to accidents and incidents, BAT is to use BAT 14g and all of the techniques given (a – c as per BAT Conclusions for Waste Treatment).** | No | Not applicable to this application. |
| **27.** | **In order to prevent deflagrations and to reduce emissions when deflagrations occur, BAT is to use technique a. and one or both of the techniques b. and c. given below (as per BAT Conclusions for Waste Treatment).** | No | Not applicable to this application. |
| **28.** | **In order to use energy efficiently, BAT is to keep the shredder feed stable.** | No | Not applicable to this application. |
| | **BAT conclusions for the treatment of WEEE containing VFCs and/or VHCs** | | |
| **29. to 30.** | **BAT conclusions 29-30** | No | Not applicable to this application. |

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| | **BAT conclusions for the mechanical treatment of waste with calorific value** | | |
| **31.** | **BAT conclusion 31** | No | Not applicable to this application. |
| | **BAT conclusions for the mechanical treatment of WEEE containing mercury** | | |
| **32.** | **BAT conclusion 32** | No | Not applicable to this application. |
| | **General BAT conclusions for the biological treatment of waste** | | |
| **33. to 35.** | **BAT conclusions 33-35** | No | Not applicable to this application. |
| | **BAT conclusions for the aerobic treatment of waste** | | |
| **36. to 37.** | **BAT conclusions 36-37** | No | Not applicable to this application. |
| | **BAT conclusions for the anaerobic treatment of waste** | | |
| **38.** | **BAT conclusion 38** | No | Not applicable to this application. |
| | **BAT conclusions for the mechanical biological treatment (MBT) of waste** | | |
| **39.** | **BAT conclusion 39** | No | Not applicable to this application. |
| | **BAT conclusions for the physico-chemical treatment of solid and/or pasty waste** | | |
| **40. to 41** | **BAT conclusion 40-41** | No | Not applicable to this application. |
| | **BAT conclusions for the re-refining of waste oil** | | |
| **42. to 44.** | **BAT conclusions 42-44** | No | Not applicable to this application. |
| | **BAT conclusions for the physico-chemical treatment of waste with calorific value** | | |
| **45.** | **BAT conclusion 45** | No | Not applicable to this application. |
| | **BAT conclusions for the regeneration of spent solvents** | | |
| **46. to 49.** | **BAT conclusions 46-49** | No | Not applicable to this application. |
| | **BAT conclusions for the water washing of excavated contaminated soil** | | |
| **50.** | **BAT conclusion 50** | No | Not applicable to this application. |
| | **BAT conclusions for the decontamination of equipment containing PCBs** | | |
| **51.** | **BAT conclusion 51** | No | Not applicable to this application. |
| | **BAT conclusions for the treatment of water-based liquid waste** | | |
| **52.** | **In order to improve the overall environmental** | No | Not applicable to this application – only non-hazardous leachate from Deerplay Landfill Site to be treated and stored at the proposed RO Plant. No leachate will imported and treated at the |

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| | **performance, BAT is to monitor the waste input as part of the waste pre-acceptance and acceptance procedures (see BAT 2).** | | site and therefore waste acceptance and pre-acceptance does not apply. The non-hazardous leachate from Deerplay Landfill Site is well characterised – see 'H1 Surface Water Pollution Risk Assessment' ref. 5987-CAU-XX-XX-RP-O-0300 included as part of this permit application. |
| **53.** | **In order to reduce emissions of HCl, NH3 and organic compounds to air, BAT is to apply BAT 14d and to use one or a combination of the techniques given below (a-d as per BAT Conclusions for Waste Treatment).** | Yes | • There are no point source emissions to air proposed as part of the RO Plant and associated operations. The risks of emissions such as odour and dust from the proposed operations have been assessed in the 'Environmental Risk Assessment' report ref. 5987-CAU-XX-XX-RP-V-0303 and are considered 'low' with control measures in place. |

## 8.0 REFERENCES

1. Best Available Techniques (BAT) reference document for waste treatment, IED 2010/75/EU (Integrated Pollution Prevention and Control) (Updated October 2018).

2. Best Available Techniques (BAT) Conclusions for Waste 'Establishing best available techniques (BAT) conclusions for waste treatment, under Directive 2010/75/EU of the European Parliament of the Council. (updated August 2018).

3. The Environment Agency's Sector Guidance Note (SGN IPPC 5.06) 'Guidance for the Recovery and Disposal of Hazardous and Non-Hazardous Waste' (last updated 10th October 2018).

## DRAWINGS

| | |
|---|---|
| WR7979/01/01 | Site Location |
| WR7979/01/02 | Existing Site Layout |
| WR7979/01/03 | Proposed RO Plant Site Layout |
| WR7979/01/04 | Proposed RO Plant Elevations |
| WR7979/02/07/R2 | Pipe and Cable Runs |

**NOTES**

1. ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM.

2. DO NOT SCALE FROM THIS DRAWING.

3. ANY ANOMALIES IDENTIFIED WITH THE DETAILS SHOWN ON THIS DRAWING ARE TO BE BROUGHT TO THE ATTENTION OF SIRIUS ENVIRONMENTAL PRIOR TO CONSTRUCTION WORKS COMMENCING.

**KEY**

FCC OWNERSHIP BOUNDARY

PROPOSED RO PLANT BOUNDARY

| REV | DESCRIPTION | DATE | BY |
|---|---|---|---|
| 1 | Boundary Amended | 18.01.2024 | ARK |

**CLIENT**

FCC Environment

FCC Environment (UK) Limited
6 Sidings Court, White Rose Way, Doncaster. DN4 5NU

Sirius Environmental

4245 Park Approach, Thorpe Park, Leeds. LS15 8GB. 0113 264 9960

**JOB TITLE**

DEERPLAY LANDFILL SITE
PROPOSED RO PLANT

**DRAWING TITLE**

SITE LOCATION

| DRAWN | DATE | APPROVED | DATE |
|---|---|---|---|
| JE | 16/11/2023 | A.K | 17/11/2023 |

| SCALE | SHEET | DRAWING NUMBER | REVISION |
|---|---|---|---|
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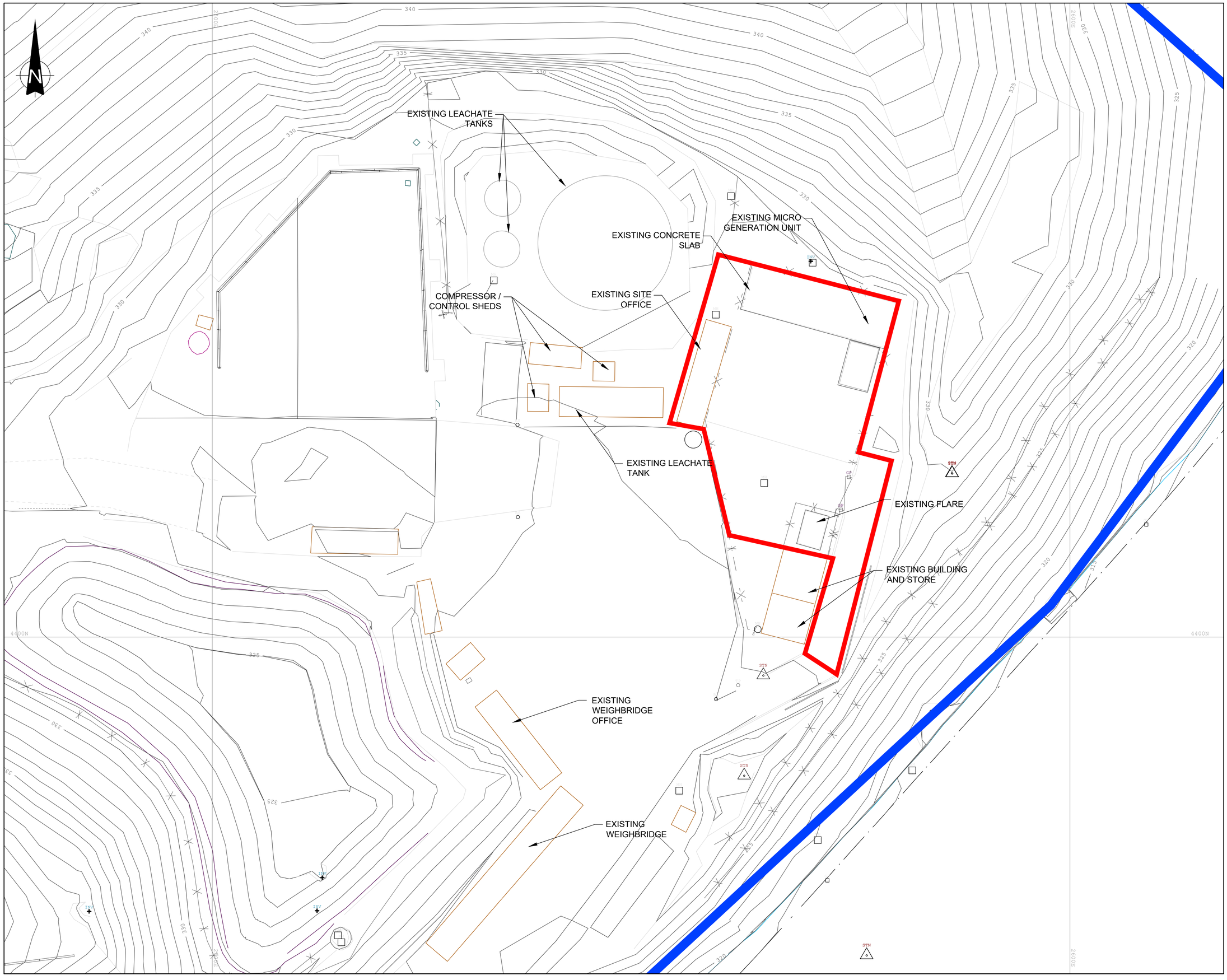




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3. ANY ANOMALIES IDENTIFIED WITH THE DETAILS SHOWN ON THIS DRAWING ARE TO BE BROUGHT TO THE ATTENTION OF SIRIUS ENVIRONMENTAL PRIOR TO CONSTRUCTION WORKS COMMENCING.

**KEY**

- FCC OWNERSHIP BOUNDARY
- PROPOSED RO PLANT BOUNDARY

| REV | DESCRIPTION | DATE | BY |
|---|---|---|---|
| 1 | LAYOUT UPDATED | 18.01.2024 | ARK |

**CLIENT**

FCC Environment

FCC Environment (UK) Limited
6 Sidings Court, White Rose Way, Doncaster, DN4 5NU

Sirius Environmental
4245 Park Approach, Thorpe Park, Leeds. LS15 8GB. 0113 264 9960

**JOB TITLE**

DEERPLAY LANDFILL SITE
PROPOSED RO PLANT

**DRAWING TITLE**

EXISTING SITE LAYOUT

| DRAWN | DATE | APPROVED | DATE |
|---|---|---|---|
| JE | 16/11/2023 | A.K | 17/11/2023 |

| SCALE | SHEET | DRAWING NUMBER | REVISION |
|---|---|---|---|
| 1:2500 | RO | WR7979 01 02 | 1 |

## NOTES

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## KEY

FCC OWNERSHIP BOUNDARY

PROPOSED RO PLANT BOUNDARY

| REV | DESCRIPTION | DATE | BY |
|---|---|---|---|
| 2 | MICRO GENERATION UNIT ADDED | 15/01/24 | ARK |
| 1 | REVISED LAYOUT | 11/12/23 | JE |

**CLIENT**

FCC Environment (UK) Limited
6 Sidings Court, White Rose Way, Doncaster. DN4 5NU

sirius Environmental
4245 Park Approach, Thorpe Park, Leeds. LS15 8GB. 0113 264 9960

**JOB TITLE**

DEERPLAY LANDFILL SITE
PROPOSED RO PLANT

**DRAWING TITLE**

PROPOSED SITE LAYOUT

| DRAWN | DATE | APPROVED | DATE |
|---|---|---|---|
| JE | 16/11/2023 | A.K | 17/11/2023 |

| SCALE | SHEET | DRAWING NUMBER | REVISION |
|---|---|---|---|
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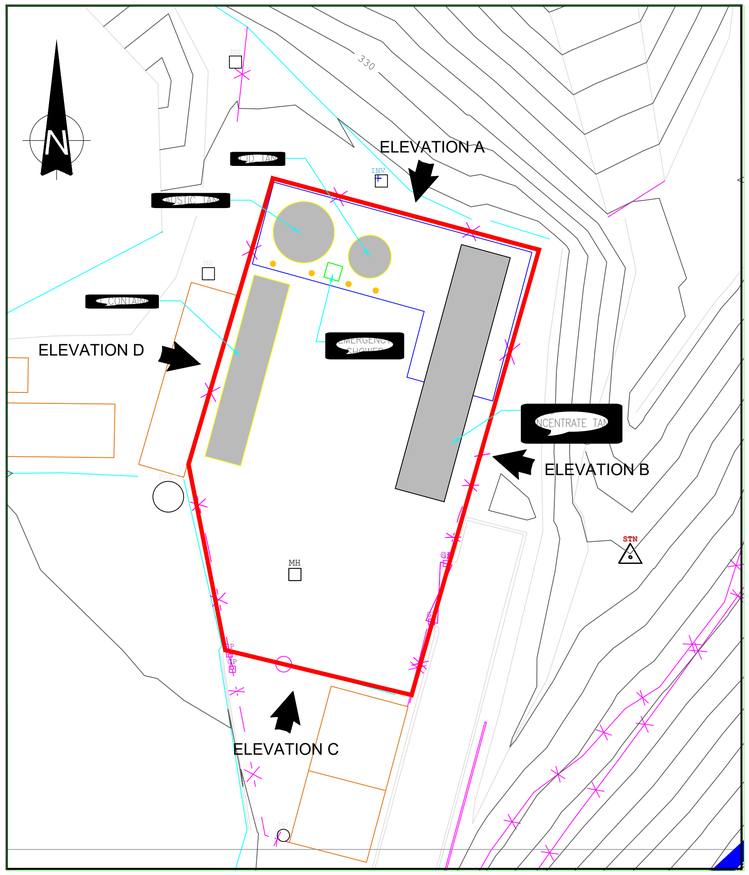
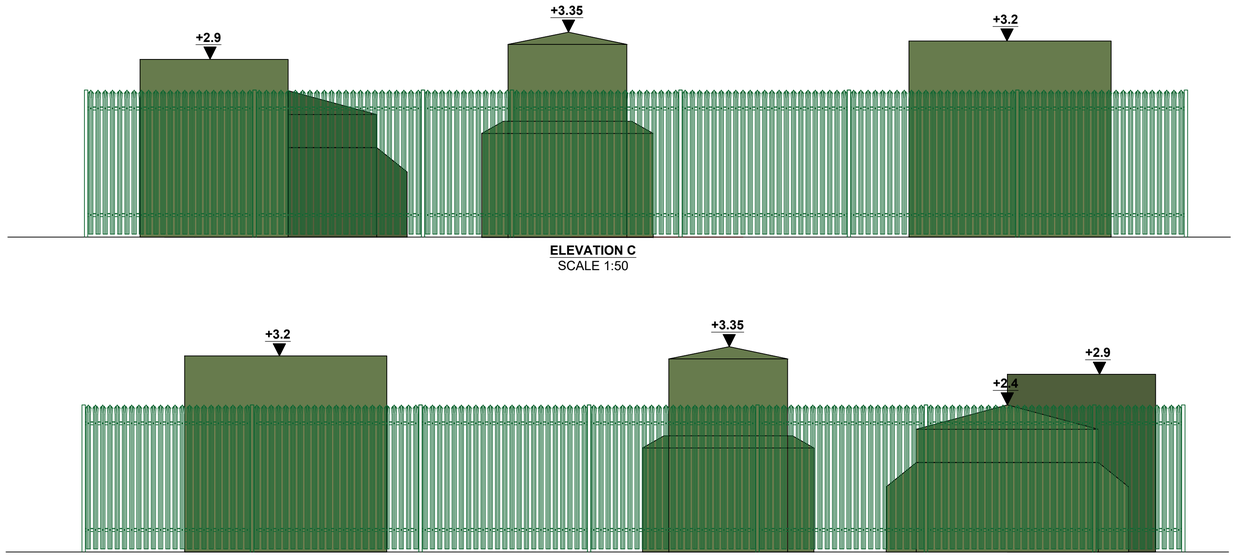


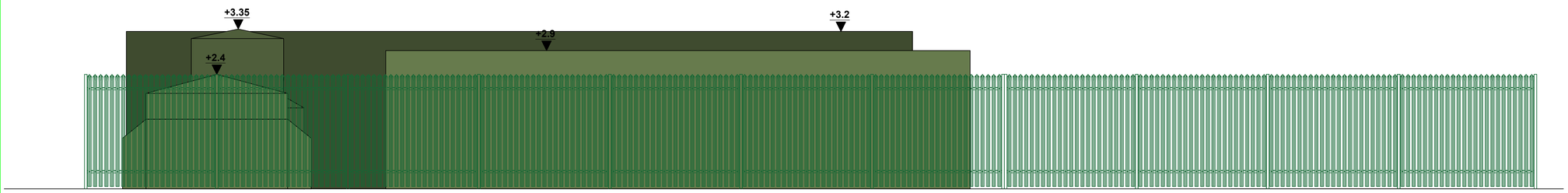

**PROPOSED RO PLANT LAYOUT & ELEVATION LOCATIONS**
SCALE 1:200



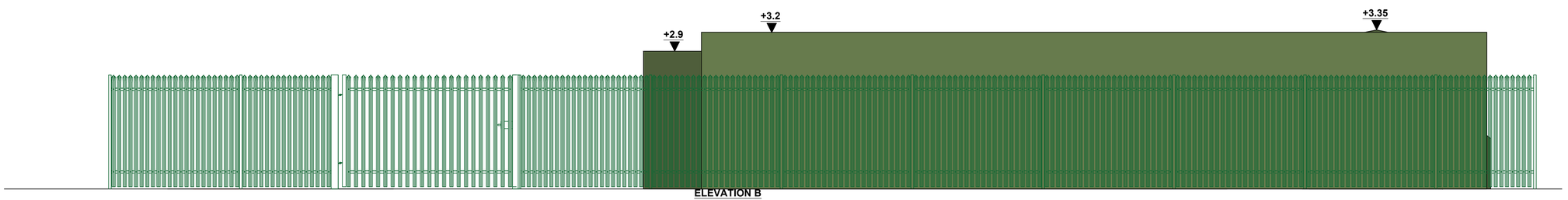

**ELEVATION C**
SCALE 1:50




**ELEVATION A**
SCALE 1:50




**ELEVATION D**
SCALE 1:50




**ELEVATION B**
SCALE 1:50



**NOTES**

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**KEY**

| REV | DESCRIPTION | DATE | BY |
|---|---|---|---|
| 1 | REVISED LAYOUT | 11/12/23 | JE |

**CLIENT**

FCC Environment

FCC Environment (UK) Limited
6 Sidings Court, White Rose Way, Doncaster. DN4 5NU

Sirius Environmental

4245 Park Approach, Thorpe Park, Leeds. LS15 8GB. 0113 264 9960

**JOB TITLE**

DEERPLAY LANDFILL SITE
PROPOSED RO PLANT

**DRAWING TITLE**

PROPOSED RO PLANT
ELEVATIONS

| DRAWN | DATE | APPROVED | DATE |
|---|---|---|---|
| JE | 16/11/2023 | A.K | 17/11/2023 |

| SCALE | SHEET | DRAWING NUMBER | REVISION |
|---|---|---|---|
| AS SHOWN | RO | WR7979 01 04 | 1 |

## NOTES

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LEGEND

- SITE SURVEY
- PROPOSED TOP OF SLAB
- A1-A2 - CAUSTIC DOSING LINE - 12 x 1.5mm PTFE INSIDE A 1&1/2" PVCU SLEEVE - TRACE HEATED
- B1-B2 - ACID DOSING LINE - 12 x 1.5mm PTFE INSIDE A 1&1/2" PVCU SLEEVE
- C1-C2 - RO TO CONCENTRATE PIPE = 2 x 63mm HDPE (BACKWASH AND CONCENTRATE)
- D1-D2 - RO TO EXISTING LTP DISCHARGE BALANCE TANK = 63mm HDPE
- E1-E2 - LEACHATE TANK TO RO = 63mm HDPE - FED VIA 2" SUB PUMP
- F1-F2 - WATER PIPE TO EMERGENCY SHOWER - SIZE/SPEC AS EXISTING PIPE

  F2 - BIB TAP AND HOSE LOCATED NEXT TO EMERGENCY SHOWER.
- G1-G2 - CONCENTRATE TANK TO LOADING POINT 110mm HDPE - REQUIRES SIPHON PROTECTION
- H1-H2 - LEACHATE TANK TO LOADING POINT 110mm HDPE - REQUIRES SIPHON PROTECTION
- EXISTING FOUL SEWER
- EXISTING FLOW METER
- SP SAMPLING POINT
- FM FLOW METER

ISSUED FOR CONSTRUCTION

| REV | DESCRIPTION | DATE | BY |
|---|---|---|---|
| 2 | FLOW METER / SAMPLE POINT ADDED | 11.03.24 | CAU |
| 1 | CONNECTION TO EXISTING OUTLET ADDED | 11.03.24 | MCC |

**CLIENT**

FCC Environment

FCC Environment (UK) Limited
6 Sidings Court, White Rose Way, Doncaster. DN4 5NU

sirius Environmental
4245 Park Approach, Thorpe Park, Leeds. LS15 8GB. 0113 264 9960

**JOB TITLE**

DEERPLAY LANDFILL SITE
Proposed RO Plant

**DRAWING TITLE**

Proposed RO Plant Pipe and Cable Runs

| DRAWN | DATE | APPROVED | DATE |
|---|---|---|---|
| M.C | 07/03/2024 | A.K | 07/03/2024 |

| SCALE | SHEET | DRAWING NUMBER | REVISION |
|---|---|---|---|
| 1:100 | A1L | WR7979/02/07 | 2 |

# APPENDIX 1

**Indicative Technical Proposal – Reverse Osmosis Plant 200m$^3$/day**

**Client:**
FCC Environment

**Date:**
26/09/2022

**A/C:**
Ian Martin

**No of pages:**
29

**AST - Soluções e Serviços de Ambiente Lda.**

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# TECHNICAL PROPOSAL

## LEACHATE TREATMENT PLANT
## MOBILE REVERSE OSMOSIS SYSTEM (200 $m^3$/day)

Ref. PROJ202209_072SL_a_UK_FCC_Calvert_OI200

*Figure 1: Reference AST - Landfill site in Tondela (Portugal) 2x200m3/day and 1x120 m3/day.*

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# 1 Introduction

The present technical proposal specifies the scope of supply of a **Reverse Osmosis Leachate Treatment Plant** for the waste landfill site Calvert, owned and operated by FCC Environment.

This Reverse Osmosis (RO) plant has a three purification stages to **guarantee a high discharge quality** and give the client the possibility of reusing the purified water and reduce the hydric footprint of his business.

The RO module has a treatment capacity of 200 $m^3$/day of raw leachate. The maximum operating pressure is 80 bar, to minimize the concentrate production. The present solution considers a 3-stage treatment because, due to variations of leachate quality and temperatures, solutions with two stages have revealed to be insufficient in terms of the quality compliance of the treated leachate.

The suggested technological solution will be completely installed inside one 40ft marine-type container, ready to use (turnkey solution), and its construction allows the direct feed with leachate from the usually used storage lagoons or tanks. On the other hand, it is a high-mobility solution, as the containers can rapidly be removed and set into operation in other landfill sites for the leachate treatment of those facilities.

The technology on which this solution is based on enables a **fast and easy adjustment to the naturally occurring variations of the leachate composition.**

The implementation of AST's new proprietary **Turboclean®** technology in leachate treatment systems enhances system availability, extends the membranes lifetime, and reduces the operational costs.

There are more than 100 similar units of this type in the market.

The design of these units was developed to **minimize the operational costs, maximize service life, and enable a safe and easy operation**. The following issues are crucial:

- Production of high-quality purified water.
- Minimization of concentrate production.
- Low membrane replacement costs.
- Protection of the system against corrosion/degradation: Container is divided, having a machine compartment and a monitoring and control compartment.
- Additional protection of the monitoring and control system by means of an air conditioning system *(to be provided locally by the client and not included in this offer price)* and forced air ventilation with activated carbon filtration to increase the service life of the electrical installation and control system.
- High level of automation for a comfortable and safe operation.
- Electromagnetic flow measuring devices with a higher reliability, which are installed in all important measuring points.



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- Visualization on a 19” monitor, color, for the easy and rapid perception of the process and the operation parameters.
- Up-to-date and robust industrial computers by Siemens.
- Easy change of operation parameters to enable a better and a more rapid adjustment regarding the change of the leachate.
- Remote control via Internet.
- Value and event recording system, with a report and graphic output.
- Container insulation (acoustical and thermal improvements)
- The container is constructed to serve as a retention basin, including a pump station and a level sensor, to avoid a possible leachate spillage into the environment.
- Cleaning tank with the possibility to use liquid or powdery products (reduction of operation costs).
- Acid injection system, completely closed in an acid-resistant housing and equipped with a sensor that shuts down the system when there is a spillage.

## 1.1 Optional Extras

### 1.1.1 Automatic cleaning program

Is a cleaning necessary, chemical pumps feed the selected liquid cleaner medium into the CIP tank until the desired amount is reached. The washing program starts automatically for the pre-settled time or until the maximum allowed temperature is reached.
The pH of the cleaning solution is constantly measured during the cleaning and corrected if necessary.
This method ensures that the optimum amount of chemicals is used during the cleaning. Advantages of this cleaning program and the use of automatically dosing are safety, the saving of chemicals, workforce, and downtime.

### 1.1.2 Operation in “Concentrate Mode”

The plant allows processing the already produced concentrate with a proprietary and automatized mode. The first concentrate will be sent to an intermediate storage lagoon (by the client). When the tank is full, the plant will be changed through local operator by selecting concentrate mode. This solution will be implemented on the software and hardware side and includes a daily acid cleaning and soaking cycle. In this case, the second and third purifications stage will be deactivated and therefore permeate of the plant usually do not comply with direct discharge parameters and must be sent to the leachate lagoon with the positive side effect of diluting. By experience, it is possible to reduce concentrate at around 30%. Naturally, the wear of the membrane increases by factor 4-6.



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### 1.1.3 Video Surveillance

Video Surveillance will be implemented in the interior of the container and can be accessed by remote control. Two cameras (one in the machine room and one in the control room) are allowing the video on-line supervision to see liquid spills and permitting operator online support and control.

### 1.1.4 Stripping tower

We would like to offer you the option to install a stripping tower for the treatment of the permeate. The advantage of the stripping tower is that it increases the ph-value of the permeate, and as a result, no caustic soda is needed. It is possible to recover the investment of the stripping tower within two years (return of investment).

### 1.1.5 Online measurement of ammonium

Optionally we propose you a multi-parameter probe for the online measurement of ammonium connected to the plc. It is a reliable device outclassing conventional analyzers in terms of measurement stability and lifetime. Precision is guaranteed by real-time compensation of the ammonium value with temperature, pH and potassium and a high-performance reference electrode.

*Figure 1 – Three stage RO System, 200 m3/d, Brazil, Maceio.*



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# 2 Technical Description of the Reverse Osmosis System

## 2.1 Technological principles of the Reverse Osmosis

### 2.1.1 Cross-flow filtration

Modern membrane processes are based on the "cross flow" dynamic filtration, instead of the ordinary "dead-end" statistic filtration.

During the "cross flow" filtration, there is a high flow (volume) of the liquid that passes through the filtering membrane, to avoid the accumulation of particles on the membrane surface.

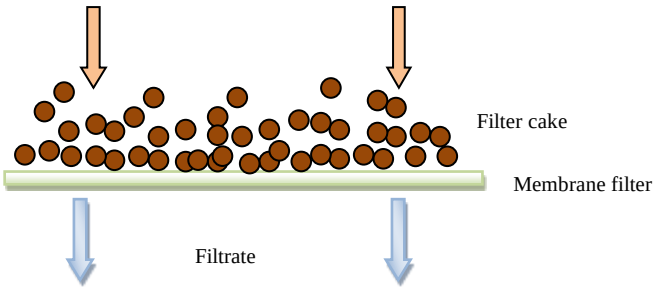


*Figure 2: "Classical" filtration.*

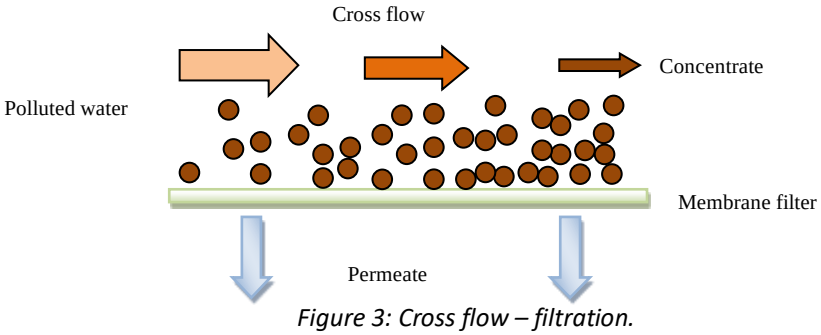


*Figure 3: Cross flow – filtration.*

The cross flow - filtration is a process that separates the liquid flow at the entrance into two types of effluent: permeate[1] and concentrate[2]. The relation between the two flows is the result of the concentration factor one of the indicators of the separation efficiency.

[1] The permeate is the clean effluent that passed through a membrane.



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### 2.1.2 Diffusion and osmosis

The phenomenon of diffusion is defined as being a process in which different concentrations has the tendency to equilibrate and homogenize/mix together, because of the random movement of its components: atoms, molecules, or ions.

If there is a separation of two liquids through one semipermeable membrane with the selection only for the molecules of the solvent, the result is a unidirectional diffusion of the solvent through this semi-permeable membrane. The movement of the solvent molecules takes place through the membrane, in the direction of the more concentrated solution. The resulting pressure on the membrane is called osmotic pressure.

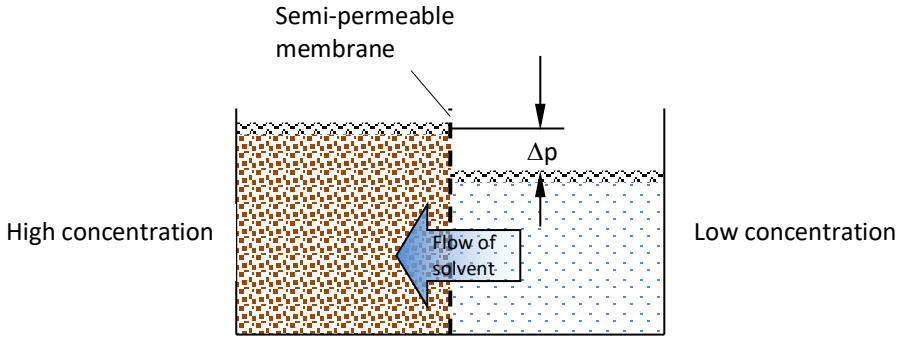


*Figure 4: Osmosis.*

When a high pressure is applied on the solution, with high concentration, the solvent diffuses through the membrane, starting from the more concentrated solution to the more diluted. This process is called REVERSE OSMOSIS.

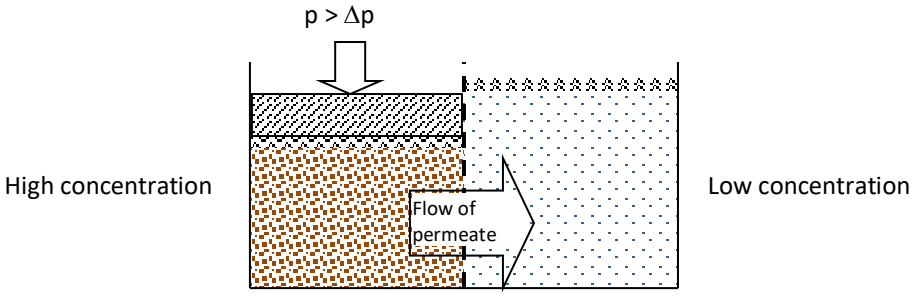


Figure 5: Reverse Osmosis.

The membrane process by cross-flow filtration, based on this effect of the Reverse Osmosis, allows the separation of nearly 100% of molecules with a molecular weight higher than 100g/mol and around 95-99% of salt retention. Individual effects are depending on the form and charge of the molecules.

[2] The concentrate is the liquid effluent ("filter cake") that did not pass through a membrane.



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## 2.2 Types of membranes

Membranes used in the Reverse Osmosis systems have a high selectivity, as they should retain nearly all dissolved substances, allowing only the diffusion of water molecules and a very small fraction of these substances. The retention amount depends on the type of substance, varying between 85-100%.

The form of utilization of the membranes normally used in the leachate treatment are tubular, disk or spiral-type membranes.

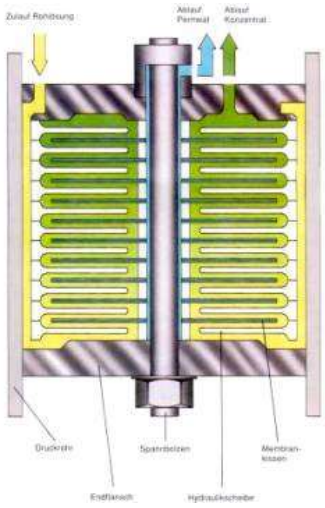

*Figure 6: Disk module*

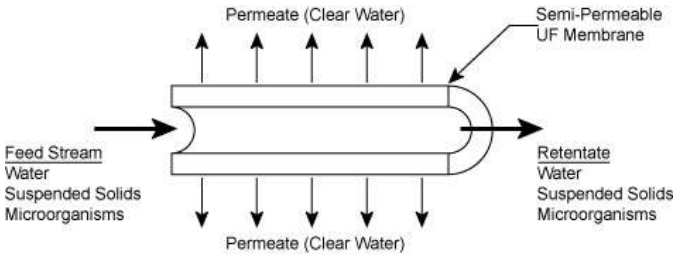


*Figure 7: Tubular module.*

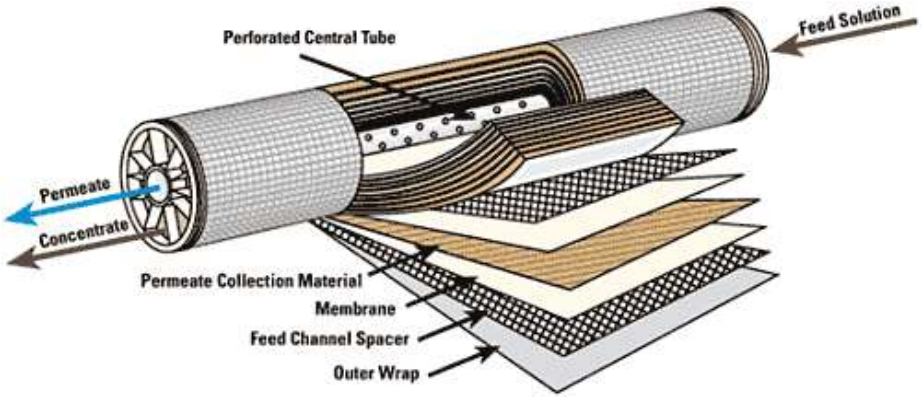


*Figure 8: Spiral module.*



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The technological progresses of membranes have been considerable, especially in the conception of new structural forms. Spiral membranes are the result of this development and allow a best relation of membrane surface/space, this permitted the development of a dimensional "standard".

Structurally, the spiral of the membrane is constructed by "gluing" the membrane sheets in the form of an envelope inserting the open side into a central tube. The permeate enters the space in the envelope-like form where it is conducted until the central tube. The channels in between the membrane sheets are created by the utilization of "spacers". The spiral membranes of "wide-spacer" type which are used in the proposed system show the best relation of price/handling/space/performance in the leachate treatment and are, for these reasons, our choice for the Reverse Osmose system. The active material in the membrane surface is polyamide with a high mechanical and chemical resistance. There are several types of membrane surfaces which influence, specially, the higher or lower salt passage. The used membranes are of the "high rejection" type (of salts) to improve permeate.

Main characteristics and advantages of applied "wide-spacer" spiral membranes, compared to other current types:

- Considerably lower replacement costs.
- Lower maintenance costs, due to the easy accessibility - fast control and change.
- Optimization of space, due to the good relation of membrane area/volume.
- Optimized hydraulic characteristics with a tangential flow at high velocity on the membrane surface, resulting in a turbulent flow.
- Reduction of the blocking risk (phenomena of "Fouling and Scaling"[3]), resulting in a lower washing frequency and the increase of lifetime.
- The membrane type is a high rejection membrane to allow a better quality of the permeate.
- TFC (Thin film composite) - type with an active surface of polyamide, resistant to a wide temperature and pH range.

[3] Precipitation due to biological and chemical reasons.



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# 3 AST Technology for Leachate Treatment by Reverse Osmosis

The proposed system of Reverse Osmosis is executed according to the current standard in this type of equipment and integrates a three-stage treatment to ensure a high quality of the treated effluent and with a higher operating pressure, up to 80 bar, to optimize the permeate flow. The system is equipped with “wide spacer” spiral membranes and with the properties mentioned in the previous chapter.

It was found in many cases, that the treatment of leachate by Reverse Osmosis with a two-stage treatment is insufficient to reach permeate discharge quality. The proposed system has three purification stages, with the advantage of being able to treat heavy loads of leachate and being more adaptable to future situations in terms of variations of flow and quality of the affluent.

The operation is completely automatized including various security systems switching off the system in case of problems increasing the unit’s level of protection. Each detail of the process is visualized and monitored, and all data are registered by *software* enabling the assessment of the operation and process parameters. Automation, of a modern industrial standard, embodies the highest level of comfort and safety for the operator, who can follow the process, on every step of the treatment and intervene with a “Mouse click”. The proposed system is developed and assembled in Portugal according to the highest quality standard levels, and the applied construction standards is ISO.

## 3.1 Local integration of the Reverse Osmosis system

The feeding of the system consists of an external pump, placed inside the leachate lagoon or tank, and controlled by the Reverse Osmosis module. As the topography varies from place to place, this pump must be made available locally *(to be provided locally by the client and not included in this offer price).*


*Figure 9: Reference: Landfill site in São Gonçalo – Rio de Janeiro (Brazil) 120 m$^3$/day (31 700 gpd).*



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## 3.2 Flow

In this proposal the plant ensures an adequate treatment with a constant entry flow at the plant of 200 $m^3$/day (constant 24h) of leachate with or without pre-treatment.

For the balance of the masses in this proposal we considered an affluence of leachate with 21 500 µS/cm conductivity. The annual capacity of the system must be calculated by the availability which is typically 90%.

The complete system is assembled in a 40" container. The plant can also accept leachate with different conductivity values, with adapted operating parameters.

## 3.3 Description of the process

### 3.3.1 Feeding of the process

The leachate is pumped to the container by the mentioned external supply pump. The pump is controlled by the level signal of the leachate reception tank in the Osmosis. The leachate enters the container, passes a sieve, and flows into the leachate reception tank which is equipped with two level sensors, one sensor for controlling the feed pump and the other sensor to avoid spillages.

### 3.3.2 Treatment stages in the Reverse Osmosis container

The main treatment stages which are integrated in the container are the following:

- Sieve with a 1,5 mm - mesh
- Pre-filtration by a pressurized sand filter
- Control of pH by dosing of sulphuric acid
- Addition of antiscalant
- Pre-filtration by microfiltration 10µm (1-10 µm)
- 1st stage of Reverse Osmosis
- 2nd stage of Reverse Osmosis
- 3rd stage of Reverse Osmosis

After the RO process it is necessary to remove the dissolved gases from the permeate. The degasifier is installed outside the container due to the corrosion of the emitted gases. It serves for the removal ("stripping") of the dissolved gases in the permeate principally $CO_2$. To control quality of permeate at the outlet conductivity value is measured inline. The permeate can be discharged to the environment or, alternatively, be used for irrigation or as process water, etc…



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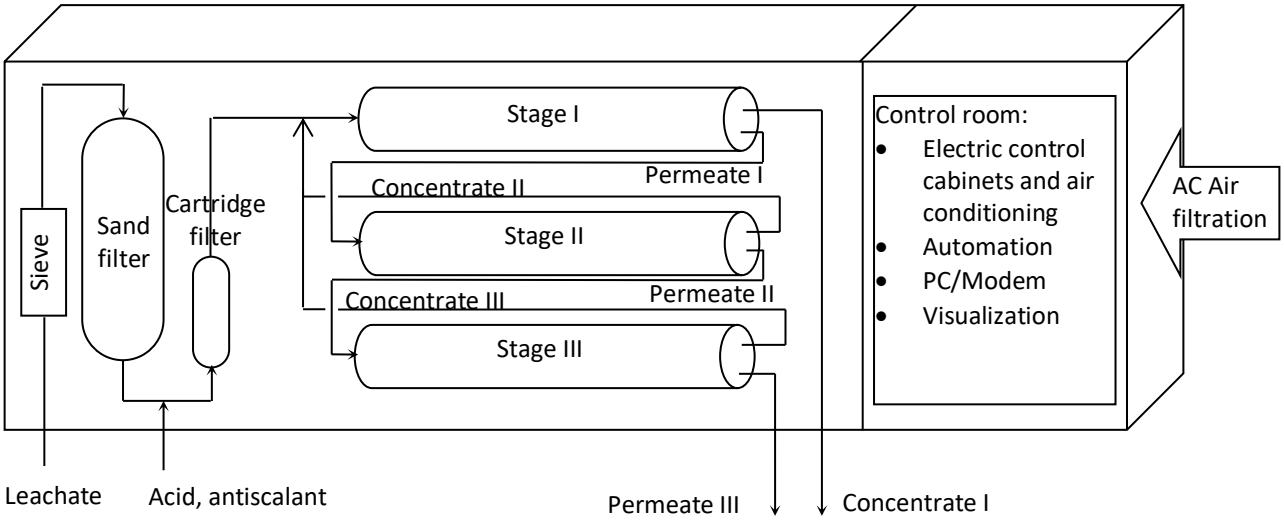


*Figure 10: Scheme of a 3 stage containerized system.*

### 3.3.3 Pre-filtration

As a pre-treatment and for the pumps and membranes protection there is a sieve with a 1,5mm mesh, a sand filtration and two microfiltration stations.

Sand filtration is carried out in pressurized filters. The sand filters are cleaned by applying an elevated (automatism included), the cleaning liquid is leachate. The periodicity depends on the content of suspended solids in the leachate and is usually weekly.

*Figure 11: Cartridge filter.*

After the sand filtration, there are two filtration stations with 10µm cartridge (microfiltration, porosity adjustable to the sort of leachate between 20 to 1µm) to avoid the entry of small particles which may damage the membranes. Each station takes various filtrating cartridges adapted on the



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size of the plant. In the case of blockage, a message appears on the system's screen. Replacement of cartridges is fast, simple, and economical and due to the parallel system, it can be executed during operation.

### 3.3.4 Chemical dosing system

The chemicals used in the process are used to increase the solubility of the salts and to reduce the precipitation of less volatile salts.

- pH adjustment with acid.
- Antiscalant.

Acidification is done with 96-98% concentrated sulfuric acid, which is usually the cheapest commercialized acid. The transportation and dosage pump are integrated in the container. For safety reasons, the acid injecting system is completely sealed in a chemically resistant box and equipped with a overfill sensor that switches the system off, in case of a spillage.

The pH of the leachate is controlled by the sulfuric acid dosage system, before passing through the membranes. The acid is injected directly into the piping with a dosing valve. Advantage of this solution – injection in a closed and pressurized system allows avoidance of production of foaming and strong odors.

Also, antiscalant and dispersant is added inline at a proper dosing station. Depending on the leachate composition, there are suitable products which are added to the process, to improve the performance of the plant in terms of treatment, washing cycles and lifetime of the membranes.

The pre-treatment system is equipped with pressure, flow, conductivity, temperature, and pH sensors used for the control and monitoring of the process.

### 3.3.5 Membrane system

The three stages of the Reverse Osmosis system are equipped with pressure sensors for process control. In case of a malfunction (under- or overpressure), the process shut down automatically. In addition, there is an overpressure safety valve in the first stage to avoid damage to the system.

#### *3.3.5.1 1st Stage*

Downstream the filtration stage, a piston pump increases the pressure according to the operating parameters (which depend on the characteristics of the leachate).

Several membrane modules are installed in a high-pressure tube, forming a block. In addition, each block is equipped with a recirculation pump which maintains the velocity at a high level, and thus, a



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turbulent flow over the membrane surface, to reduce the effects of “scaling and fouling.” The high-pressure pump and a pneumatic pressure control valve create and control the pressure inside the blocks. The flow of the final concentrate is measured by an electromagnetic flow meter and controlled according to the adjusted efficiency by a special anti-cavitation pneumatic control valve with highly resistant stellite components. Depending on the type of operation, the plant can be controlled also by the pressure. Each block can be switched off separately (by-passed), to adapt the plant to different operating conditions.

The concentrates that result from the first stage can be sent to a specific area *(to be defined)*, at the remaining pressure of the modules (max. 5bar).

#### *3.3.5.1 2nd and 3rd Stage*

To ensure a proper treatment of the leachate and to guarantee the compliance of the limit values of discharge, the Osmosis system is equipped with a second and a third treatment stage. Permeate of the 1st stage follows directly to this 2nd stage without buffer tank. The operation of the process of the 2nd stage is identical to the 1st stage, only the pressure is naturally reduced due to the lower osmotic pressure (max. 35bar) in this 2nd stage. This allows a simplification of the membrane system and equipment which is executed in only one block. The concentrate of the 2nd stage is recirculated and sent to the inlet tank of the leachate in the inside of the container. This concentrate is treated together with the leachate.
The 2nd and 3rd stages can be switched off and permeate of the first stage can pass through the by-pass, directly to the receiving environment.

To ensure that there is no problem with the membrane system the permeate is monitored at the outlet by the conductivity value.

Cleaned leachate (permeate) can be discharged directly to the environment or reused for irrigation, washing of equipment, as process water or in another way by the client.

## 3.4 Concentrate

The proposed Reverse Osmosis system can operate up to a pressure of 80bar, diminishing significantly the volume of concentrate. There are various final solutions for the concentrate. In most cases in Europe, the concentrate is infiltrated again into the mass of waste, in a controlled manner. We can propose an additional system for the reduction of the concentrate called “Stage of concentrate”. These systems have higher operational costs and, in many cases, do not compensate the level of reduction of the concentrate.

The proposed Reverse Osmosis system can pump the concentrate to a significant distance and height, without any additional energetic costs and using solely the residual pressure after the regulation valve.



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## 3.5 Expected lifetime of membranes

The lifetime of the 1st phase membranes depends on the composition of the leachate and of the operating and the performed maintenance. In our experience, the modules from the 1st phase have to be replaced, on average, every 2 to 3 years, and the 2nd and 3rd phase membranes every 5 to 10 years. AST has worked with the proposed membrane solution for more than 15 years; the accumulated experience allows to maximize the expected lifetime of the membranes by optimization of the operational parameters. For the operational cost's calculations, we assume a change every two years. This also allows a higher system efficiency and saves cleaning times and costs.

### 3.5.1 Change of membranes

The modules of the membranes are exchanged on site, this work can also be performed by the client after training. The duration of the membrane exchange operation takes approximately 4 hours.

## 3.6 Membrane cleaning

There is an internal buffer tank receiving the first produced permeate, which is used for the washing and cleaning of the system (CIP Tank – Cleaning in Place Tank). The level of this tank is controlled and supervised by the system and can be altered by the operator.

Throughout the system's operating the phenomena of *scaling* and *fouling* are occurring naturally. The time until these effects are taking place depends on the composition of the leachate. Taking into consideration that the system controls the flows, an increase of pressure in the system indicates the need to wash the membranes. In case of a significant increase of pressure, the integrated safety system automatically initiates an operating system with pressure control, and in case of excessive pressure it switches off.

The cleaning frequency depends on the type and specific composition of the leachate and of the operation and it is usually weekly. Cleaning is made with the permeate originating from the internal tank with adequate products.

The cleaning process can be done by remote control, or by the operator by adding the cleaning product and starting the automatic cleaning cycle.

We foresee a cleaning cycle with weekly intervals ("typical" leachate) using for that effect a specific solution, which is pumped at high velocity and low pressure through the system.

The use of individual or combined cleaning depends on the consistency of the leachate. To increase the efficiency of the cleanings, these can be done with high temperatures, these cleanings must be made with accompaniment of AST.



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The cleaning products are regularly available in the international and national markets. Based on its practical experience of over 15 years with these plants AST uses a cleaning system which makes it possible to utilize of powdery or liquid cleaners.

*Figure 12. RO Leachate System treatment in three stages, flow rate of 250 m3/d, and OR System for concentrate reduction followed by evaporation, Ibiza, Spain.*

## 3.7 Command and control system

The functioning of the process is continuous and automatic, through a programmable automaton (PLC), in case of malfunctions, the plant automatically stops. Flow control is done by electro-pneumatic automatic valves, which are controlled by PLC. The transmission of signals to the valves is done with a Profi/Asi-Bus system.

In addition, the system is equipped with a remote-control system which allows remote visualization of all the control and supervision of the process on an external PC, including access permission and modem connection. The system enables a more comfortable control, simplifies the detection of malfunctions, and increases the speed of technical assistance (direct connection to AST). Remote alterations of the monitoring and control system can be done by the PLC programmers. It is also possible to connect other automation systems if they are compatible with the Profibus protocol. This interconnection is not covered in this proposal.

The control of the plant is done through a programmable automaton, PLC. An industrial PC, by SIEMENS serves as a parameter control unit. The visualization and control of the process, such as the acquisition, evaluation and data visualization are made through the PC screen and the visualization Software (SCADA). The control surface and the control system of Reverse Osmosis of the plant will be in English language, with aid of the client we can translate additionally to local languages. The operative system will be Windows 7 or a more recent version. Additionally, a program on electric



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tension supervision will be furnished, with a protection for the control system by UPS. For additional protection of the electronic system, tension stabilizers are installed.

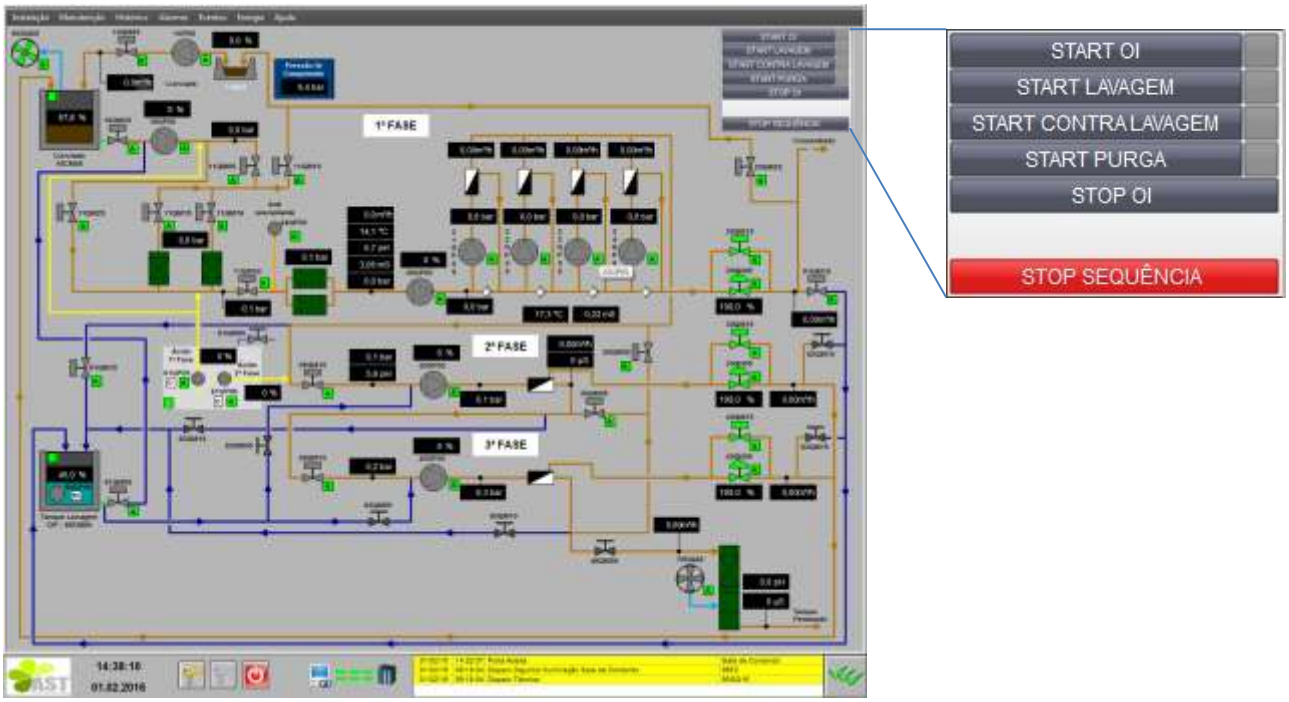


*Figure 13. SCADA - Main screen from an AST RO unit.*

## 3.8 Turboclean Technology

In the forefront of leachate treatment by Reverse Osmosis membrane systems and the more than 20 years of experience of AST's collaborators, allowed AST to acquire the sensitivity and knowledge necessary to develop/design and implement solutions to optimize the conventional process of Reverse Osmosis.

Reverse Osmosis membrane treatment systems are one of the standard solutions for landfill leachate treatment. Due to various chemical components and colloidal solids typically contained in leachate and other industrial wastewater, membrane purification systems can experience fouling resulting from the deposition of particles on their surface and in the channels of the membrane spacers, which we call particular fouling.

The removal of this fouling is extremely difficult and requires aggressive and prolonged chemical cleaning, in some cases cleaning is impossible and membrane replacement is inevitable.
AST is strongly committed to develop and improve its membrane systems not only to increase availability and robustness, but also to reduce operating costs. In this context. Therefor AST's engineering and design team have developed a proprietary technology that allows the flow direction over the membranes to be reversed during operation, "Turboclean®".



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This flow direction change system is fully automated and, although it can be activated manually, it has been designed to operate automatically.

For extreme applications, the mode of operation in directional flow change allows the clearing of membranes exposed to strong particular fouling effects. In this way, the AST solution reduces the frequency of flushing and increases the availability of the systems. In turn, a lower number of washes is not only reflected in a reduction in the consumption of cleaning chemicals, but also in the wear and tear on the membranes caused by cleaning, thus increasing their useful life.

## 3.9 Operation of the system

The mass balance - flow diagram with the results of the estimated flow calculations of the system operation is shown in another chapter. The calculations for the balance are based on the flow and the typical leachate composition, as shown in table 1. It is possible to operate the plant with higher concentration factors or conductivity, but the balance varies, of course, for each situation.

The proposed system is extremely flexible and allows the adaptation to different flow situations and effluent qualities.



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# 4 Technical Data of the Reverse Osmosis System

## 4.1 Leachate flowrate

The base data which have been considered for the plant design and calculations are the following:

*Table 1: Leachate flowrate considered in plant design.*

| Parameter | Value / Unit |
|---|---|
| Plant Influent Flowrate | 200 $m^3$/day |
| | 8,33 $m^3$/h |
| | 6.083 $m^3$/month |
| | 73.000 $m^3$/year |
| Plant Design Availability | 90% |
| Plant Effective Influent Flowrate | 180 $m^3$/day |
| | 7,50 $m^3$/h |
| | 5.475 $m^3$/month |
| | 65.700 $m^3$/year |
| Operating time | 7.884 h/year |

For the estimated balance of the leachate – permeate/concentrate, with calculated flows, see flow diagram in chapter 5.

## 4.2 Parameters for process calculation

As the base of process calculation, we considered the reference values for leachate which we received from the client. The following table shows these values, as well as complementary values to have been considered, necessary for the design of the system and to the guarantees related.

The calculations for the balance which is presented in this proposal are based on the shown values. If the leachate parameters remain within the limits of the following table, the system operation will achieve the predicted balance defined in this proposal; the operation costs will be according to the presented estimation, and the values of the discharge will attend the values which are shown in the table.

Regarding the operation guarantees and the costs for the normal operation of the RO unit, we also presumed that there are no substances in the leachate that damage or clog the membranes.



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*Table 2: Leachate composition considered for the plant's design and quality and efficiency performance.*

| Parameter | Value / Unit |
|---|---|
| Conductivity | 21500 µS/cm |
| pH | 8 |
| BOD | 723.8 mg/L |
| COD | 4710 mg/L |
| Chloride as Cl | 21500 mg/L |
| Ammoniacal Nitrogen as N | 1370 mg/L |
| Total Sulphur as SO4 (Dissolved) | 280 mg/L |
| Zinc as Zn (Dissolved) | 0.244 mg/L |
| Nickel as Ni (Dissolved) | 0.202 mg/L |
| Lead as Pb (Dissolved) | < 0.01 mg/L |
| Copper as Cu (Dissolved) | < 0.01 mg/L |
| Chromium as Cr (Dissolved) | 0.253 mg/L |
| Cadmium as Cd (Dissolved) | < 0.002 mg/L |
| ***Parameter maximum concentrations for design criteria:*** | |
| *Total suspended solids* | < 200 mg/L |
| *Iron* | < 10 mg/L |
| *Fluoride* | < 1 mg/L |
| *Manganese* | < 3 mg/L |
| *Oils and greases* | < 1 mg/L |
| *Calcium* | < 100 mg/L |
| *Magnesium* | < 40 mg/L |
| *Silica* | < 10 mg/L |
| *addition and grouping of heavy metals (Zn+Pb+Cd+Cr+Cu+Hg+Ni) (in solution)* | < 10 mg/L |
| *each heavy metals (Zn+Pb+Cd+Cr+Cu+Hg+Ni) (in solution)* | < 0,3 mg/L |

*Table 3: Guaranteed reduction rates.*

| Parameter | Reduction rate $(C_{in}-C_{out})/C_{in}$ |
|---|---|
| BOD | 98-99% |
| COD | 98-99% |
| Total Nitrogen Kjeldahl | 96-98% |



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## 4.3 Operation data

*Table 4: Technical data of the RO plant.*

| Parameter | Unit | Value |
|---|---|---|
| **Leachate** | | |
| Transport capacity ("Feed") | $m^3/h$ | 7,50 |
| Temperature (calculation base) | °C | 20 |
| Concentration factor | | 2 – 5 |
| Min-max. efficiency | % | 50– 80 |
| pH after acid dosage | | 6 – 7 |
| | | |
| **Pressures (20 °C)** | | |
| Pressure, outlet concentrate | bar | ca. 5 |
| Pressure, outlet permeate (max.) | bar | 0,5 |
| Normal operation pressure | bar | Controlled by concentrate flow |
| Leachate pressure at inlet | bar | 0,5 – 2 (1) |
| Max. pressure 1st stage | bar | 80 |
| Max. pressure 2nd stage | bar | 35 |
| Max. pressure 3rd stage | bar | 35 |
| | | |
| **Electric components (supply according to European Standards)** | | |
| System – three phase supply | V | 400 |
| Control voltage 1 (internal) | V | 230 |
| Frequency | Hz | 50 |
| Control voltage 2 (internal) | V | 24 DC (stabilized) |
| Installed electrical power | kW | 70 |
| Specific electric energy consumption | $kWh/m^3$ | 8 |

## 4.4 Dimensioning of organs and equipment

All pumps, pipes, connections, filters, and other equipment are designed in order to resist to pressures that are higher than the expected maximum pressure in the respective organ. The piping and the transport capacity of the pumps were designed to allow the movement of the expected maximum leachate flow which has the composition as shown in Table 2. The geometric dimensions of the main components of the plant are shown in the drawing of the container presented in chapter 7.



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## 4.5 Chemical reagents

a) Sulfuric acid 96-98%;

b) Antiprecipitant – Antiscalant;

c) Powdery or liquid acid cleaning agent for membranes;

d) Powdery or liquid alkaline cleaning agent;

e) Buffer solutions for pH sensor;

f) Cleaning agents for the container: Washing-up liquid, etc.

**The products can be purchased freely in the market!**

## 4.6 Applied materials

Materials in contact with leachate: steel 1.4401, 1.4539, 1.4571; PVC, PVC-C, PEAD, PP, PVDF, PTFE, NBR and glass fiber reinforced polyester.

## 4.7 Unit structure

The system is installed in a 40-foot container with standard dimensions:

L x W x H: 12,192 x 2,438 x 2,55 m

The container is thermally and acoustically isolated and includes the RO unit with all electromechanical equipment, tanks, electrical cabinets and a monitoring and control system. The monitoring and control system is installed in an independent compartment and equipped with a pressurizing system and air filtration by activated carbon filter. Air conditioning system for the control cabinet must be installed locally, physical space and electrical connections are included.



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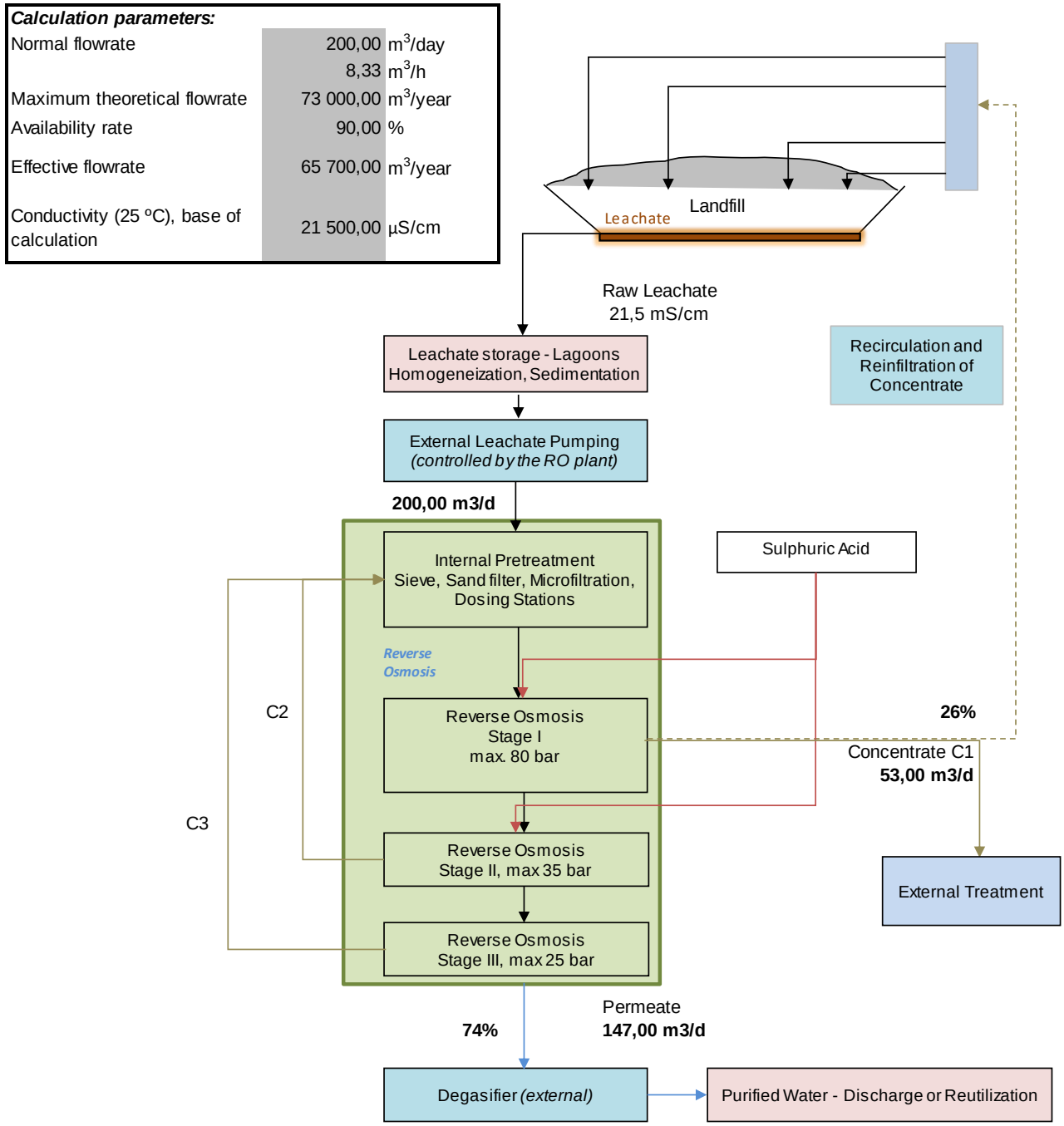
# 5 Calculated Mass Balance

**Preliminary Balance**
**Three Stage Reverse Osmosis Treatment of Landfill Leachate**
**FCC UK - Calvert Landfill**
**RO 1 x 200 m3/day; 3 stages**

| ***Calculation parameters:*** | | |
|---|---|---|
| Normal flowrate | 200,00 | $m^3$/day |
| | 8,33 | $m^3$/h |
| Maximum theoretical flowrate | 73 000,00 | $m^3$/year |
| Availability rate | 90,00 | % |
| Effective flowrate | 65 700,00 | $m^3$/year |
| Conductivity (25 ºC), base of calculation | 21 500,00 | µS/cm |



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# 6 Operational Costs

**Estimation of Operational Costs *(based on actual EU Costs)***

FCC UK - Calvert Landfill

Three Stage Reverse Osmosis Treatment of Landfill Leachate

| **Bases for Calculation** | |
|---|---|
| Leachate Conductivity | 21 500 µS/cm |
| Estimated Efficiency | 73,50% |
| Concentration Factor | 3,77 |
| Maximum Input Flowrate | 73 000 m3/year |
| Availability | 90% |
| Operation Hours | 7 884 h/year |
| Average Input Flowrate | 65 700 m3/year |
| Permeate Generation | 48 290 m3/year |

| Operational Costs | Estimated Cost | Consumption | Annual Cost |
|---|---|---|---|
| **Energy:** | | | |
| Electrical consumption | 0,25 €/kWh | 525 600 kWh/year | 131 400,00 € |
| **Consumables:** | | | |
| Sulfuric acid 96% -98% | 0,30 €/kg | 229 950 kg/year | 68 985,00 € |
| Acid cleaner | 4,55 €/kg | 986 kg/year | 4 484,03 € |
| Alkaline cleaner | 7,00 €/kg | 2 628 kg/year | 18 396,00 € |
| Inhibitor/Antiscalent | 6,20 €/kg | 657 kg/year | 4 073,40 € |
| Cartridge filters | 4,50 €/un | 920 un/year | 4 139,10 € |
| Bag Filters | 8,00 €/un | 104 un/year | 832,00 € |
| **Wear and spare parts** | | | |
| Annual average | 22 600 €/year | 1 un/year | 22 600,00 € |
| **Membranes:** | | | |
| Membranes 1st Stage | 1 200 €/un | 15 un/year | 18 000,00 € |
| Membranes 2nd and 3rd Stage | 800 €/un | 3 un/year | 2 400,00 € |
| **Labour** | | | |
| Technician | 3 000 €/month | 12 /year | 36 000,00 € |
| Total anual operation costs | | | **311 309,53 €** |
| Specific cost per volume of raw leachate fed to the RO plant | | | **1,79 €/m3** |
| Specific cost per volume of RO permeate | | | **2,44 €/m3** |



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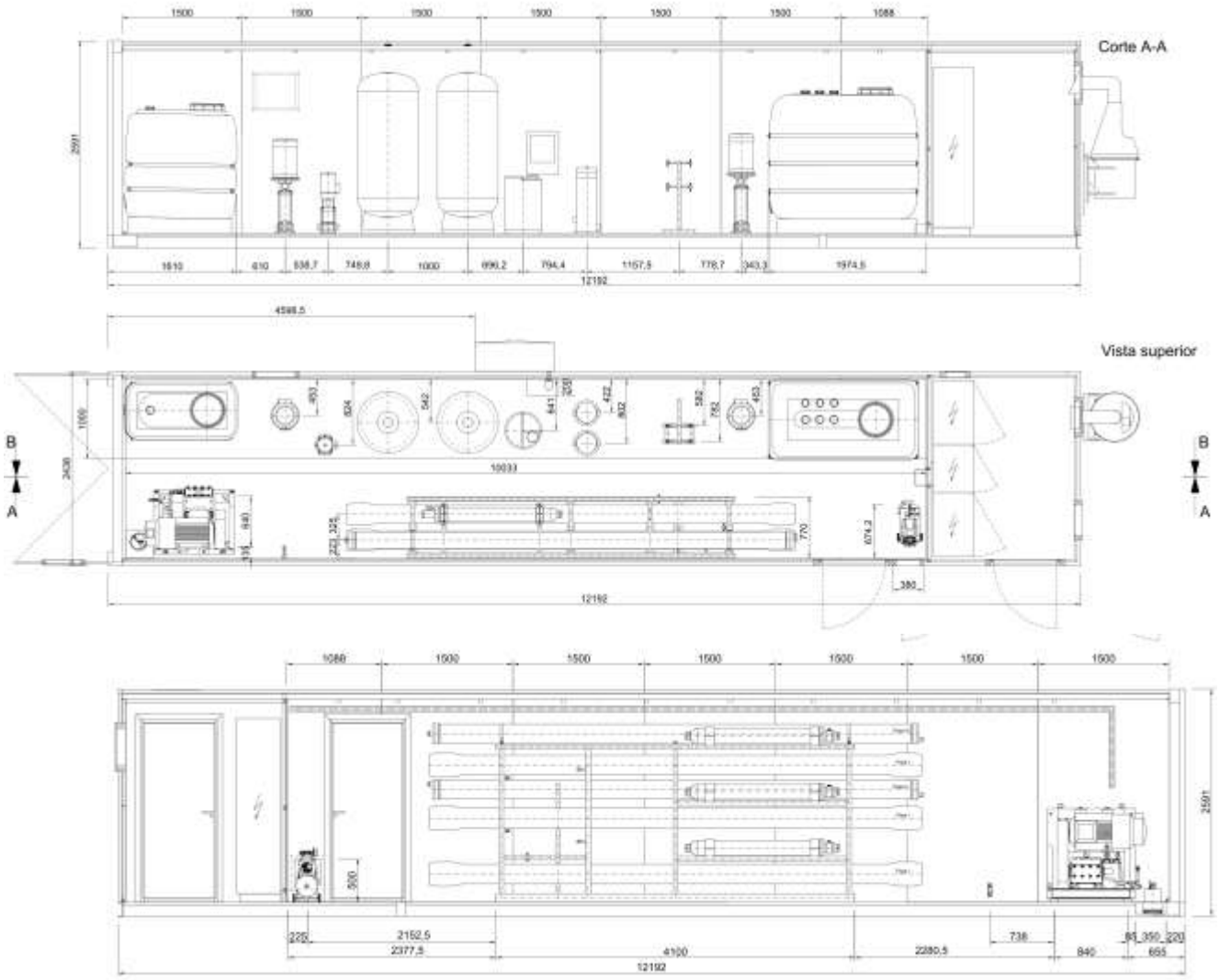
# 7 Similar System's Scheme



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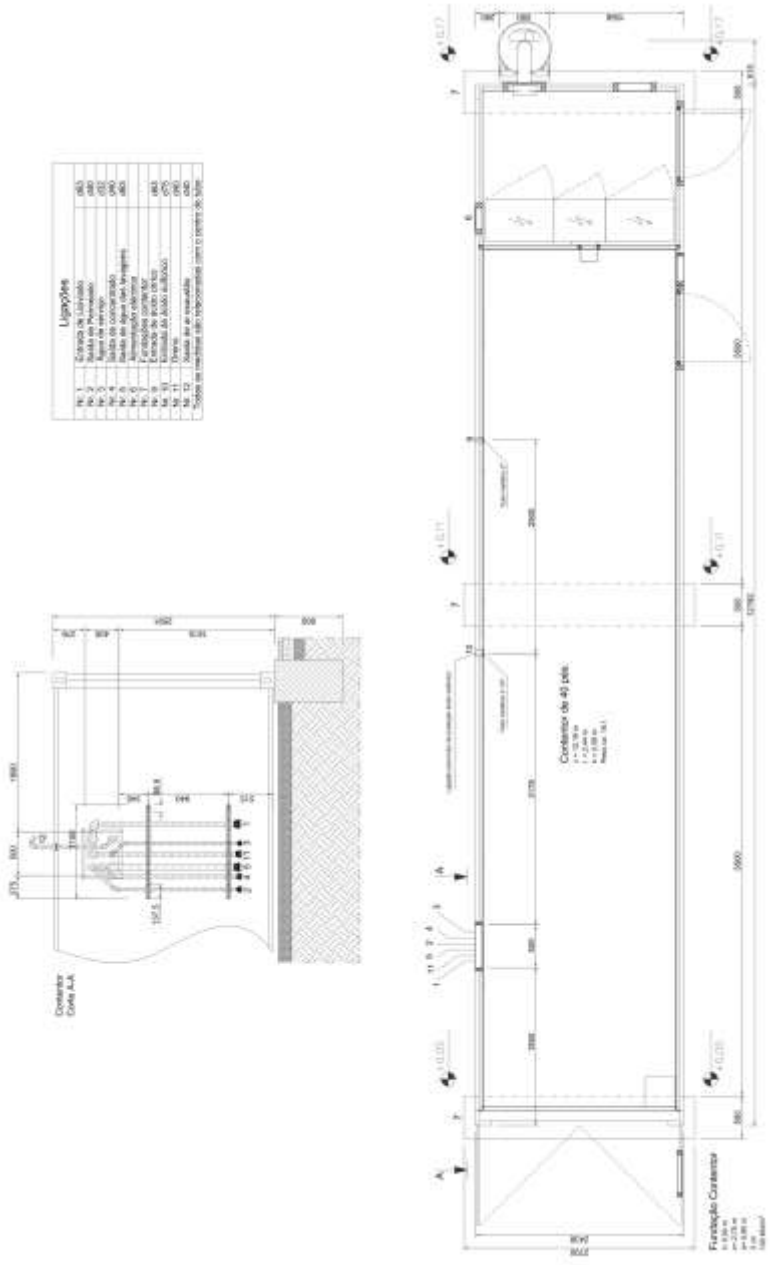
# 8 Basement Diagram and Connections of the System



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# 9 Pictures of a Similar System



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# 10 Confidentiality

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(1) Crime of unfair competition;
(2) Crime of disclosure of secret;
(3) Crime of violation of professional secrecy;

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# APPENDIX 2

## Sulphuric Acid and Caustic Storage Tank Specifications

FCC ENVIRONMENT
KNOSTROP STW
KNOWSTHORPE LANE
LEEDS
WEST YORKSHIRE
LS9 0PJ

For The Attention Of: Allen Brooks

Quotation Reference: DCE22693 REV1

Date: 17th May 2023

Dear Allen,

**Ref: Sulphuric Acid & Caustic Storage**

Many thanks for your continued interest. Further to our recent communication please find enclosed our revised budget proposal for the design and manufacture of the following;

A. 15m$^3$ Sulphuric Acid Storage Tank c/w Integral Bund
B. 30m$^3$ Caustic Storage Tank c/w Integral Bund
C. Delivery Of Both Tanks To SG15 6RF

The price is based on delivery only.

I hope the information we've supplied is comprehensive and meets your requirements, but should you have any questions or require further assistance please do not hesitate to reply by email or call us on 01924 499466.

Kind Regards

Gary Smith
Chem Resist Group Ltd

# CONTENTS




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Email: enquiries@chemresist.com
Web: www.chemresist.com





Cert No. 19390
ISO 9001, ISO 14001
ISO 45001

# WORKING WITH CHEM RESIST

Founded in 1964, we have pioneered the use of Thermoplastics as the best material to safely contain corrosive and aggressive chemicals due to their broad range of chemical compatibility. We are experts in spiral wound manufacturing, a process we developed in the early 1990's, refined with Cambridge University and further enhanced to the method we use today. By combining the products and services of Chem Resist's divisions we can offer full turnkey project services, for further details please watch our video here.

Our Fluid Transfer Division offers an extensive range of premium branded pumps including: Almatec, Munsch, World Chemical, Pan World and Schmitt. More details can be found here.

Our Pipework Services Division offer a range of installation, modification and bespoke fabrication services. More details can be found here.

# CHEM RESIST - TECHNICAL SPECIFICATION

## Quality

All Chem Resist process plant products are fabricated under our Quality Assurance system assessed to **BS EN ISO 9001:2008**, **BS EN 14001:2004** and **BS EN 45001** covering "The design, manufacture, installation and repair of chemical process plant in thermoplastics. The stockholding and distribution of fluids transfer equipment and associated spare parts, after sales repair / renovation / testing service on special request from customers" (Certificate No's. 19390, issued by Alcumus).

## General Construction

All tanks are designed to the British and European Standard '**BS EN 12573:2000** 'Welded Static Non-Pressurised Thermoplastic Tanks' supplemented with the German Guideline **DVS 2205** where necessary. Further details on this standard can be found here in this document

The tank cylinders will be of homogeneous construction being made up of machine spiral wound extruded virgin polymer. In all cases the tank top and base will be manufactured using PLC controlled automatic butt fusion and welded into position using advanced extrusion welding techniques several times stronger than cord welding. Nozzle and ancillary equipment will be welded into position using a combination of hot gas welding and advanced extrusion welding. All welds will be inspected at each stage of fabrication in line with our Quality Management System. All our fabricators are accredited in accordance with BS EN 13067:2003, more details can be found on page 10 in this document.

All flanged nozzles are **none load bearing** PN10/16 and supplied complete with glass filled Polypropylene coated mild steel backing rings. All gaskets supplied will be either EPDM or Viton, application specific.

The material of construction throughout will be 100% UV Stabilised High Density Polyethylene PE100/RC in black colour unless required by the specification. Further details on PE100RC can be found here in this document.

Watch our video to see how we manufacture a Chem Resist Chemical Storage Tank here.

## Hydrostatic Testing

A full hydrostatic water test to **DVS 2206-2** will be carried out at our works prior to delivery. This test should always be repeated on site after installation.

As part of our commitment to sustainability, Chem Resist have invested in a full water recycling system. All water used for hydrostatic tests is stored on site in a Chem Resist Storage Tank, with in-built testing & treatment to maintain purity.

## Installation

Offload and positioning must be undertaken by qualified personal in accordance with the recommendation detailed in the Tank Data Book.

It is recommended that these units be given a full base support with provision for low-level flanged outlets.

Concrete bases should be smooth, free from debris with a flatness tolerance on +/- 1mm/metre. No material such as loose sand or bitumen should be placed between the tank and base.

If the tank is located externally then consideration must be given to an appropriate restraining system, available from Chem Resist. The tank is not designed to cater for any uplift forces that may occur in the event of a bund filling with water. All bunds either integral or civil construction must be kept dry at all times.

Pipework should be supported independently from the tank and allowance made for expansion of both pipe and tank. Tank nozzles must not be stressed due to pipework loads.

# SUSTAINABLE CHEMICAL STORAGE

Spiral Wound Thermoplastic Chemical Storage Tanks have a lower carbon footprint than steel and GRP alternatives.

In a commitment to the recycling of our tanks, we have formed a partnership with a specialist plastic processing and recycling company in order to offer our customers a complete recovery and recycling service for tanks at the end of their operational life.

Watch our video to see the full lifecycle of a Chem Resist Chemical Storage Tank here or for further reading download our whitepaper 'The Chemical Storage Carbon Footprint' here.

# INTEGRITY MANAGEMENT

Recently a number of plastic tank manufacturers including Chem Resist worked with EEMUA (Engineering Equipment and Materials Users Association) to develop a guide to the specification, installation, commissioning, inspection, maintenance, repair and disposal of Above Ground Plastic Tank. **Publication 225** was published in 2018 and is a 'Users' guide detailing the expectations with respect to information that should be provided to the Storage Tank Manufacturer, as well as guidance on the installation, commissioning, operation and inspection of Plastic Tanks. Undertaking of post installation hydrostatic tests, as well as any 3rd party inspections fall within the remit of the end user and not the manufacturer. A copy is available from the EEMUA website here.

# STORAGE TANK SPECIFICATION

**Tank Description:** A. 15m³ Sulphuric Acid Storage c/w Integral Bund

## Design Criteria

| | | | |
|---|---|---|---|
| Working Volume | 15.00m³ | Gross Volume | 16.50m³ |
| Contents | 96% Sulphuric Acid | Specific Gravity | 1.84 |
| Design Temperature | 25°C | Operating Temperature | Ambient |
| Design Pressure | Atmospheric | Operating Pressure | Atmospheric |
| Design Standard | BS EN 12573:2000 | Design Life | 20 Years |
| Safety Factor | 1.50 | (Chemical Reduction) A2 Factor | 2.70 |

## Tank Configuration

| | | | |
|---|---|---|---|
| Internal Diameter | 2.30m | Overall Cylinder Height | 4.45m |
| Lid Type | Coned | Base Type | Flat |
| Material of Construction | PE100-RC HDPE | Colour | Black Ral 9005 |

## Bund Configuration

| | | | |
|---|---|---|---|
| Actual Volume | 18.15m³ | Internal Diameter | 2.80m |
| Overall Height | 2.95m | Bund Lid | Welded Rainskirt |
| Material of Construction | PE100-RC HDPE | Colour | Black Ral 9005 |

## Tank Nozzle Connections

1 x 150mm NB Mushroom Vent c/w Demister
1 x 100mm NB Overflow c/w Down Pipe
1 x 600mm Top Mounted Manway – Bolted
1 x 50mm NB Flanged Inlet (Top)
1 x 50mm NB Flanged Outlet (Top)
1 x 100mm NB Flanged Connection – Level (Top)
1 x 80mm NB Flanged Connection – Level (Top)

## Bund Nozzle Connections

1 x 100mm NB Elbow Vent
1 x Inspection Port
1 x 50mm NB Flanged Drain (Top)
1 x 80mm NB Flanged Connection – Level

## Additional Inclusive Equipment

6 x Lifting Lugs
4 x Positioning Clamps (TBC)
1 x Nameplate
1 x 50mm NB Internal Removeable Dip Pipe On Tank Outlet c/w 50mm NB Foot Valve. Pipework To Extend Across The Tank Top & Down The External Wall, Flanged Termination
1 x Bund Drain Pipework, As Above
1 x Cat & Mouse Level Gauge c/w Calibration Strip
1 x Radar Level Transmitter (FMR20)
1 x Ultrasonic Level Switch – HL
1 x Ultrasonic Level Switch – LL
1 x Ultrasonic Level Switch – Bund LL
1 x Access Ladder c/w Perimeter Handrail (See Spec On Page 10)

**All Backing Rings PN10/16 Unless Requested Otherwise**

**All Side Access Manways supplied c/w Galvanised Mild Steel Backing Rings unless otherwise stated. N.B. Please check dimensions carefully as these may differ from any provided to us. If critical please communicate accordingly.**

## Installation Requirements

Full Support of Tank Base on Flat Skimmed Concrete Plinth – Flatness Tolerance 1mm/1m

# STORAGE TANK SPECIFICATION

**Tank Description:** B. 30m³ Caustic Storage Tank c/w Integral Bund

## Design Criteria

| | | | |
|---|---|---|---|
| Working Volume | 30.00m³ | Gross Volume | 33.00m³ |
| Contents | 22% Caustic | Specific Gravity | 1.24 |
| Design Temperature | 25°C | Operating Temperature | Ambient |
| Design Pressure | Atmospheric | Operating Pressure | Atmospheric |
| Design Standard | BS EN 12573:2000 | Design Life | 20 Years |
| Safety Factor | 1.50 | (Chemical Reduction) A2 Factor | 1.00 |

## Tank Configuration

| | | | |
|---|---|---|---|
| Internal Diameter | 2.96m | Overall Cylinder Height | 5.27m |
| Lid Type | Coned | Base Type | Flat |
| Material of Construction | PE100-RC HDPE | Colour | Black Ral 9005 |

## Bund Configuration

| | | | |
|---|---|---|---|
| Actual Volume | 36.30m³ | Internal Diameter | 3.46m |
| Overall Height | 3.86m | Bund Lid | Welded Rainskirt |
| Material of Construction | PE100-RC HDPE | Colour | Black Ral 9005 |

## Tank Nozzle Connections

1 x 150mm NB Elbow Vent
1 x 100mm NB Overflow c/w Down Pipe
1 x 600mm Top Mounted Manway – Hinged
1 x 150mm NB Flanged Inlet (Top)
1 x 50mm NB Flanged Outlet (Top)
1 x 50mm NB Flanged Spare (Top)
2 x 80mm NB Flanged Connection – Level (Top)
1 x 100mm NB Flanged Connection – Level (Top)

## Bund Nozzle Connections

1 x 100mm NB Elbow Vent
1 x Inspection Port
1 x 50mm NB Flanged Drain (Top)
1 x 80mm NB Flanged Connection – Level

N.B. Inlet Flow Will Need To Be Confirmed To Size The Overflow & Vent Appropriately. Increases Would Affect Costs

## Additional Inclusive Equipment

6 x Lifting Lugs
4 x Positioning Clamps (TBC)
1 x Nameplate
1 x 50mm NB Internal Removeable Dip Pipe On Tank Outlet c/w 50mm NB Foot Valve. Pipework To Extend Across The Tank Top & Down The External Wall, Flanged Termination
1 x Bund Drain Pipework, As Above
1 x Cat & Mouse Level Gauge c/w Calibration Strip
1 x Radar Level Transmitter (FMR20)
1 x Vibration Level Switch – HL
1 x Vibration Level Switch – LL
1 x Vibration Level Switch – Bund LL
1 x Top Entry Electric Immersion Heater c/w PT100 & Thermaster Controller
1 x Access Ladder c/w Perimeter Handrail (See Spec On Page 10)
1 x 50mm Rockwool Insulation c/w 10mm PE100 Sheet Cladding (Exposed Cylinder Only)

**All Backing Rings PN10/16 Unless Requested Otherwise**

**All Side Access Manways supplied c/w Galvanised Mild Steel Backing Rings unless otherwise stated. N.B. Please check dimensions carefully as these may differ from any provided to us. If critical please communicate accordingly.**

## Installation Requirements

Full Support of Tank Base on Flat Skimmed Concrete Plinth – Flatness Tolerance 1mm/1m

**Chem Resist Contact Details**
Tel: + 44 (0) 1924 499466
Email: enquiries@chemresist.com
Web: www.chemresist.com



Cert No. 19390
ISO 9001, ISO 14001
ISO 45001

# COMMERCIAL DETAILS

Exclusions:

Any Site Offloading or Installation
Any Site Electrical Or Pneumatic Installation
Any Civil Works
Any Post Installation Hydrostatic Test
Any Control Panel
Any Wiring To Low Level Or Cable Trays

Inclusions:

Hydrostatic Test Certificate
Data Book
As Built General Arrangement Drawings.

Price:

| | | |
|---|---|---|
| A. | 15m$^3$ 96% Sulphuric Acid Storage Tank c/w Integral Bund | £ 20,436.00 |
| A1. | Dip Pipe Assemblies To Tank & Bund | £ 1,860.00 |
| A2. | Cat & Mouse Level Gauge c/w Calibration Strip | £ 1,663.00 |
| A3. | Radar Level Transmitter | £ 1,175.00 |
| A4. | 3 No Ultrasonic Level Switch | £ 730.00 Each |
| A5. | Access Ladder c/w Perimeter Handrail | £ 4,156.00 |
| B. | 30m$^3$ 22% Caustic Storage Tank c/w Integral Bund | £ 24,813.00 |
| B1. | Dip Pipe Assemblies To Tank & Bund | £ 2,055.00 |
| B2. | Cat & Mouse Level Gauge c/w Calibration Strip | £ 1,663.00 |
| B3. | Radar Level Transmitter | £ 1,175.00 |
| B4. | 3 No Vibration Level Switch | £ 705.00 Each |
| B5. | Access Ladder c/w Perimeter Handrail | £ 6,036.00 |
| B6. | Heating, Insulation & Cladding | £ 7,000.00 |
| C. | Delivery Of Both Tanks To SG15 6RF | £ 3,670.00 |
| | **Total Budget Price** | **£ 80,007.00** |
| D. | Delivery Of Both Tanks To Burnley | £ 2,195.00 |
| E. | Delivery Of Both Tanks To Leicester | £ 3,175.00 |

Please Note: Delivery includes for 2 hours waiting time only, additional charges may apply thereafter. All prices quoted are excluding VAT. Where fuel surcharges are incurred these will be passed on at net cost. Projects may be subject to requote where they are delayed outside the given lead time, should this be the result of delays in approval or site readiness, in consideration of increased supply costs to Chem Resist.

Lead Time: 16 - 18 working weeks from receipt of official order, initial payment and drawing approval. In the event of an order, delivery times can be tailored to meet your needs.

Payment Terms: 30% with order – payment due immediately from date of invoice.
Balance 30 days from date of completion, or in readiness to deliver against agreed schedule, in accordance with our Terms & Conditions of Sale. Copy here in this document. Subject to satisfactory credit checks.

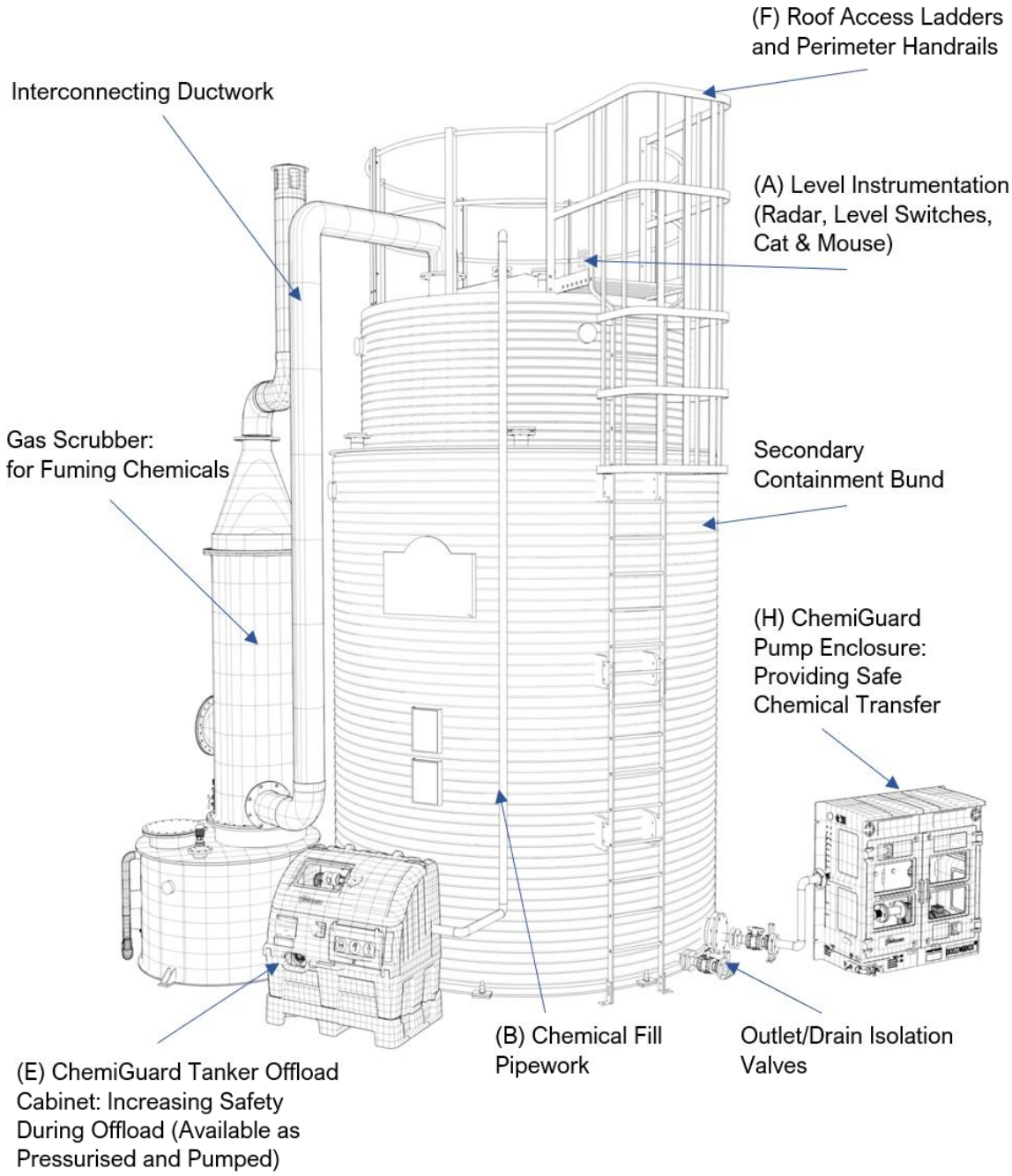
**Chem Resist Contact Details**
Tel: + 44 (0) 1924 499466
Email: enquiries@chemresist.com
Web: www.chemresist.com



Cert No. 19390
ISO 9001, ISO 14001
ISO 45001

| | |
|---|---|
| Validity: | We are facing ongoing, significant price increases from suppliers for many of our raw materials. This is a result of low supply but high demand of plastic resins. This is a global issue and one which we cannot influence. Until the situation resolves, we are temporarily only validating proposals for 30 days. Pricing of sub-contract items may be subject to change during this period and will be confirmed at order placement. |
| Important Notes | 'Stand down' time is chargeable at our standard hourly rates.<br>Our proposal does not include for any of the following events which may occur during delivery:<br>Chargeable police escorts associated with abnormal loads<br>Removal of highway obstacles associated with access routes<br>Public road closures required to accommodate offloading and positioning |

# DIAGRAM OF OPTIONAL ITEMS



# OPTIONAL ITEMS – Available on Request

## A. Level Management

1 No Cat and Mouse Level Gauge c/w Calibration Strip
1 No Radar Level Transmitter
1 No High Level/Low Level/Bund Liquid Detection Switch

## B. Tank Fill Pipework

1 No 50mm NB HDPE Tanker Fill Pipework c/w Isolation Valve, Drain Valve and Drip Tray

## C. Heating, Insulation & Cladding

1 No 50mm Rockwool Insulation c/w 10mm PE100 Sheet Cladding
1 No Top Entry Electric Immersion Heater c/w PT100 & Thermostatic Controller
1 No Side Entry Electric Immersion Heater c/w Integral Thermostat (Single Skinned Tanks)

## D. Side Manways

1 No Side Access Manway (600mm or 900mm) c/w Davit Arm. If Integrally Bunded, 600mm In The Tank, 900mm In The Bund. N.B, Davit Arm On The Bund Only. *The Use Of Side Manways Maybe Restricted Depending On Temperature Or Chemical Stored*

## E. ChemiGuard Secure Tanker Discharge Unit

Chem Resist exclusively offer secure tanker discharge units, enhancing operator safety in either blown or pumped discharge operations. Please advise if you would like further information.

## F. Roof Access Equipment

1 No Vertical Access Ladder Designed To BS 4211:2005+A1:2008 c/w Perimeter Handrail Designed to BS EN ISO 14122-4:2016 c/w 200 mm Kickboard. Safety Gate Included. Finish: Galvanised Mild Steel BS EN 150 1461. Powder Coatings Or Colour Wet Coating Systems To Be Quoted On Request. Please Note: Initial Delivery Costs May Need Amending If This Option Is Subsequently Added.

## G. Chemical Transfer Pumps

We can offer a wide range of chemical transfer pumps specified in line with your requirements.

## H. ChemiGuard Secure Dosing Cabinets

Secure housing for dosing systems with containment of spillages or leaks. Lockable doors with integrated storage for PPE, compatible with all makes of dosing pumps. Bespoke internal pipework arrangements can be discussed.

## I. Offload & Installation

Chem Resist can offer through our experienced partners complete offload and position under contract lift conditions. Installation is undertaken by our own experienced engineers who have the appropriate Health and Safety certification. Full risk assessments and method statements are provided as standard.

# EQUIPMENT DESIGN

The code used for the design of thermoplastic vessels is the European and British Standard BS-EN12573. This designed code can only be used for atmospheric vessels.

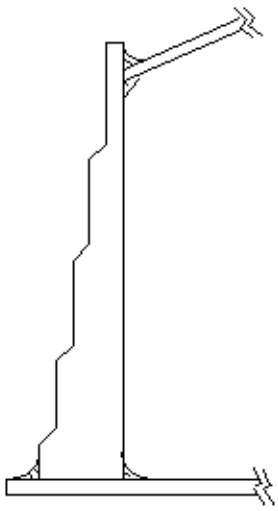


**Figure 1**
**Representation of a Tank Wall**

BSEN12573 calculates the permissible stress for the thermoplastic vessel being designed and uses this value to determine the minimum wall thickness permitted.

Various factors are used in the calculation of the permissible stress:

**The joint factor** – considers the reduction in permissible stress due to the type of welded joints in the shell.

**The liquid medium reduction factor** – reflects the effect that the liquid medium has in reducing the strength of the thermoplastic under long term exposure.

**The material reduction factor** – is derived from impact strength data and takes into account the specific strength of the material.

**The creep strength** – of a thermoplastic material is how much the material will 'stretch' under a continuous load. This value is determined for the life span of the vessel, eg. 1 year, 10 years, 20 years etc.

The calculated wall thickness reduces for differing wall heights and gives a 'stepping' effect when fabricated. An example of this is shown in figure 1.

All Chem Resist thermoplastic storage vessels are designed to BSEN12573.

# CERTIFICATION OF WELDERS

The integrity of vessels built from thermoplastics, as with other materials, depends largely upon the skill of the welding personnel. Chem Resist fabricators are accredited in accordance with the European Standard BS EN 13067:2003 "Certification of Welding Personnel".

This sets the minimum standards of weld integrity to be attained in a range of common thermoplastics used in chemical plant fabrication, e.g. Polypropylene, High Density Polyethylene, Polyvinyl Chloride and Polyvinylidene Fluoride.

# MATERIAL SPECIFICATION

## High Density Polyethylene PE-100/RC

Polyethylene is manufactured by the low-pressure polymerisation of ethylene. The structure of ethylene is given in figure 2 below.

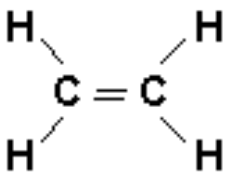



**Figure 2**
**Structure of Ethylene**

Polyethylene molecules are branched, with the degree of branching in the molecular chains and the length of side chains having a considerable effect on the properties of polyethylene. When molten polyethylene cools, it crystallises. Different degrees of crystallisation produce different densities, due to the crystallisation regions having a higher density than amorphous regions. The degree of crystallinity ranges between 35% and 80% according to polyethylene grade. High density polyethylene (HDPE) attains a 60-80% degree of crystallinity at a density of 0.940 g/cm$^3$ to 0.965 g/cm$^3$; medium density polyethylene (MDPE) attains a 50-60% degree of crystallinity at a density of 0.930 g/cm$^3$.

The properties of polyethylene are primarily determined by density, molar mass and molar mass distribution.

With increasing density (higher crystallinity), the following properties are increased: tensile strength; stiffness; hardness; solvent resistance, while the permeability to gases and vapours is reduced. On the other hand, impact strength, transparency and stress cracking resistance decrease with increasing density.

The cylinders of Chem Resist vessels are extrusion wound in virgin High Density Polyethylene PE100/RC.

This Black material demonstrates excellent corrosion resistance to a wide range of inorganic and organic acids and bases. PE100/RC complies with EU Directive 2002/72/EU (Food grade Plastic Materials) and is WRAS approved (Certificate 2205504).

PE100/RC is the next generation Polyethylene, developed to exhibit an increased resistance to stress cracking which can be caused by highly oxidising chemicals. Full Notch Creep Tests show average results over 27 times that of standard PE100.

**Properties of High-Density Polyethylene PE100/RC**

| Property | Test Method | Units | Value |
|---|---|---|---|
| Nominal Density | DIN 53479 | g/cm³ | 0.96 |
| Breaking Strength | DIN 53455 | N/mm² | 37 |
| E-Modulus through bending (60s – value) | DIN 53457 | N/mm² | 1000 |
| Resistance to Sow Crack Growth (9,2 bar, 80 °C) | ISO 13479 | hours | >5000 |
| Carbon Black Content | ISO6964 | % | 2 – 2.5 |
| Impact Strength | DIN 53453 | kJ/m² | 83 |
| Hardness | DIN 53505 | Shore D | 61 |
| Linear Coefficient of Thermal Expansion | ASTM D696-44 | 1/K | 2.0 x $10^{-4}$ |
| Thermal Conductivity | DIN 52612 | W/m K | 0.40 |
| Working Temperature without Mechanical Pressure | DIN 53446 | ºC | -40 TO +80 |

**Chem Resist Contact Details**
Tel: + 44 (0) 1924 499466
Email: enquiries@chemresist.com
Web: www.chemresist.com



Cert No. 19390
ISO 9001, ISO 14001
ISO 45001

# General Terms & Conditions of Sale and Supply of Chem Resist Group Limited

These are the terms and conditions on which we CHEM RESIST GROUP LIMITED contract with our clients for the supply of goods and/or equipment and/or services. They are incorporated into all our contracts in this respect to the exclusion of any terms and conditions which may be proffered and which conflict with them.

1. Delivery

We will make every reasonable effort to ensure that delivery (or installation if we are undertaking that) is completed on or before the due date but unless specifically agreed in writing, time is not of the essence. We will not in any event accept responsibility or liability for delay caused in whole or in part by strikes, lock-outs, works breakdown, fire shortages of materials or labour, delay in provision or approval of engineering drawings or other technical information, or any other event of whatsoever nature beyond our reasonable control.

2. Storage

If we do not receive forwarding instructions sufficient to enable dispatch of the goods or equipment within 30 days after the date of notification that they are ready for despatch, the client shall accept delivery when tendered or arrange storage. If the client is unable to accept delivery or cannot arrange for storage, we shall be entitled to arrange storage on the client's behalf and notify the client of all charges for storage, insurance and conveyance which shall be the responsibility of, invoiced to, and paid by the client.

3. Damage in Transit

We will only be responsible for damage or deterioration in transit undertaken by us provided the client notifies us in writing within 10 days of delivery. We shall not be liable for damage or deterioration in transit if that is undertaken by the client.

4. Contract Date

The contract shall bind us only when we accept an order from the client in writing. These terms are incorporated into any such contract.

5. Cancellation

Orders accepted by us cannot be cancelled except with our consent on terms that we be indemnified for any loss. Goods returned without our prior consent in writing will not be accepted for credit.

6. Overdue Accounts

The client shall be liable to pay interest at the rate of 5% over Barclays Bank PLC base rate calculated on a daily basis on all overdue accounts.

7. Consequential Loss

Other than in the case of death or personal injury caused by our negligence or breach of duty we shall not be liable for any consequential loss or damage suffered by the client howsoever caused including loss due to delay, loss of production, loss of profits, loss or damage to other property or goods. Other than death or personal injury, our liability shall be limited to providing replacement goods equipment or services or repairing the goods or equipment in question or refunding the price or such portion thereof as relates to the item in question.

8. Guarantee

For a period of twelve (12) months from the date of delivery, or, where the goods or equipment are installed by us from the date of completion of installation, we shall be liable for any defects in goods or equipment supplied by us which develop under proper use as a result of faulty materials or bad workmanship in manufacture (or installation if that was done by us) on condition that:-

(i) The goods or equipment have at all times been operated in accordance with our operating and maintenance manual and good practice.

(ii) The nature of the inlet water or other governing plant factors has not changed in composition by a significant amount.

(iii) There has been no exchange or modification of the goods or equipment or the parts thereof after installation without our agreement.

(iv) The plant has not been misused or damaged by external force or event.

9. Claims under Guarantee

The entitlement of the Client to any benefit of the guarantee shall be subject to the following conditions:-

(i) Any complaint must be notified in writing to us in the case of alleged defects within fourteen (14) days of the date of the alleged defect arising or being discovered by the client and in any event not later than fourteen (14) days after the expiry of the guarantee period.

(ii) The client shall make the goods and/or the equipment or part in question made available for inspection by our representative at the Client's premises.

(iii) Goods or equipment may only be returned to as if we have first agreed.

10. Jurisdiction

These general terms and conditions and our dealings with our clients are subject to English law and the jurisdiction of the courts of England and Wales.

11. Passing of Risk

Risk in goods and equipment shall pass to the client on the sooner of delivery or tender for delivery.

12. Title

All goods and equipment sold or supplied shall remain the property of Chem Resist Group Limited until we have been paid for them in full. Until title has passed, the client shall not endeavour to dispose of or mortgage or charge or lend or part with the goods or equipment without our express written consent. All goods and equipment which has been delivered but not paid for must be kept distinct from any other goods or equipment and marked as being our property.

# APPENDIX 3

## 54.5m$^3$ Bunded Storage Tank Specifications

Regal Tanks
Ellough Park
Benacre Road
Beccles, Suffolk
NR34 7XD (UK)

T: +44 (0) 1502 710100
F: +44 (0) 1502 710103
E: info@regaltanks.co.uk
W: www.regaltanks.co.uk

# Hire Tank Details – 54.5m$^3$ Bunded Storage Tank


## Tank Specification

| | | | |
|---|---|---|---|
| **Capacity** | 54,500 lt | **Thickness** | Bund: 6 mm, Tank: 6 mm |
| **Overall Length** | 12,300 mm | **Material** | Mild Steel |
| **Overall Width** | 3,300 mm | **Orientation** | Horizontal |
| **Overall Height** | 3,500 mm | **Type** | Bunded Single Skin Tank |
| **Weight (Empty)** | 13,000 kg | **Mount** | Skid |

## Tank Fittings

| | |
|---|---|
| **Front** | 1 x 4” 150# ANSI flanged inlet / outlet.<br>1 x 4” 150# ANSI flanged internal fill line.<br>1” Visual site tube with stop valve. |
| **Top** | 2 x 4” 150# ANSI flanged vent.<br>1 x 600mm bolted manway. |
| **Lifting** | 4 Leg wire rope sling complete with ring assembly.<br>3rd Party certified to LOLER 98. |

**View online:** regaltanks.co.uk/hire-tanks/54500-litre-bunded-storage-tank/



Regallien Ltd trading as Regal Tanks
Company Registration 1968032
VAT Number: 496877757

**WWW.CAULMERT.COM**

Registered Office: InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG
**Tel:** 01248 672666
**Email:** contact@caulmert.com
**Web:** www.caulmert.com