SECTION 2: Alternatives

2.1 Introduction

This Section of the EIAR describes the alternatives considered by Uisce Éireann during the design process for the Proposed Development and outlines the main reasons for choosing the Proposed Development. It has been prepared in accordance with Part 2 of Annex IV of the EIA Directive which identifies that the following is required in the EIAR:

"A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, taking into account including a comparison of the environmental effects."

The Section describes the following reasonable alternatives that have been considered:

- The do-nothing scenario;
- Alternative treatment location;
- Alternative processes (technologies) for treating wastewater; and
- Alternative designs (including scale, layouts and specific characteristics) for the Proposed Development.

2.2 Do-nothing Scenario

The do-nothing scenario refers to what would happen if the Proposed Development was not implemented and Castletroy WwTP continues to operate at its current treatment capacity.

As outlined in **Section 1.2**, the WwTP is currently operating at the upper limits of its design capacity for treatment of incoming wastewater. Various factors will cause the plant to become overloaded should nothing be done. There are existing industrial licenses that are now only being partially utilised. Licence holders can increase production at any time without further permissions in terms of wastewater generation, which poses an immediate risk to plant operations. At a medium to long term outlook, population and general industrial growth projections, will cause overloading of Castletroy WwTP.

When the plant becomes overloaded, it will not be able to provide appropriate wastewater treatment to the Castletroy agglomeration. Concentrations of wastewater will be too high for the receiving waters to dilute appropriately. In turn, this is likely to harm the aquatic environment in the Lower River Shannon, which is an area of environmental conservation under the Habitats Directive 92/43/EEC (Commission of the European Communities, 2007). As well as this, in the absence of appropriate treatment, the WwTP will become non-compliant with the UWWTD, EPA WWDL and other relative legislations.

Without the addition of stormwater storage, excess flows from storms and heavy rainfall will continue to be discharged directly to the Lower River Shannon at an approximate rate of up to 123 spills per annum. The WwTP will remain in breach of the EPA WWDL, DoHELG and Uisce Éireann guidelines. Environmental incidents will continue to be reported in the AERs, and there will be no potential for improvement in downstream recreational water quality.

For those reasons, the 'do-nothing' scenario was not considered further.

2.3 Treatment Location Alternative

The existing plant was constructed in 1992 and the proposed solution maximises the use of the existing infrastructure. It was also decided that should new infrastructure be required as part of the final design, there is sufficient space on site that can be utilised. Therefore, there was no site selection process undertaken as part of this upgrade project.

However, the feasibility of pumping wastewater to the main Limerick (Bunlicky) WwTP for treatment was considered. Following a number of workshops in 2018 and 2019, Uisce Éireann investigated the upgrade options listed in Table 2.1.

Table 2.1: Upgrade Options for the Proposed Development

Option	Description
A	Upgrade the existing Castletroy WwTP to meet +10-year growth with civil infrastructure to meet +25-year growth
B	Partially upgrade the existing Castletroy WwTP and pump remaining PE to Bunlicky WwTP
C	Decommission Castletroy WwTP and pump all to Bunlicky WwTP

Options were assessed with regard to the following criteria;

- The cost of additional treatment and requirement for additional capacity at Bunlicky WwTP;
- The energy cost of pumping to Bunlicky WwTP;
- The cost of treatment options at Castletroy;
- The value of the existing assets at Castletroy WwTP and residual life of the tank structures, building, interconnecting pipework and road infrastructure;
- Planning and environmental considerations; and
- Whole Life Cost.

2.3.1 Option A (Preferred) – Upgrade existing WwTP

An upgrade of the existing WwTP was found to be the most energy efficient and cost-effective measure to support growth and development in the agglomeration. The upgrade works will see the re-use and upgrading of existing assets at Castletroy, while also providing new infrastructure to cater for increasing wastewater loads to the WwTP and stormwater management. Treatment process solutions were subsequently given careful consideration, details of which are presented in **Section 2.4** below.

2.3.2 Option B – Upgrade Castletroy WwTP and pump to Bunlicky WwTP

Option B would involve upgrading the existing Castletroy WwTP to 70,000 PE and pumping the excess (up to 11,100 PE) for treatment at Bunlicky WwTP, via the existing Southern Interceptor Sewer and Corcanree pumping station (PS). General requirements for Option B are listed as follows:

- Upgrade of the existing WwTP to 70,000PE, including new storm tanks;
- Upgrade of Bunlicky WwTP to account for the additional wastewater loads;
- Construction of a new pumping station to pump from Castletroy to the Southern Interceptor sewer on the Limerick Main Drainage network;
- Construction of a 355mm diameter rising main, a distance of 2-1pprox.. 1,800m;and
- Associated M&E & SCADA works and to link to Bunlicky WwTP.

Under the original Limerick Main Drainage Scheme, capacity was provided in the interceptor sewers to facilitate connection of the Castletroy WwTP and to pump to Bunlicky WwTP. It is assumed that Corcanree Pumping Station has the pumping capacity and that no significant changes are required for this additional flow.

However, construction costs for the upgrades to the two WwTPs and additional rising main, as well as the ongoing energy requirement and cost of pumping to Bunlicky WwTP, deemed this a less preferred option.

2.3.3 Option C – Decommission Castletroy WwTP and pump to Bunlicky WwTP

Option C would involve decommissioning the existing Castletroy WwTP. All wastewater from the agglomeration would be pumped to treatment facilities at Bunlicky WwTP via the existing Limerick Main Drainage Southern Interceptor sewer. General requirements for Option C are listed as follows:

- Upgrade of Bunlicky WwTP to account for the additional wastewater load;
- Retain and refurbish the existing inlet works and pump sump at Castletroy WwTP;
- Conversion of the existing aeration tanks to storm tanks;
- Install new pumping infrastructure to pump from Castletroy to the Southern Interceptor sewer on the Limerick MD network;
- Construct an 800mm diameter rising main, a distance of 2-2pprox.. 1,800m. Under this option the rising main would be considered a critical asset and the need for a twin rising main should be considered;
- Associated M&E & SCADA works and to link to Bunlicky WwTP;
- Decommissioning and demolition of the remaining infrastructure at Castletroy WwTP.

The construction costs, ongoing energy requirements, cost of pumping to Bunlicky WwTP and the decommissioning of valued assets at Castletroy WwTP, deemed this a less preferred option.

2.4 Treatment Process Alternatives

The Proposed Development will be procured as a Design and Build project, as detailed in **Section 3** and **Section 4**, with the appointed contractor responsible for the final detailed design. A number of alternatives were considered in the selection of the specimen design for the WwTP which will be used for the purposes of the assessment in this EIAR.

In order to identify a preferred specimen design for the treatment processes to be included in the Proposed Development, the following details were considered:

- Design parameters and constraints to be considered in the design;
- Process options for the level of treatment required;
- Relevant legislation, best practice and industry design standards for wastewater treatment;
- Preliminary sizing of the various structural and MEICA elements of the treatment process;
- Possible layout arrangements for the proposed major process units; and
- Capital and operational expenditure for the preferred options.

The process selection formed the foundation on which the design of the Proposed Development could progress. In terms of WwTP design and selection, the key design criterion is the anticipated Emission Limit Values (ELVs) likely to be enforced through a review of the existing Wastewater Discharge License (WWDL) by the EPA (the consenting authority).

Alternatives were considered with regard to each phase of the wastewater treatment process as follows:

- Inlet works / preliminary treatment;
- Stormwater management;
- Primary treatment;
- Secondary treatment; and
- Sludge treatment and dewatering.

2.4.1 Inlet Works

Wastewater is pumped from Mountshannon and Castleconnell agglomerations to Castletroy sewer network and discharges via gravity sewer to the main lift pump station located on the WwTP site. There are 3 no. Dry Weather Flow (DWF) pumps installed which operate on a duty/standby/assist configuration at a maximum operating flow rate of 283 l/s.

The +25-year projected maximum design flow is expected to reach 811 l/s. However, a Drainage Area Plan (DAP) model for the agglomeration (by RPS Ltd) has reported that, based on a 30-year storm event, incoming flows could reach up to 1,200 l/s. This would result in unscreened spills upstream of the inlet works which would discharge directly the Lower River Shannon.

Alternative Option – Discharging excess storm flows through a high-level overflow pipe located in the wet well. Overflows would be conveyed directly to the final effluent inspection chamber, by-passing the proposed stormtank and treatment process. This would impact the storage capacity in the upstream sewer network, and during flood event flows would not be able to gravitate from the pump station to the final inspection chamber. It would cause localised flooding in the network and the potential for untreated spills to occur where the stormtank volume is not fully utilised. For these reasons, this was an infeasible option.

Optimal Solution – Excess flows will be transferred directly to the proposed stormwater storage tank which will utilise the available storm storage, as well as minimising chances of surcharging of the sewer network and causing localised flooding.

The storm tank cells will receive screened wastewater from the inlet works. The first operational cell will act as a first flush cell, capturing heavy solids. The function of subsequent operational cells is to capture flows from a sustained rainfall event. Following the rainfall event, the contents of the stormwater tanks will be returned for full treatment through the WwTP. If the capacity of the stormwater tanks is exceeded, excess flows will discharge by gravity to the final effluent chamber and through the SWO to the Lower River Shannon.

Refer to **Sections 3.4.2** and **3.4.4** for further details regarding the design criteria.

2.4.2 Stormwater Management

Alternatives of installing a storm tank were not considered as stormwater storage is required in accordance with the EPA programme of improvements, as outlined in **Section 1.2**. A stormwater storage tank with a design volume 4,500 m^3 is proposed to be installed as part of the upgrade works.

Alternative Option – provide a **circular** stormwater storage tank. This option does not maximise the available space between the larger 25m diameter clarifier and the proposed primary treatment location. Further, a circular tank will extend further west into the flood plain relative to the rectangular option below which can extend north to reduce its impact.

Optimal solution – provide a **rectangular** stormwater storage tank partially above ground with the top of walls located at an elevation above the 1% AEP fluvial flood level. Given the area available within the existing site to construct a stormwater storage tank and that a significant portion of the current site lies within Flood Zones A & B, this solution provides the most efficient use of land compared to a circular tank design. Refer to **Section 3.4.3** for further details regarding the design criteria.

2.4.3 Primary Treatment

Primary treatment is required to reduce the loading on the secondary treatment process, while also reducing sludge volumes at the end of the works. The existing arrangement has primary treatment incorporating primary sludge mechanical filtration/separation.

Upgrade options with regard to the primary treatment process were considered as follows:

Alternative Option 1 – the new system would bypass primary treatment stage and transfer screened sewage directly to secondary treatment. Additional secondary stage aeration and settlement tanks volumes of up to 30% would be required for this option. Given the capacity of the existing aeration tank and the existing primary treatment stage, this option was not feasible.

Alternative Option 2 – Construction of new conventional primary settlement tanks.

Based on a preliminary design, in accordance Uisce Éireann specification IW-TEC-700-02 Primary Treatment (Wastewater), this option would require two 19.3m diameter tanks with a total surface area of 584m^2. A third tank would also be required to allow for service and maintenance, resulting in a total footprint of approximately of approximately 876m^2. As outlined earlier, a large portion of the site is located within a flood zone. Any proposed works will need to consider minimising the impact on the available floodplain within the site, therefore this was a less preferred option.

Optimal solution – upgrade and increase capacity of the existing primary filtration system with additional primary sludge mechanical filtration units.

The following are benefits compared to conventional primary treatment:

- c. 50% lower investment cost;
- Significantly less land requirements (proposed area required for the filters and associated equipment is 218m^2);
- The additional benefit of grit removal in the separation stage;
- Significantly lower lifecycle costs;
- Less civil works;
- Smaller secondary/biological treatment processes (less aeration and/or space needed);
- Primary sludge with higher energy value;
- Fully-automated equipment; and
- Lower operating costs (no chemicals to purchase).

Further consideration had to be given whether to instal the filters externally on an uncovered plinth or house them within a building. Housing the filters is the preferred option as it has the following advantages:

- Improved operator comfort during routine operation and inspection;
- Clean and dry area for servicing and maintenance work; and
- Removes the requirement to install external kiosks required to house control panels and ancillary equipment.

Refer to **Section 3.4.5** for further details regarding the design criteria; **Appendix 2B** for examples of Mechanical Filters.

2.4.4 Secondary Treatment

Aeration Process

While there are a wide variety of treatment alternatives, many are compromised because of the limited footprint available, the projected scale of development and the existing site infrastructure. The viable options identified and assessed for Castletroy WwTP are listed as follows (described in further detail below);

- Conventional Activated Sludge (CAS);
- HyBacs (Hybrid Activated Sludge);
- Aerobic Granular Sludge (AGS); and
- Integrated fixed film activated sludge (IFAS).

Alternative Option 1 – Conventional Activated Sludge (Expansion of existing arrangement)

The conventional activated sludge process is currently in operation at Castletroy WwTP. It is a type of plug flow system where the primary effluent from the previous stage enters the aeration tank and travels through the tank at a constant rate to the point of discharge. The wastewater is aerated in the tank, in which micro-organisms metabolise the suspended and soluble organic matter. In the aeration stage, primary effluent mixes with return sludge from the secondary settlement stage providing a medium to reduce the organic load by up to 95%. The treated wastewater then goes forward to final settlement. The final effluent is separated from the secondary sludge during final settlement with the secondary sludge being thickened and dewatered prior to being disposed off-site and the treated effluent going to tertiary treatment (if required) or discharged to the receiving waters.

Expansion of the existing arrangement could provide treatment up to 77,500PE without an upgrade to the mechanical primary filters, and would operate in parallel to the existing process stream. However, design calculations estimate it would require an additional 4 no. aeration tanks and 2 no. clarifiers, totalling and area of 12,023m^2. This would incur significant capital and annual maintenance costs as well as substantial loss of flood zone, and therefore was not investigated any further.

Alternative Option 2 – Aerobic Granular Sludge (Royal Haskoning-DHV)

The Nereda™ Aerobic Granular Biomass Technology was developed by Royal Haskoning DHV (RHDHV) in collaboration with the Dutch water sector and Delft University of Technology. Nereda™ is an innovative and advanced biological wastewater treatment technology that purifies wastewater using the unique features of aerobic granular biomass. The following sequential steps and processes occur in the Nereda™ system.

<u>Simultaneous fill and draw:</u> During the fill phase, influent wastewater is fed to the bottom of the reactor and flows under near-plug flow conditions through the settled granular biomass. As a result of the plug flow there is no contact between the purified effluent at the top of the reactor and the raw influent wastewater at the bottom, enabling wastewater treated in the previous cycle to be displaced or "pushed" out of the reactor as well-treated effluent, whilst the reactor is simultaneously being fed. Unlike SBR systems, Nereda™ does not require a separate time consuming decant phase. More importantly, static fixed overflow weirs are used instead of the moving and maintenance intensive decanters typically applied in SBR systems.

<u>Aeration:</u> During the aerated reaction phase all biological processes take place. Fine bubble aeration generates an oxygen gradient in the compact structure of the granular biomass. At the aerobic outer layer of the granule organic pollutants are efficiently oxidized. Nitrifying bacteria also accumulate in the outer layer of the granules and convert ammonium to nitrate. The produced nitrate diffuses into the anoxic core of the

granule where it is simultaneously denitrified. In addition, enhanced and extensive biological phosphate fixation takes place.

Fast settling: In this phase the biomass is separated from the treated effluent. As result of the excellent characteristics of the biomass, the required duration for settling is short and this phase is also used to discharge excess biomass formed as a result of growth and accumulation during the aeration phase.

The outline solution would comprise of:

- Convert existing 25m dia. Settlement tank to an influent buffer tank;
- Convert existing aeration tanks to AGS reactors (2 no.);
- Repurpose existing 20m dia. Settling tank to balance final effluent; and
- Repurpose existing 20m settling tank to sludge buffer tank.

The AGS Nereda^{TM} system was not progressed any further due to a higher whole life cost compared to the preferred option (over 40 years), which includes capital and annual operating costs.

Alternative Option 3 – HYBACS (Bluewater Bio)

HYBACS comprises two biological stages: a patented attached growth reactor referred to as a SMART^{TM} unit, followed by a conventional activated sludge plant (ASP). The SMART^{TM} Unit provides rapid hydrolysis, enhancing the subsequent treatment performance in the existing activated sludge plant. Crucially, the high floc load in the SMART^{TM} unit also encourages the growth of a dense, well-settling sludge which improves the performance of the clarifiers also. The SMART^{TM} units, aeration tanks and clarifiers operate together, providing a continuous-flow high-rate biological treatment process with low cost and small footprint.

Preliminary design indicated that 14 No. SMART^{TM} units (77,500 PE), would be required to be installed upstream of the existing activated sludge plant (2 no. aeration tanks and 3 no. clarifiers), as shown in the process flow schematic below. Return Activated Sludge (RAS) diversion to the SMART^{TM} units is required.

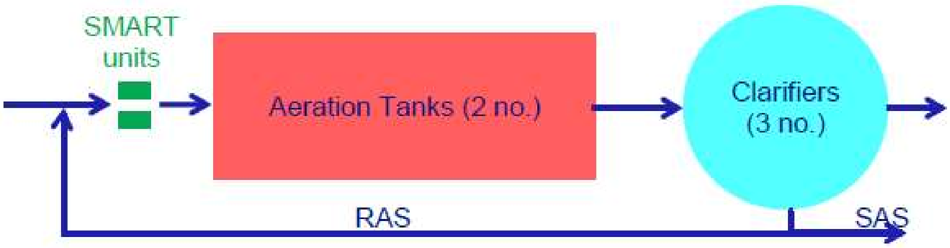

Figure 2.1: Outline HYBACS Flow Schematic

The HYBACS system was not progressed any further due to the significantly high Whole life cost (over 40 years), which includes capital and annual operating costs.

Optimal Solution – Integrated fixed film activated sludge (IFAS)

Integrated fixed film activated sludge (IFAS) is a technology that describes any suspended growth system that incorporates an attached growth media within the suspended growth reactor (U.S. EPA 2010).

Conventional activated sludge (existing arrangement) is a suspended biomass growth reactor. Retrofitting it with integrated fixed-film activated sludge (IFAS) technology provides for additional biomass within a wastewater treatment facility, to meet increased loadings, without the direct need for additional tankage. Refer to **Section 3.4.6** for further details regarding the design criteria.

Benefits and reasons for selecting IFAS are listed as follows:

- IFAS is a proven process on plants of a similar size and complexity;
- IFAS has the lowest whole life cost (over 40 years) and includes capital replacement of mechanical and electrical equipment;
- IFAS solution has the minimum footprint required minimising the use of Flood Zone A;
- IFAS allows for the continued use of suspended activated sludge process supplemented by fixed film media in lieu of additional volume;
- IFAS allows hydraulic optimisation of existing secondary settlement tanks by improving sludge settleability;
- IFAS retains use of existing return activated sludge pumping station and associated infrastructure; and
- IFAS is the most suitable option to maximise and retain existing assets.

Secondary Clarification

It is proposed to increase the hydraulic capacity of the existing 20m diameter clarifiers to equal the capacity of the larger 25m diameter clarifier. Flow will be equally split to each clarifier and the increased capacities will provide future redundancy should a tank be required to be taken offline for maintenance.

Alternative Option – Tube settlers can be installed in a tangential arrangement along the outer edge of the two 20m diameter tanks. Tube settlers can increase the settling capacity in circular clarifiers by reducing the vertical settling distance of floc particles.

Optimal Solution – Installation of Stamford and McKinney baffles

Stamford density current baffles are an effective method minimising the effects of short-circuiting and improving effluent quality. In addition, McKinney baffles cut the density current and, if designed correctly, completely separates the stilling and settling zones. They can also act to separate the stilling zone from the settling zone and this design can increase the volume flow rate. For these reasons, this baffle arrangement was deemed the preferred option.

Refer to **Section 3.4.6** for further details regarding the design criteria.

2.4.5 Sludge Dewatering

All indigenous sludge produced from primary and secondary treatment processes in the upgraded WwTP will be dewatered on-site. A full upgrade of the sludge dewatering systems is also required taking into consideration the age and condition of the existing units. Two options were considered for the upgrade of the dewatering units currently installed, sludge presses and centrifuges.

Alternative Option – replacement of existing dewatering equipment with new belt presses.

The belt press dewaters the sludge by passing it between two tensioned porous belts pressured by rollers of various diameters. Increased pressure is created as the belt passes over rollers which decrease in diameter. Advantages of the belt press include easy operation and maintenance, low noise and vibration and low energy consumption at approximately 40kW/unit.

However, they have limited dewatering capability at 18% dry solids (DS). They also require more space and washwater than a centrifuge and are not well suited to deal with varying sludge. For these reasons this option was not developed any further.

Optimal Solution – replacement of existing dewatering equipment with new centrifgues.

The centrifuge dewaters by passing the sludge through a cylinder that uses a fast rotation to separate wastewater liquid from solids. 2 no. duty/assist centrifuges with a capacity of 400kgDS/h/unit are required, operating for approximately 6 hours per day. Centrifuges can dewater sludge up to 20-24% dry solids (DS) and have an approximate power consumption of 25kW/unit based on manufacturers literature. Wash water will be required for cleaning the centrifuge when not in dewatering mode.

Centrifuges are considered the most suitable upgrade for Castletroy WwTP, offering a higher percentage of dry solids, higher hydraulic throughput with smaller footprint, greater odour control and less operator input. Refer to **Section 3.4.8** for further details regarding the design criteria.

2.4.6 Sludge Cake Storage

Optimal Solution –cater for peak sludge production and provide adequate storage at non-working hours i.e. weekends. To achieve this 3 no. sludge skips are required to be installed outside the building. Refer to **Section 3.4.8** for further details.

Alternative Option – The existing situation has 1 no. sludge trailer placed in the building directly underneath the existing belt press. Consideration was given to retaining this arrangement however, increasing the capacity for the sludge dewatering requires additional sludge dewatering units and greater volume to cater for daily sludge production. In order to cater for daily peak design sludge production up to three trailers are required. Replacing the skips up to three times per day is not an acceptable solution.