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Barnhill SHD Pumping Station - Sizing and Design Methodology



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1 Introduction

The Barnhill Strategic Housing Development (SHD) is a proposed residential development located approximately 3km west of Blanchardstown. The development is a joint venture between developers Alanna Homes and Alcove Ireland Four Limited. The SHD lands are situated directly south of the Dunboyne to Clonsilla Rail line and Hansfield Train Station, west of the Royal Canal and the Dublin to Maynooth Railway Line and east of the existing R149 Leixlip to Clonee Regional Road. It is the vision of the property developers and Fingal County Council to create a place to live that is appealing, distinctive and sustainable.

Facilities for the collection and disposal of the wastewater generated by the future proposed Barnhill SHD shall be provided for by means of a foul pumping station that will be constructed as part of the proposed overall development. This foul pumping station shall be in accordance with the requirements of Irish Water and Fingal County Council.

Foul sewerage / wastewater will be collected by means of manholes and underground pipework networks which are to be laid primarily along the internal road networks traversing the development site. Typical pipe sizes of the foul sewer network shall be 225–450mm Ø. The wastewater will discharge via gravity to a proposed pumping station located within the south-east of the site. The proposed pumping station is to be a wet well type arrangement with 6 hours storage capacity at three times the dry weather flow to allow for breakdown of pumps or maintenance works to be carried out. The proposed pumping station is located a minimum of 35m from the nearest residential units within the development in compliance with Fingal County Council Guidelines.

The foul sewerage / wastewater will then be pumped, via a 200mm Ø SDR 17 PE rising main, from the proposed pumping station to the existing services culvert that passes beneath the existing Clonsilla – M3 Parkway Railway line immediately east of Hansfield Train Station. The maximum pumped flow from the site is to be approximately 20 l/s. From here, the foul rising main will connect to a foul rising main discharge manhole constructed within the Hansfield development. This foul effluent will then flow, via gravity, by means of the as constructed internal 375mm ø Hansfield foul sewer to the existing foul sewer infrastructure located along the existing Ongar Distributor Road, from where it will ultimately discharge to the Ringsend Wastewater Treatment Plant (WWTP). The Ringsend WWTP is currently undergoing upgrade works to increase its capacity and will therefore have sufficient capacity to cater for the foul sewer effluent created by the development.

The proposed foul pumping station shall be sized to cater for the predicted wastewater flows for the Barnhill SHD as well as providing additional capacity within the pumping station to allow for future development in the lands immediately adjacent to the development site.

2 General Design Criteria

2.1 Contributing Areas

The design and sizing of the wastewater pumping station shall have the capacity to serve the following future catchments:

1. The zoned Barnhill SHD lands that planning permission is being sought for under this planning application. The area of these lands is approximately 29.60 hectares. This area is the sum total of the Barnhill SHD lands both east and west of the future Ongar to Barnhill Distributor Road that shall be constructed prior to the commencement of the Barnhill SHD. The number of residential units supported on the SHD lands will be 1,243 units. The proposed development shall also include provision for commercial units and a crèche facility. Lands are also to be set aside for a future primary school within the Village Centre Character Area of the development. The estimated wastewater flows generated by the future primary school shall also be considered when designing the Barnhill SHD pumping station. The proposed 1,243 units as part of the Barnhill development shall be constructed on a phased basis.

2. Potential future development lands located adjacent to the Barnhill SHD zoned lands. The pumping station will also need to consider the future development of the Iarnród Éireann lands in the vicinity of Hansfield Train Station. To account for future development in the area surrounding the Barnhill SHD lands, it is proposed to have additional capacity in the pumping station to accommodate for an estimated additional 1,200 units.

2.2 Capacity

The design of the pumping station shall be sized for the following predicted flows, shown in Table 1 below, for the Barnhill Strategic Housing Development (SHD) and potential future development in the immediate surrounding area:

	Phase 1 - Barnhill SHD with Estimated Wastewater Generated by Future Primary School	Phase 2 - Potential future development in surrounding area	Total
Projected Units	1,243	1,200	2,443
Dry weather flow (DWF) per unit (inclusive of 10%-unit consumption allowance) ¹	446 litres/day/unit	446 litres/day/unit	446 litres/day/unit
DWF Average Flow (Litres per day)	554,378 litres/day	535,200 litres/day	1,089,578 litres/day
Additional DWF Average Flow (Litres per day) for future school ²	27,500 litres/day	N/A	27,500 litres/day
Overall DWF Average Flow (Litres per day)	554,378 + 27,500 = 581,878 litres/day	535,200 litres/day	581,878 + 535,200 = 1,117,078 litres/day
Overall DWF Average Flow (Litres per Second)	6.735 litres/second	6.194 litres/second	12.929 litres/second

Table 1: Projected Wastewater Flows for Barnhill SHD and potential future development in the surrounding area.

¹ – DWF (Average) per Unit = (2.7 * 150 l/s) + 10%-unit consumption = 446 litres/day/unit

² – DWF (Average) per future School = (500 persons (estimated number of students and staff) * 50 l/head/day) + 2,500 l/day (10% Infiltration) = 27,500 litres/day

2.3 Phasing of Housing

Although the Barnhill Strategic Housing Development (SHD) will be constructed using a phased approach and the potential future development may not be constructed until a number of years thereafter, the proposed Barnhill SHD pumping station shall be fully constructed during the construction of the Barnhill SHD to allow sufficient capacity for the proposed and future projected flows. The proposed pumping station will be constructed during Phase 1 of the Barnhill SHD. The proposed pump configuration can, however, be separated into two phases. These are as follows:

- Phase 1 – The Proposed Barnhill Strategic Housing Development (SHD) consisting of 1,243 residential units and the wastewater discharge from a future Primary School (lands are proposed to be set aside for a future Primary School, which is to be made available to the Department of Education).
- Phase 2 – Future development in the surrounding lands adjacent to the Barnhill SHD site. An additional 1,200 residential units has been estimated for these lands.

2.4 Post Development Peak Discharge (3 * DWF Average Flow)

Table 2, shown below, outlines the projected flow rates to the pumping station after completion of the phases as shown section 2.3 of this report.

	Total Average DWF Flow (litres / second)	Peak Flow - 3 Times Average DWF Flow (litres per second)
Completion of Phase 1 – Barnhill SHD consisting of 1,243 units and including a future primary school (in lands set aside to be made available to the Department of Education)	6.735	20.205
Completion of Potential Phase 2 – Future Development in surrounding lands adjacent to the Barnhill SHD site (Estimated 1,200 units)	Phase 1 + Phase 2 6.735 + 6.194 = 12.929	(Phase 1 + Phase 2) * 3 (12.929) * 3 = 38.787

Table 2: Post Development Peak Discharge (3*DWF) based on Projected Phases

2.5 Proposed / Existing Rising Main and Pipe Discharge Velocity

The acceptable velocity range for foul sewer rising main pipes is between 0.75 metres per second and 1.80 metres per second, as per Section 3.7 of the Irish Water Code of Practice for Wastewater Infrastructure. 0.75 metres per second is considered a minimum self-cleansing velocity, whilst in velocities greater than 1.80 metres per second there is a danger of erosion to the internal rising main pipe walls over time.

The foul rising main size proposed to carry the wastewater from the pumping station is 200mm ø SDR 17 PE rising main. This rising main shall pass through the existing services culvert that passes beneath the existing Clonsilla – M3 Parkway Railway line immediately east of Hansfield Train Station. From here, the foul rising main will connect to a foul rising main discharge manhole constructed within the Hansfield development currently under construction.

Table 3, shown below, shows the pipe velocities for Phase 1 (the Barnhill SHD) and phase 2 (the Barnhill SHD plus potential future development in the lands adjacent to the Barnhill SHD site):

Pipe Diameter External (mm)	Phase	Cross Section Area (A) (m ²)	Flow Rate (Q) (m ³ /sec)	Pipe Velocity (Q/A) (m/sec)	Pass / Fail (Within the range 0.75m – 1.80m per second)
200	Phase 1	0.0244	0.02021	0.828	0.75 < 0.828 > 1.80 (PASS)
200	Phase 1+2	0.0244	0.03879	1.590	0.75 < 1.590 > 1.80 (PASS)

Table 3: Velocities in Rising Main per Phase

2.6 Storage Times and Pumping Station Storage Volumes

Storage times for the Barnhill Strategic Housing Development (SHD) are determined with respect to the following criteria:

1. The need to provide sufficient storage capacity in the event of systems failure (6 hours @ 3*DWF).
2. The need to avoid anaerobic conditions being generated within the pumping station (Approximately 6 hours).

The sump capacity is therefore calculated by providing 6 hours storage time of foul wastewater effluent within the pumping station wet well.

	Peak Flow Rate (3*DWF) (litres/second)	Storage Filling Times for 1 hours @ Peak Flow Rate (3*DWF) (m ³ / 1 hour)	Storage Filling Times for 6 hours @ Peak Flow Rate (3*DWF) (m ³ / 6 hours)
Phase 1 – Barnhill SHD consisting of 1,243 units and including a future primary school (in lands set aside to be made available to the Department of Education)	20.205	72.738	436.428
Phase 1 + Phase 2 (Phase 2 is the potential future development in surrounding lands adjacent to the Barnhill SHD site (Estimated 1,200 units))	38.787	139.633	837.798

Table 2: Post Development Peak Discharge (3*DWF) based on Projected Phases

2.7 Sizing of Underground Storage Tanks

See below for the sizing of the storage tanks required to cater for Phase 1 and Phase 2. As per Irish Water guidelines the foul pumping station is to be constructed to cater for the overall storage volume required for Phases 1 and 2 inclusive.

2.7.1 Phase 1 Storage Requirement

The capacity of one tank and the wet well provides sufficient capacity for Phase 1 of the Barnhill Strategic Housing Development (SHD) consisting of 1,243 housing units and a future primary school (in the lands set aside that are to be made available to the Department of Education). Based on the Storage Filling Times for 6 hours @ Peak Flow Rate (3*DWF) for phase 1, shown in Table 2, it is proposed to provide 1 no. storage tanks (Phase 1 storage tank and Wet Well Storage) with the following capacities.

- Wet Well Capacity = 5.40m * 3.00m * 5.40m Deep = 87.48m³
- Phase 1 Underground Storage Tank = 16.00m * 6.75m * 3.65m Deep = 394.20m³

The volume of benching to the floor of the Phase 1 Underground Storage Tank and the Wet Well needs to be considered when determining the useable capacity for Phase 1 of the development. The volume of benching for this Phase 1 arrangement is approximately 19m³.

Therefore:

Overall Phase 1 Storage Volume = 87.48m³ + 394.20m³ – 19.00m³ = 462.68m³ (**Required = 436.428m³**).

2.7.2 Phases 1 & 2 (Inclusive) Storage Requirement

The phase 2 underground storage tank will be required to cater for potential future development in the lands immediately surrounding the Barnhill SHD site. It is estimated that this potential future development could require storage and pumping provision for an additional 1,200 housing units. Based on the Storage Filling Times for 6 hours @ Peak Flow Rate (3*DWF) for phases 1 & 2 inclusive, shown in Table 2, it is proposed to provide 2 no. storage tanks (Phase 1 storage and Phase 2 storage tank and Wet Well Storage) with the following capacities.

- Wet Well Capacity = 5.40m * 3.00m * 5.40m Deep = 87.48m³
- Phase 1 Underground Storage Tank = 16.00m * 6.75m * 3.65m Deep = 394.20m³
- Phase 2 Underground Storage Tank = 16.00m * 6.75m * 3.65m Deep = 394.20m³

The volume of benching to the floor of the Phase 1 and Phase 2 Underground Storage Tanks and the Wet Well needs to be considered when determining the useable capacity for Phase 1 of the development and the Phase 2 future development potential. The volume of benching for this Phase 1 & Phase 2 inclusive arrangement is approximately 31m³.

Therefore:

Overall Phase 1 and Phase 2 (Inclusive) Storage Volume = 87.48m³ + 394.20m³ + 394.20m³ – 31.00m³ = 844.88m³ (**Required = 837.798m³**).

2.8 Pump Head Requirements

The proposed invert level of the pump sump within the wet well of the foul pumping station is 47.872m OD. The Rising Main Discharge Manhole to where the proposed 200mm \varnothing SDR 17 PE Rising Main will flow to has an invert of approximately 60.500m OD. The Rising Main Discharge Manhole was constructed as part of the Hansfield SDZ development, located to the north of the Barnhill SHD site.

This equates to a static head of 12.628m approximately.

2.9 Rising Main Details

The overall length of the proposed 200mm \varnothing SDR 17 PE Rising Main from the pumping station to the Rising Main Discharge Manhole is approximately 600m.

The inside pipe diameter of the proposed 200mm \varnothing SDR 17 PE Rising Main is 176.2mm. The wall thickness of the pipe is 11.9mm.

It is proposed to lay the foul rising main at a consistent depth of 1.20m along its length. The level of the land under which the rising main travels rises, in a consistent manner, from the pumping station to the installed Rising Main Discharge Manhole. Due to this, It is not envisaged that there will be the requirement of a scour valve on the rising main.

3 Appendix A – Relevant Drawing References

Listed below are the relevant drawings relating to the proposed Barnhill Strategic Housing Development (SHD) Foul Pumping Station that accompany the Barnhill SHD Planning Application:

- 16_053_036 - Proposed Foul Sewer Layout Foul Pumping Station Location and Indicative Rising Main.
- 16_053_037 - Proposed Foul Pumping Station Layout.

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