

surface water sewerage

Existing Surface Water Sewerage

There are no Dublin City Council separate surface water sewers in the vicinity of the Grangegorman site.

However the Bradoge River runs southwards to the River Liffey through Grangegorman. According to the “Rivers of Dublin” by Clare Sweeney, the Bradoge River originates in Cabra, where it took a course eastwards through Cabra West and East, south easterly through Grangegorman to the ford at Broadstone where at this point the watercourse appears to split in two. The main course turns eastwards at the railway terminus and crossed under Constitution Hill/Broadstone Road into Kings Inn and down into Bolton Street where it now travels in a 2400 x 900mm brick sewer past Chapel Street into Kings Street, Halston Street, Cuckoo Lane and Chancery Street before discharge into the River Liffey.

The smaller course at the rear of Broadstone branched off due south through St Brendans before separating into two at the west end of the old Richmond Hospital on Brunswick Street North and rejoined again to run southwards on Red Cow Lane and across Kings Street North. It then flows south down Arran Street North entering the River Liffey on Arran Quay downstream of Queens Street Bridge. The Bradoge river system has been incorporated into the Dublin City Council sewerage system. The total length of the main lines of the network is 5½ kilometres.

Dublin City Council Drainage Division (DCCDD) have confirmed that the Bradoge River system has been incorporated with the public combined sewerage system and as such would not be suitable for opening up as a water feature within the development. DCCDD have indicated that the long term view of the Council was to provide for the separation of surface water and foul flows from the Bradogue Culvert upstream of Grangegorman and the North Circular Road, however a timescale is not available for this. DCCDD have suggested that following this separation the culvert could provide a permanent water source for the Ha-Ha.

Proposed Surface Water Sewerage

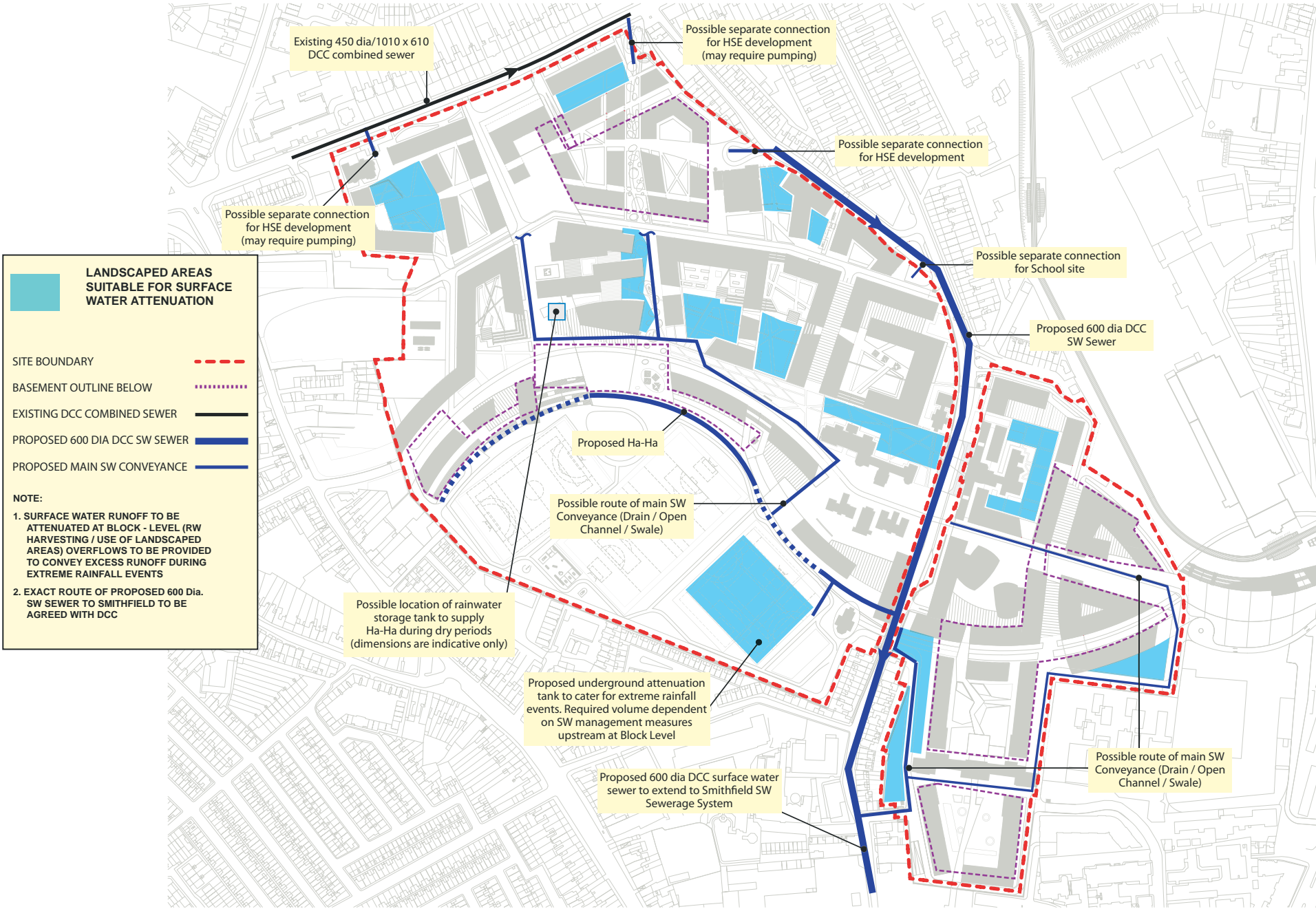
Drainage from the proposed development of Grangegorman shall be on a completely separate system with separate foul and surface water drainage before connection to separate foul and surface water sewers in the existing or new public access roads throughout the development.

Surface water disposal shall be in accordance with the Greater Dublin Strategic Drainage Study published in March 2005. Sustainable Urban Drainage Systems (SUDS) techniques shall be incorporated into the development.

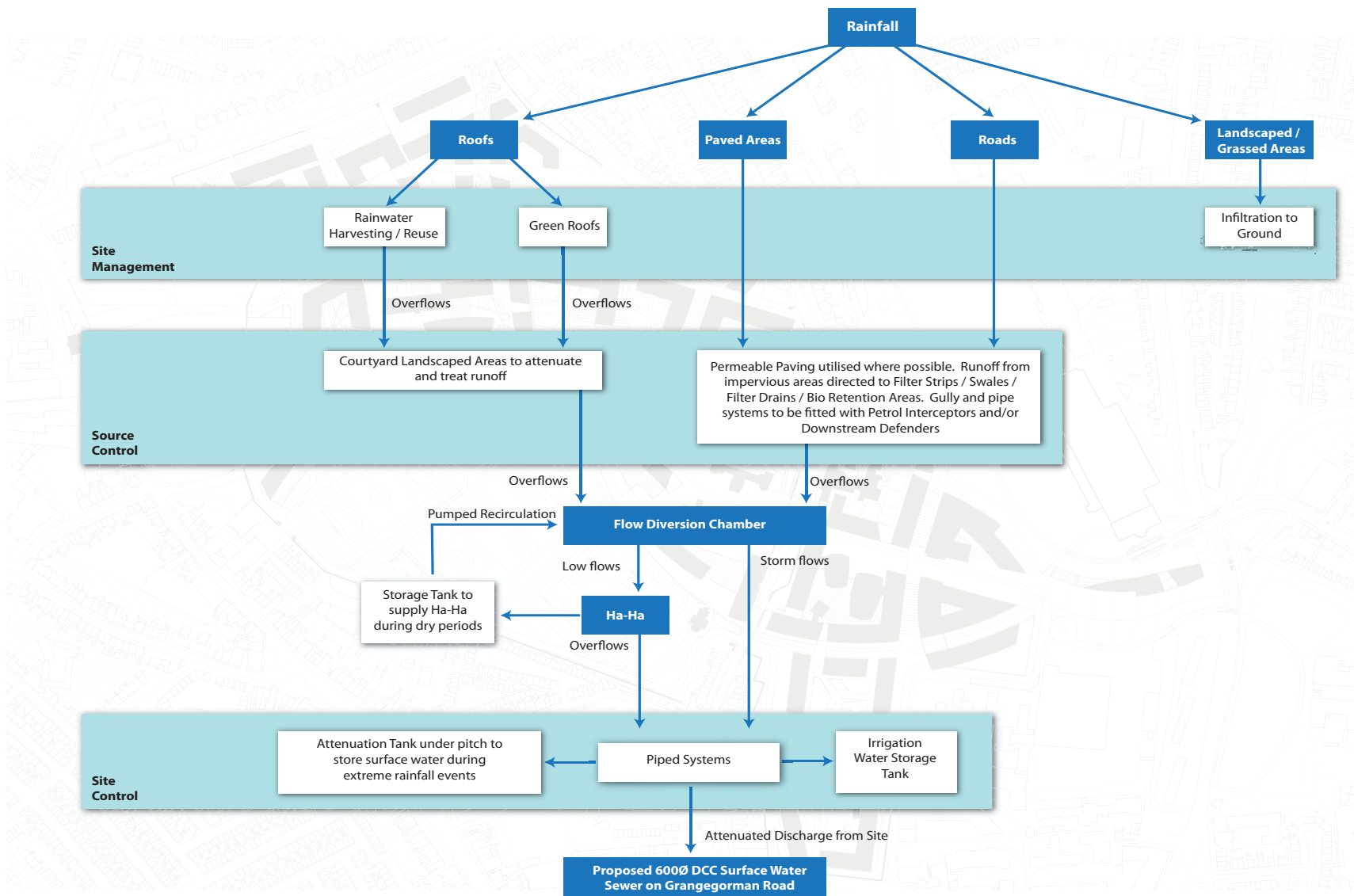
The surface water drainage system will combine various techniques through a storm water management or treatment train approach to ensure that both runoff quantity and quality are addressed.

The following SUDS measures shall be incorporated into the development where appropriate, in line with the Greater Dublin Strategic Drainage Study:

- Infiltration systems including infiltration trenches, infiltration basins, permeable paving, soakaways and green roofs (roof gardens).
- Filtration systems including swales, bioretention systems and filter strips.



Existing and Proposed Surface Water Drainage



Surface Water Treatment Train

Surface water will be stored/reused/infiltrated where possible and the outflow restricted to Greenfield rates for storm events up to and including the 100 year return period storm. Surface water runoff shall be attenuated as close to source as possible (green roofs/rainwater harvesting/landscaped areas) with overflows connected to site attenuation facilities (detention ponds/ underground tanks etc) provided as appropriate.

Surface water drainage from the proposed development either side of Grangegorman Road shall be collected separately in a private drainage system before a restricted discharge by gravity to a new public surface water sewerage system in Grangegorman Road Lower.

Discussions with Dublin City Council Drainage Division (DCCDD) have confirmed their requirement for a new surface water sewer to facilitate the proposed development. This will require the construction of a new 600mm surface water sewer from Smithfield Plaza to service the new development. The existing 600mm surface water sewer at Smithfield discharges directly to the River Liffey. The route of this new sewer to Grangegorman Road Upper will be in agreement with DCC Drainage Division.

The Proposed Primary School Site will be provided with a separate surface water drainage system and separate connection to the new 600mm diameter DCC surface water sewer on Grangegorman Road Upper, in agreement with DCCDD.

The early phase HSE Developments will be provided with a separate surface water drainage system and connections in agreement with DCCDD, to either:

- The new 600mm diameter DCC surface water sewer on Grangegorman Road Upper.
- The existing 450mm diameter or 1010x610mm combined sewer on North Circular Road. This may require a pumped connection at a controlled rate to a discharge manhole. Consent to discharge surface water to combined sewers will require further discussions and agreement with DCCDD, and may be granted on a temporary basis only, subject to construction of the remainder of the site-wide drainage infrastructure.

Surface Water Treatment Train

The treatment train is a hierarchy for the design of surface water drainage systems with the extent of treatment at each level determined by the site area, complexity and receiving system.

The surface water treatment train for the Grangegorman site is identified opposite. This should be read in conjunction with the water management section of Part D - Environmental Sustainability.

The extent of the site control measures required will be determined by the degree to which management and source control techniques are employed.

Reduction in surface water runoff volumes and peak flows, and improvements in water quality will be achieved through a number of measures in the treatment train.



Green Roof

- Retention systems including retention ponds.
- Detention systems including underground tanks, underground attenuation, detention basins and filter drains.

Careful consideration should be given to the placement of above ground surface water attenuation features (ponds, swales etc) where children are expected to play.

It is proposed that surface water drains will be provided on the main primary access routes throughout the development. It is not envisaged that drainage on the campus will be taken in charge, however DCCDD have advised that main surface water drainage within the development should be constructed to DCCDD adoptable standards. The requirements for DCCDD adoptable drainage are set out below:

- (i) Proposed surface water sewers to be a minimum of 225mm diameter.
- (ii) Sewers shall comply with Dublin City Council Drainage Division “Code of Practice”.
- (iii) Sewers and manholes shall be constructed to the details and specifications of the Drainage Division.



Swales



Bioretention Area



Detention Basin



Cellular Storage

Site Management Techniques

Rainwater Harvesting

Rainwater harvesting systems direct rainfall from roof areas to storage tanks located at high level or in-ground, for reuse as flush water for WC's or washing purposes. The roof outlet is usually provided with an in-line filter and UV treatment may also be employed.

The system requires separate pipework clearly marked as non-potable. An overflow from the storage tank should be connected to a surface water drainage system and a mains water back-up installed for use during dry weather conditions.

Green Roofs

Green roofs comprise of vegetated material placed on a waterproof membrane and drainage layer at roof level. The green roof can reduce rainfall runoff significantly, so rainwater harvesting may not be compatible with this system.

Source Control Techniques

Permeable Pavements

Permeable pavements allow direct infiltration of rainwater as it falls on the road surface. The permeable surfacing can be constructed of gravel, porous asphalt, reinforced grass or block pavers. The selection of an appropriate surfacing depends on expected traffic loading. Permeable pavements can provide treatment through filtration process in the underlying stone layers and geotextile, if provided.

Swales

Swales are open vegetated channels that can convey and filter runoff. They are often used as edge-of-road drainage accepting sheet flow and their use negates the requirement for gullies and inspection chambers. Depths of water and velocity of flow should be minimised to prevent erosion of the swale and to maximise its infiltration/filtration potential. This can be achieved by limiting gradients and side slopes. Check dams can also be introduced if necessary.

Filter Drains

Filter drains are constructed of a stone filled trench with a perforated pipe placed at the base. A geotextile may be placed around the backfill material to prevent ingress of fines and provide filtration of the runoff. Gullies are not required but it is good practice to provide inspection chambers for maintenance purposes.

Bioretention Areas

Bioretention areas are planted swales with a variety of vegetation which improve the treatment potential and flow attenuation of the swale. A perforated pipe may be introduced to prevent waterlogging of the bioretention area.

Site Control Techniques

Detention Basins/Ponds

Detention basins and ponds are provided as a final level of treatment and attenuation prior to discharge from a site. Water levels within these structures will vary according to runoff volumes. A flow control device is usually fitted to the outlet to limit discharge to an agreed rate. Silt control can be included by means of smaller primary settlement ponds or filters upstream.

Underground Storage Systems

Underground storage systems can be placed beneath roads, paved and landscaped areas to provide attenuation storage volume. Surface water treatment is limited, however if the system is sealed the stored runoff can be reused (irrigation water, for example).

Proprietary Systems

Oil Interceptors

Oil interceptors are installed on gully and pipe systems which are subject to significant hydrocarbon loading (car parks) or risk of oil spillages (petrol station forecourts, service yards). A bypass may be installed for large storm events. An alarm should be fitted to warn when the maximum oil storage volume is exceeded.

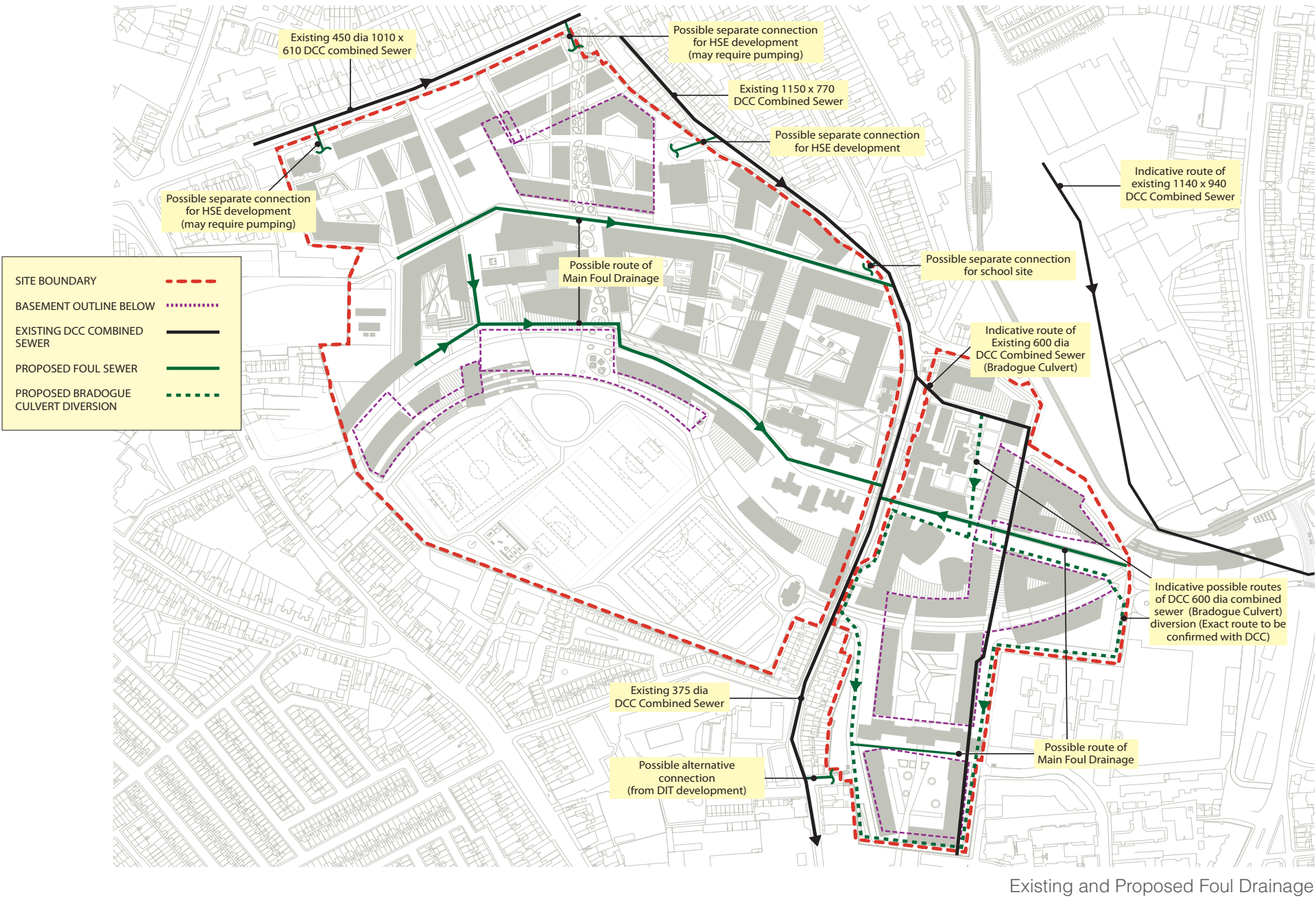
Downstream Defenders

Downstream defenders are vortex – type filters, suitable for removal of sediments where other SUDS measures cannot be employed. Regular maintenance and silt removal is essential to ensure proper operation of the unit.

Surface Water Discharge Rate from Site

Surface water discharge from the site will be limited to 2 l/s/Ha. However, where landscaping/SUDS features and other measures can be demonstrated to provide interception, treatment, and attenuation storage upstream, this allowable discharge rate may be increased subject to agreement with DCCDD.

Another factor will be the proportion of flow in the 600mm diameter DCC surface water sewer which is allocated by DCCDD to the Grangegorman site.



foul sewerage

Existing Foul Sewerage

The following Dublin City Council combined sewers are located in the vicinity of the Grangegorman site.

- A 450mm sewer runs eastwards along the North Circular Road into a 1010 x 610mm sewer at the junction of Annamoe Parade. This sewer turns southwards down Grangegorman Road Upper.
- A 1010 x 810mm sewer on Grangegorman Road Upper is part of the Bradogue River Culvert system. This sewer splits in two at Marne Villas with a 600mm pipe discharging through the eastern section of St Brendans Hospital before connecting to the 1500mm sewer on Brunswick Street North.

- A 375mm sewer splits from the 1010 x 810mm sewer at Grangegorman Road Upper and discharges southwards down Grangegorman Road Lower before connecting into a 1010 x 600mm sewer at the Stanhope Street junction.
- A 300mm sewer on Kirwin Street which drains both westwards to the 1350mm sewer on Manor Street and eastwards to the 300mm sewer on Grangegorman Road Lower.
- A 1030 x 610mm sewer on Prussia Street which drains southwards to the 1350mm sewer on Manor Street.

Drainage from St. Brendan's, Grangegorman is divided into two areas. St Brendan's West discharges eastwards to the Dublin City Council combined sewers on Grangegorman Road Upper and St. Brendan's East discharges both eastwards to the 600mm diameter Dublin City Council foul sewer (Bradogue River Culvert) traversing the site to the eastern boundary with the Broadstone Depot and westwards to a 1010 x 600mm brick sewer on Grangegorman Road Lower.

Drainage from St. Brendan's West is drained on a combined system with 5 outfall points to the Dublin City Council sewer on Grangegorman Road Upper. Four of these outfalls discharge to a 1150 x 770mm brick sewer and the fifth to the 375mm diameter sewer on Grangegorman Road Lower.

The 1150 x 770mm sewer divides at Marne Villas into a 600mm diameter sewer (Bradogue River Culvert) draining through St. Brendan's East and a 375mm diameter sewer draining southwards down Grangegorman Road Lower.

Drainage from St. Brendan's East is drained on a combined system with 6 outfall points to the City Council sewers. Four of these outfalls discharge to the 600mm diameter sewer (Bradogue River Culvert) traversing the site while the remaining two discharge to the 375mm diameter sewer on Grangegorman Road Lower. Drainage on the site is mainly constructed of glazed earthenware with brickwork manholes.

Proposed Foul Sewerage

Drainage from the proposed development shall be completely separate, with separate foul and surface water drains before connection to separate foul and surface water sewers in the existing or new public access roads throughout the development.

Existing and proposed foul drainage is shown opposite.

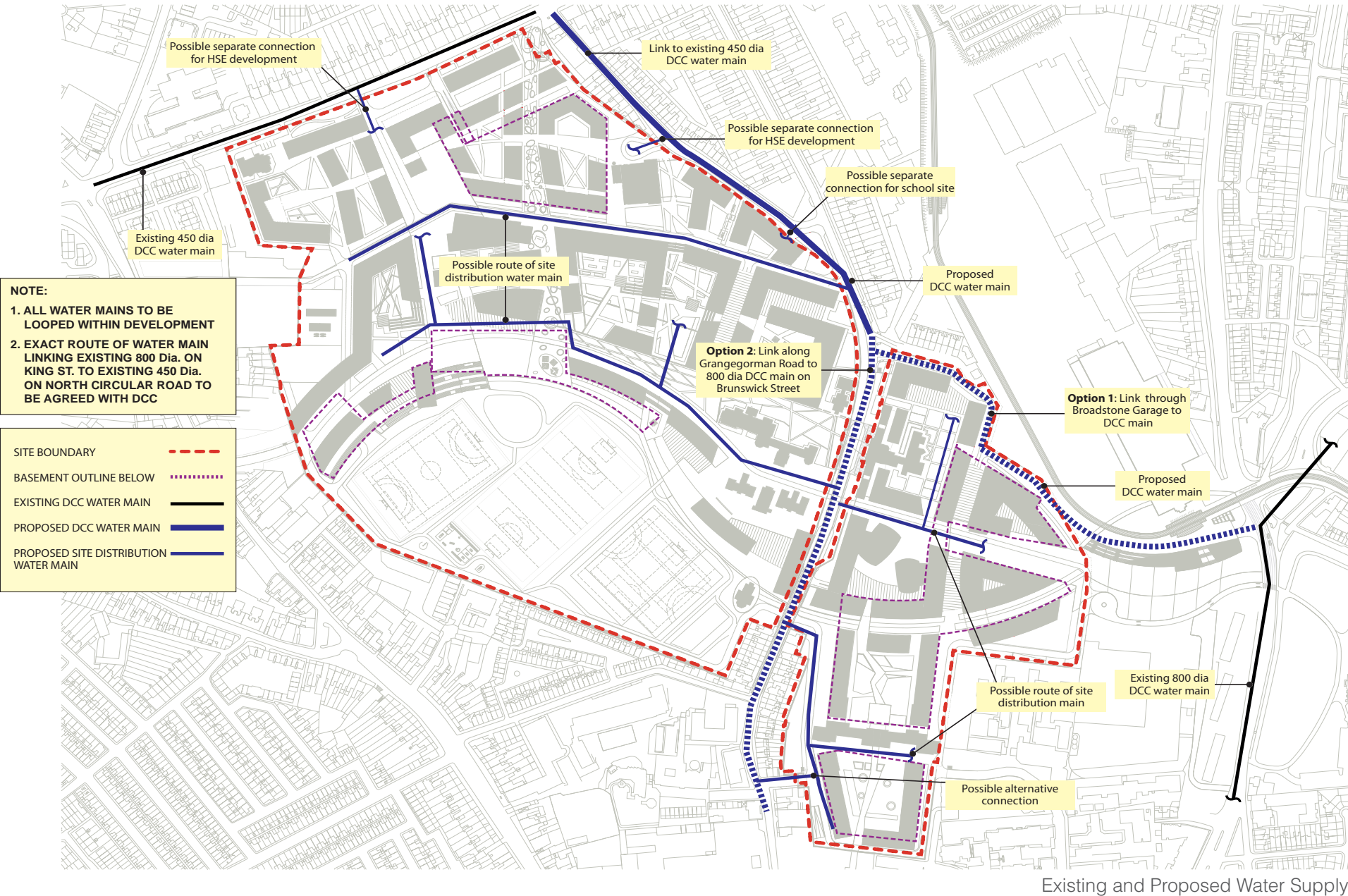
Due to the design of the development it is unlikely that any of the existing combined drains on the site will be retained. However in the event that sections of existing drains could be utilised depending on their structural integrity and capacity being verified, these drains shall be utilised as foul drains only. It is expected that the existing 375mm diameter combined outfall sewer on Grangegorman Road Lower will be utilised as the proposed foul sewerage outfall from the development to the 1500mm foul sewer on Brunswick Street North.

However any existing drains being utilised will require the following:

- (i) Condition survey including CCTV survey and report to WRC Standards.
- (ii) Capacity check.
- (iii) Agreement with Dublin City Council Drainage Division regarding items (i) and (ii) above.

The existing 600mm diameter DCC combined sewer (Bradogue Culvert), running North to South through the East side of the Development will likely require diversion within the site to avoid basements structures/buildings. Possible indicative routes for the diversion are shown on the plan opposite.

In order to complete a detailed assessment of diversionary routes, a survey of the existing 600mm diameter combined sewer should be conducted to include:



- Plan locations, cover levels and invert levels of manholes, connectivity of sewers, pipe materials and sizes.
- CCTV survey to assess condition of existing sewer and identify any branched connections. The CCTV survey would also identify the possible linkage with the Broadstone Depot sewers.

Any diversions of the 600mm diameter combined sewer will require agreement from DCCDD.

It is proposed that foul drains will be provided in the main primary access routes throughout the development. It is not envisaged that drainage on the campus will be taken in charge, however DCCDD have advised that main foul drainage should be constructed to DCCDD adoptable standards.

The requirements for DCCDD adoptable drainage are set out below:

- (i) Proposed foul sewers shall be a minimum of 225mm diameter.
- (ii) Sewers shall comply with Dublin City Council Drainage Divisions "Code of Practice".

- (iii) Sewers and manholes shall be constructed to the details and specification of the Drainage Division.

DCCDD have confirmed that a Drainage Study for the Grangegorman area has been undertaken with consultants HR Wallingford Ltd to upgrade the DCC existing drainage model, however results are not expected until 2010.

DCCDD have confirmed that due to the removal of surface water run-off from the existing Grangegorman development to the combined sewers in Grangegorman Road, there will be spare capacity for the increased foul discharge coming from the development to this sewer. However, flow monitoring will be required by DCCDD to confirm capacity of the existing foul sewerage infrastructure to deal with any new development.

Foul drainage from the proposed development either side of Grangegorman Road shall be collected separately in a private drainage system before discharge by gravity to the public sewerage system in Grangegorman Road Lower.

The Proposed School Site may be provided with a separate foul drainage system and separate connection to the existing 1150x770mm combined

sewer on Grangegorman Road Upper.

The HSE Development may be provided with a separate foul drainage system and connections in agreement with DCCDD, to either:

- The existing 1150x770mm combined sewer on Grangegorman Road Upper.
- The existing 450mm diameter or 1010x610mm combined sewer on North Circular Road. This may require a pumped connection to a discharge manhole.

A disconnecting manhole shall be provided at each site boundary with a channel interceptor (broads trap) and fresh air inlet, constructed in the manhole, to prevent noxious smells and gases entering into the development from the public sewers.

All disconnecting manholes shall be constructed to Dublin City Council Drainage Divisions requirements. All private foul drains shall be constructed to Part H of the Building Regulations 1997.

water supply

Existing Water Supply

The following Dublin City Council Watermains are in the vicinity of the Grangegorman site.

- A 450mm and 175mm main on the North Circular Road.
- A 125mm main on Grangegorman Road Upper which changes to a 150mm main on Grangegorman Road Lower. The 125mm main connects into both the 175mm and 450mm mains on the North Circular Road.
- A 100mm and 225mm main on Prussia Street continuing down into Manor Street.
- A 150mm main on Kirwin Street connecting to the 150mm main on Grangegorman Road and the 225mm on Manor Street with a connection to a larger 300mm also on Manor Street.
- A 250mm and 800mm main on Brunswick Street North.
- A 225mm main on Phibsborough Street running into Constitution Hill.
- A 800mm main on Constitution Hill which is a continuation of the main on Brunswick Street North.
- A 300mm main on Constitution Hill.

Both St. Brendan's East and West are served off the existing Dublin City Council 150mm watermain on Grangegorman Road Upper. There are 2 existing metered connections to St. Brendan's West and 2 metered connections to St. Brendan's East, with the Nurses Residences connection the only one in use on the east side.

Pressure and flow tests were carried out on the existing 150mm main on Grangegorman Road Upper in June 1998 with a pressure of 37 PSI and a flow of 160 gallons/minute being achieved. A test was also carried out in St. Brendan's West and the results achieved were 31 PSI and a flow of 130 gallons/minute.

proposed site services

There are no ring main systems in St. Brendan’s East with fire hydrants fed from the existing 150mm main on Grangegorman Road Upper.

There are 2 ring main systems in operation in St. Brendan’s West and vary from 100mm to 150mm diameter mains.

Proposed Water Supply

Existing and proposed water supply is shown in the figure on page F-5.

Dublin City Council Water Division (DCCWD) have confirmed that the 450 mm high pressure main on the North Circular Road is near to capacity.

There is an 800mm high pressure main on Brunswick Street North which runs up to Constitution Hill. DCCWD have suggested that linking the 450 mm and 800mm mains would be beneficial for the development in providing an additional supply for any future development. It would be preferable to route this new link along public routes rather than through the campus, however the exact route will be in agreement with DCCWD.

However DCCWD have confirmed that capacity checks on their network on linking the two mains would be required to ensure sufficiency of any future supply to meet the increased demand of the new development.

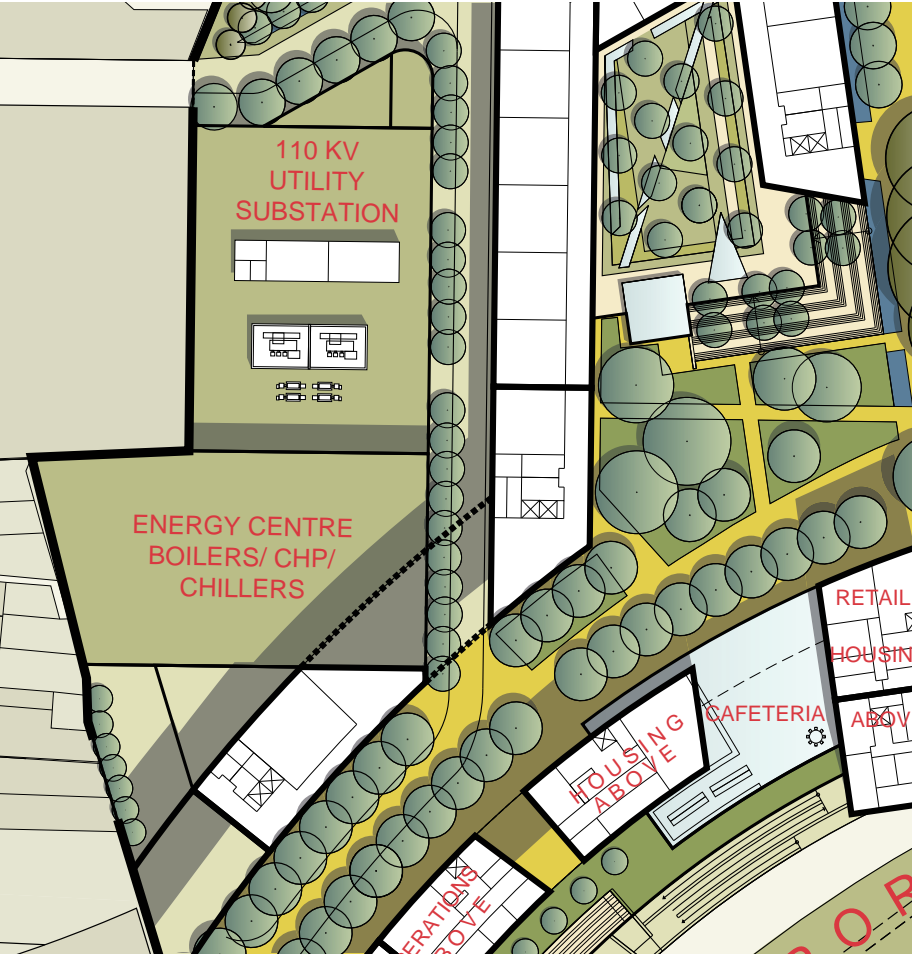
New watermains will also be required to replace the existing mains on Grangegorman Road. Dublin City Council Water Division will be looking for any sustainable proposals for reducing water consumption for the development.

New 150mm diameter connections will be made to the existing public mains to supply the new development.

The size of the new watermains along the main primary access routes within the development will be 150mm diameter. New building blocks will be served by 100mm diameter ring mains with sluice valves and fire hydrants located to the requirements of Part B of the Building Regulations 1997.

Watermains shall be constructed with MOPVC (blue) pipework and the watermains shall comply with the “Specification for the Laying of New Watermains in Private Property” issued by Dublin City Council Water Division.

Pressure and flow tests shall be carried out, in consultation with the Water Division, to confirm the (a) suitability of the existing mains system to meet Dublin City Council’s Fire Officer’s requirements for the area and (b) to assess whether boosting will be required to serve the high level storage tanks.



Mechanical and Electrical Utilities infrastructure

electrical network

Existing Electrical Network

The existing electricity supply to the site is by means of 10kV underground cables from the ESB network along Grangegorman Road, which feed into an ESB substation located in the existing Mortuary Building at the eastern side of the site. This substation houses 2 No. 400kVA ESB transformers from which power is distributed across the site by means of underground 400V cables. This existing distribution system is unsuitable for re-use in the development and it will be necessary for this to be decommissioned and removed.

There is also a 10kV substation at Prussia Street Shopping Centre at the western side of the site. This substation does not supply any buildings on the site and is unsuitable to supply power to the final development. It may however be used to provide power during the construction stage of the development.

Proposed Electrical Network

A power load estimate of 10MW has been advised to ESB. They have advised that the existing medium voltage (10kV) network in the vicinity of the site will not be capable of meeting the demand of the development and it will be necessary for a new high voltage (110kV) substation to be constructed. Details have been issued to ESB planning department for preliminary design. The process involved in the planning and construction of a new high voltage substation is approximately 3 years and the works will therefore need to start at an early stage.

Once the new 110kV substation has been constructed, the development would be supplied by means of a network of 10kV underground cables from the 110kV substation to several strategically located 10kV/400V substations, which would house the transformers required to provide low voltage (400V) power to the various buildings.

The proposed new development may be supplied as a single point supply or under ESB’s Business Parks Policy. As a single point supply, there would be a single customer and the electricity would be distributed internally on a needs basis. The ESB would build and equip the new 110kV substation on a site provided by the developer. The developer would install all necessary cable ducts, the 10kV network from the 110kV substation and the 10kV/400V substation buildings and equipment required for the development. Under the Business Parks Policy, ESB would build and equip the new 110kV substation on a site provided by the developer, install the new 10kV network from this substation and provide electrical connections to customers in the development under its standard policy. The developer would install all necessary cable ducts and 10kV/400V substation buildings required for the development and provide easement rights to ESB for all cable routes within the development.

Size and Layout of Substations

The new 110kV substation will be a Mixed Technology Substation (MTS) and requires a 53m x 39m site to be transferred to ESB for its construction. It will include outdoor switchgear and a control building and will be surrounded by a 3m high boundary wall. Full vehicular access will need to be provided to the site to facilitate the construction and subsequent operation of the substation. The suitability of the proposed site will need to be agreed with ESB.

If the substation is required to be installed internally, a capital contribution would be required by the ESB to construct a non-standard substation.

The 10kV substations will be accommodated at grade and/or incorporated into other buildings. They will have unrestricted vehicular access and be constructed in accordance with ESB standard details.

The quantity depends on the final layout but approximately 17 no. are expected to be required. Each 10kV substation will also require a 400V switchroom immediately adjacent to it to accommodate the main low voltage switchgear / metering equipment associated with the substation. The substations will each require a 16m x 4m area.

Combined Heat and Power Plant

Combined Heat and Power (CHP) plants for the development have been found to be viable. The viability of a CHP depends on utilising the waste heat from the generator all year round to increase the plant efficiency. This would be used in cool months to heat water for the district heating system. During warm months it would be used to supply heat to facilities that require it year round (swimming pool, hospitals etc.) and could supply cooling via local absorption chillers in buildings with significant cooling loads.

The CHP units would reduce the peak load requirement from the ESB and could also act as emergency back-up generators. They would be installed in the Energy Centre and would replace a number of the boilers. Based on the preliminary heating load and cooling load estimates, it is expected that a low level of CHP will prove viable.



telecommunications

Existing Telecommunications Infrastructure

Existing telecommunications infrastructure within the site is by combination of overhead and underground cables, fed from the existing Eircom network on Grangegorman Road. This network is not suitable for re-use in the proposed development and it will be necessary for this to be decommissioned and removed.

Proposed Telecommunications Infrastructure

The development will incorporate a Central Communications Hub with connections to the national and international telecommunications networks.

It is expected that dual connections will be provided via separate routes to include a high level of redundancy in the design.

The hub will be provider neutral i.e. it will incorporate space for network terminating equipment for all potential network providers to buildings in the development.

Each building will have its own Equipment / Telecommunications Room which will act as the main distribution point for the cabling in that building. The hub will connect to these rooms using resilient fibre rings installed in the network of underground cable trays and ducts along the primary services routes.

Size and Layout of Equipment

The Central Communications Hub will be installed adjacent to the Energy Centre. It will be subdivided into 3x3m cages to accommodate rack mounted equipment for each network operator.

The quantity and size of telecommunications rooms in buildings depends on the size and use of the building.

natural gas

Existing Natural Gas Supply Network

There are existing 4 bar and 700 mbar gas mains running along North Circular Road to the north of the site, with tee-off 700 mbar mains routing down along both Grangegorman Road and Prussia Street. There are currently several separate gas connections to serve the existing buildings within the site.

Proposed Natural Gas Supply Network

The envisaged gas consumption throughout the development is envisaged to be relatively low, for uses such as catering and laboratories etc. There is an option of using gas as the fuel for the CHP but it is preferable to use a form of biomass.

Bord Gais have advised that the existing mains are of sufficient capacity to supply the development and that it would not be necessary to bring new infrastructure from further afield.

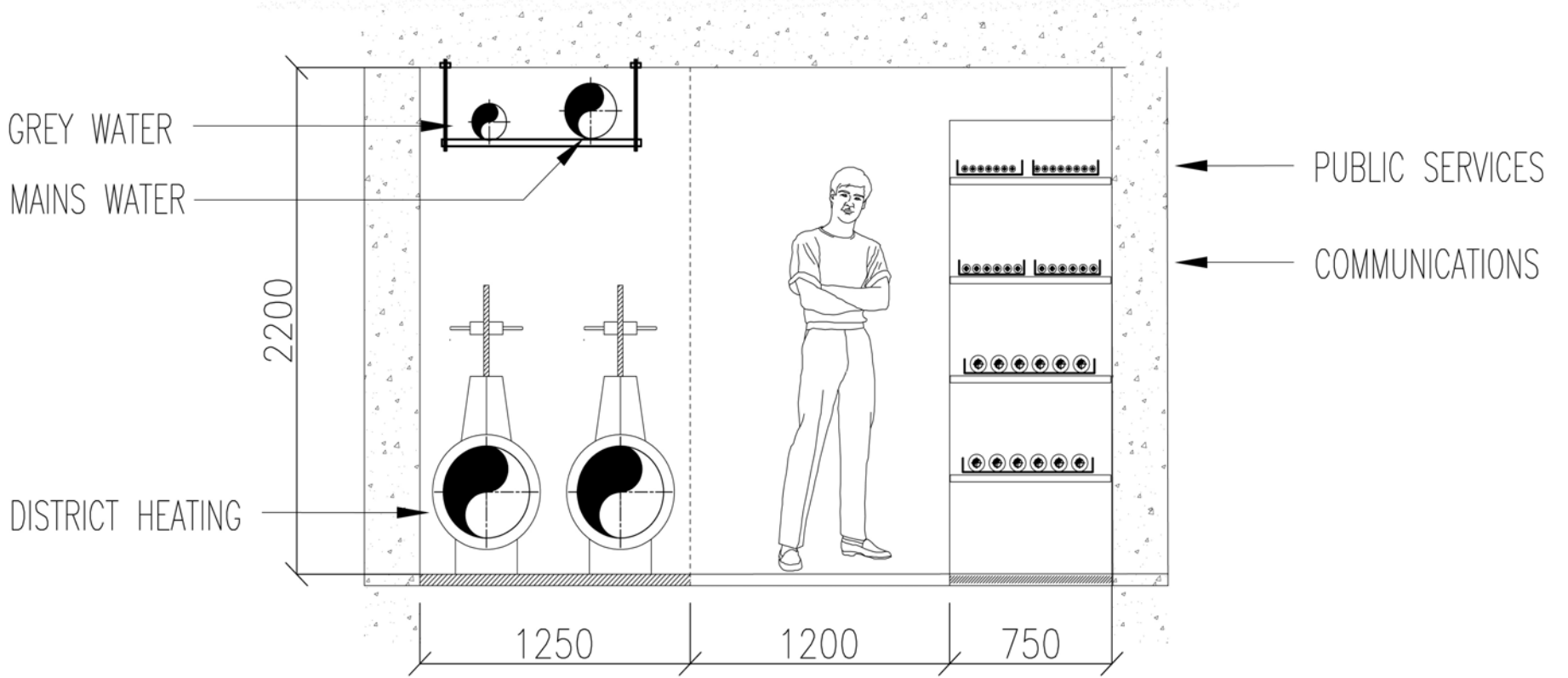
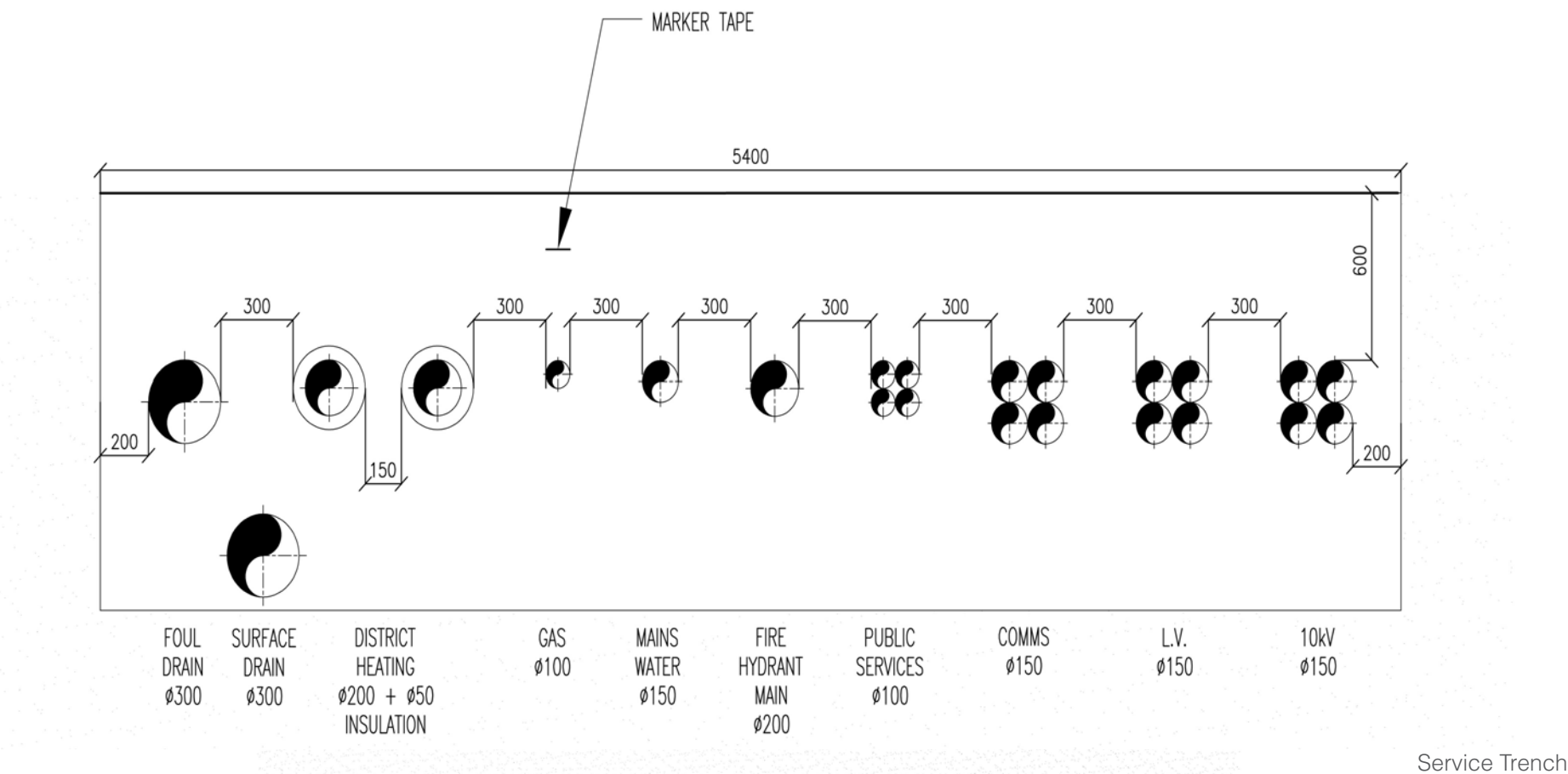
Although the overall capacity of the existing gas network will be adequate for the development it is anticipated that the positioning and alignment of the gas supplies within the existing site will need to be reviewed and it is likely that sections of the existing network will have to be removed.

Gas distribution within the development will be installed within designated service routes. Metering units for each user would be located at ground level adjacent to building entry points. Bord Gais will install underground mains up to and including the metering point. The developer will be responsible for the installation of gas services downstream of the meter positions using registered gas installers.

In terms of cost and contributions for new gas connections to the development, the developer may be required to pay a contribution of between 30% and 100% of the actual cost involved in providing the new connections. The percentage payable would be dependant on the results of an investment appraisal to be carried by Bord Gais once the requirements for the development have been fully identified.

Size and Layout of Equipment

The development will require a 4 bar gas main to be brought to the central Energy Centre location where a gas pressure reduction installation (approx. 6m x 4m) will reduce the mains pressure to 700 mbar. From this station a network of low pressure gas mains will serve the development. The station is located to the north of the MV substation.



NB: GAS MAINS IN SEPARATE INDEPENDENT TRENCH

Utilities Section

heating

The heating requirements for the development will be provided centrally by a district heating system. Central biomass powered boilers will be installed in the Energy Centre. These will provide hot water which will be distributed to all buildings in the development through a system of underground water pipes.

The pipes will be lagged to minimise heat losses. It is expected that wood pellets will prove the most viable biomass fuel for the boilers. These will be stored in a dedicated storage area in the energy centre beside the boilers with road access for delivery. The district heating system will also be fed by the CHP plant when in operation.

Domestic hot water heating will be supplemented locally at each building by solar water heating panels. These will provide approximately 50% of the domestic hot water load.

cooling

The cooling requirements for the development will be provided for locally on a building by building basis with chiller plant serving each building as required. The majority of the buildings in the development will be served by natural ventilation and passive cooling methods that do not involve chilled water.

Buildings that have a chilled water load will be served by a local absorption chiller. The absorption chiller plant will utilise the hot water service to the building to generate chilled water.

services routes

Services will be installed underground in 5m wide services trenches incorporating underground ducts and pipes to bring services to individual buildings. There will be appropriate separation distances between the different services and chambers will be installed at regular intervals and at changes of direction to allow services to be accessed and additional cables to be installed in future.

An underground concrete utilidor (utilities corridor) may be utilised from the energy centre along the main spines of the development. This would be located adjacent to underground car parks and building foundations allowing it to be constructed as an extension to these structures if the phasing was appropriate. The utilidor would have a smaller footprint (3.5m wide) for the level of services installed along the route and allow greater flexibility and ease of maintenance for installation of future services.