DPS

Document Title — VOC Abatement Project Planning Report

Project Name, Location	VOC Abatement system project, Grange Castle, Dublin 22
Client	Takeda Ireland Ltd
Document Number	A21DB035-SP-AE-001
Current Revision	A
Issue Date	13 Jul 2022
Revision Description	Issue for Planning Application
Originator	Aoife Kelly
Technical Approval	Alan Quinn
PM Approval	Eoin Flannery
DPS Project Number	A21DB035
Client Project Number	1022429

Previous Revisions							
Revision	**Date**	**By**	**Check**	**Approvals**			**Revision Description**
			Tech	**QA**	**PM**	**Client**	
A	13 July 2022	AK	AQ	MC	EF	PC	ISSUE FOR PLANNING

Revision Changes

The following is a summary of the main changes that have occurred in this document from the last revision and should be used as a guide only.

(Use this section to highlight main changes from previous revision)

REVISION CHANGES	
Section	**Remark**

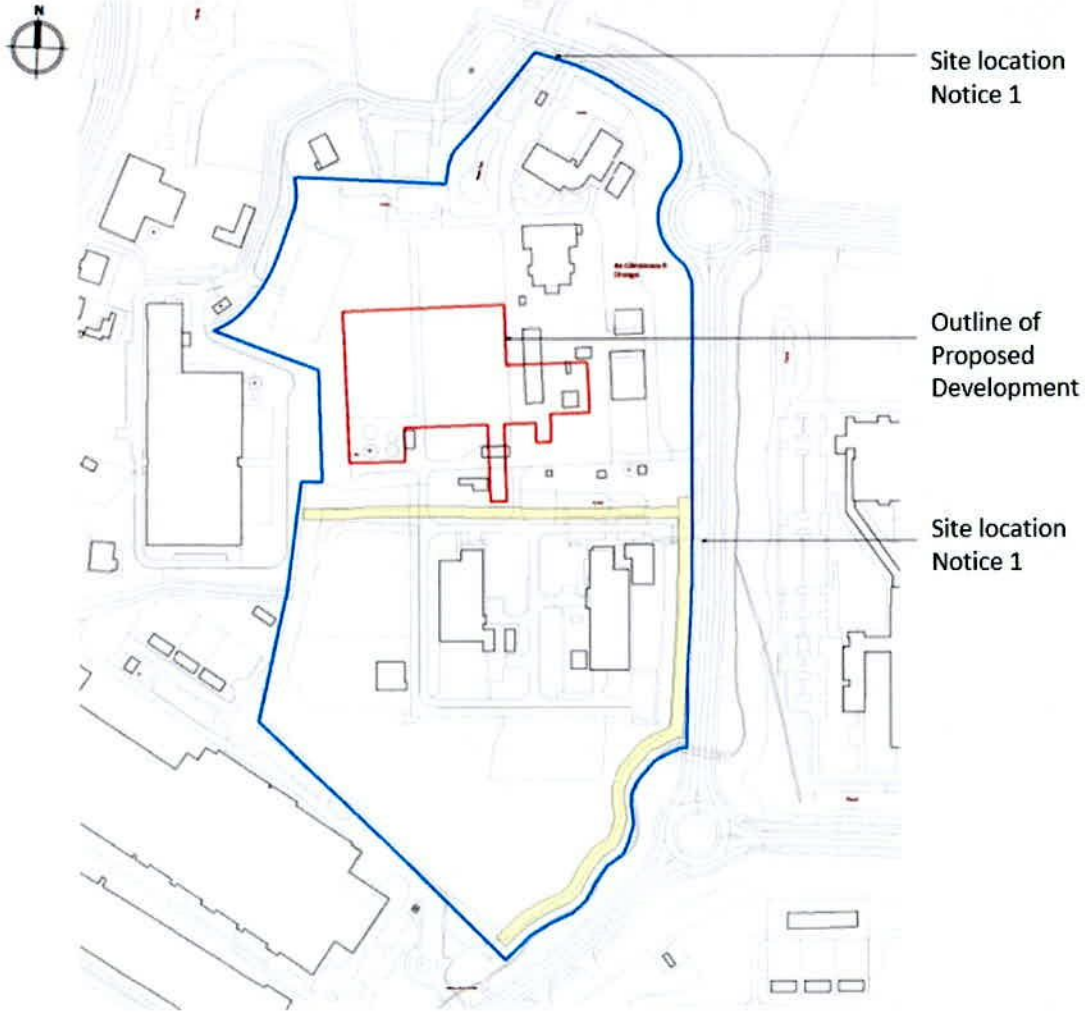
Prepared By		
	Signature	Date
Process		
Electrical		
Automation/I&C		
HVAC		
Architectural		
Civil/Structural		
Validation		
Project Controls		
Procurement		

Contents

1. INTRODUCTION

1.1 Project objectives

The project objective is to construct a new standalone Volatile Organic Compound (VOC) abatement system to manage the current gaseous waste stream from the production processes at Takeda Grange Castle, Dublin 22. The current carbon-based VOC abatement system is used to treat the waste gas stream generated by manufacturing operations and is not considered best available technology (BAT) for current EPA licencing requirements. The new Thermal Oxidiser (TO) based VOC abatement system will ensure compliance with the EPA emission limits, in line with Best Available Techniques and Regulations, with economical use of natural gas. The proposed system will work alongside the existing VOC abatement system ensuring the site always operates within EPA licencing limits even when one of the two systems is in maintenance or shutdown mode.



Site location plan Drawing A21DB035-AE-PL-300

1.2 Scope of works

1.3 The proposed VOC abatement system project will incorporate the following elements:

- A Volatile Organic Compound (VOC) Abatement system comprising of a Thermal Oxidiser (TO), associated plant equipment and scrubbers positioned on a bunded concrete plinth
- A single storey utilities workshop
- A new pipe rack with the addition of a second-tier extension to the existing pipe rack
- Contractors compound
- Modifications to the existing internal access road
- Permanent pedestrian crossing to the existing internal access road
- New access road and footpaths to perimeter of proposed development
- Modifications to the existing site lighting, signage, surface water, foul and process wastewater drainage, hard and soft landscaping

2. SITE CONTEXT:

2.1 Design Considerations for the Proposed Development Location

After detailed reviews by Takeda at concept stage the proposed location was nominated for the VOC Abatement System development based on:

- Building a standalone VOC abatement system away from existing buildings will result in zero business interruption during construction.
- The Development is located along the west boundary of the site 220m from the main entrance (along north boundary) with no view visible from the New Nangor Road, 207m from the east site boundary.
- Close Adjacencies to existing Wastewater Treatment Plant and pipe bridge.
- Proposed location makes use of the existing site road network. Ease of access during construction. Proposed tie in points allows for a one-way access road around the development.
- Minimal impact on existing trees and planting on the site.

Further Design considerations / constraints have been set by existing site conditions including

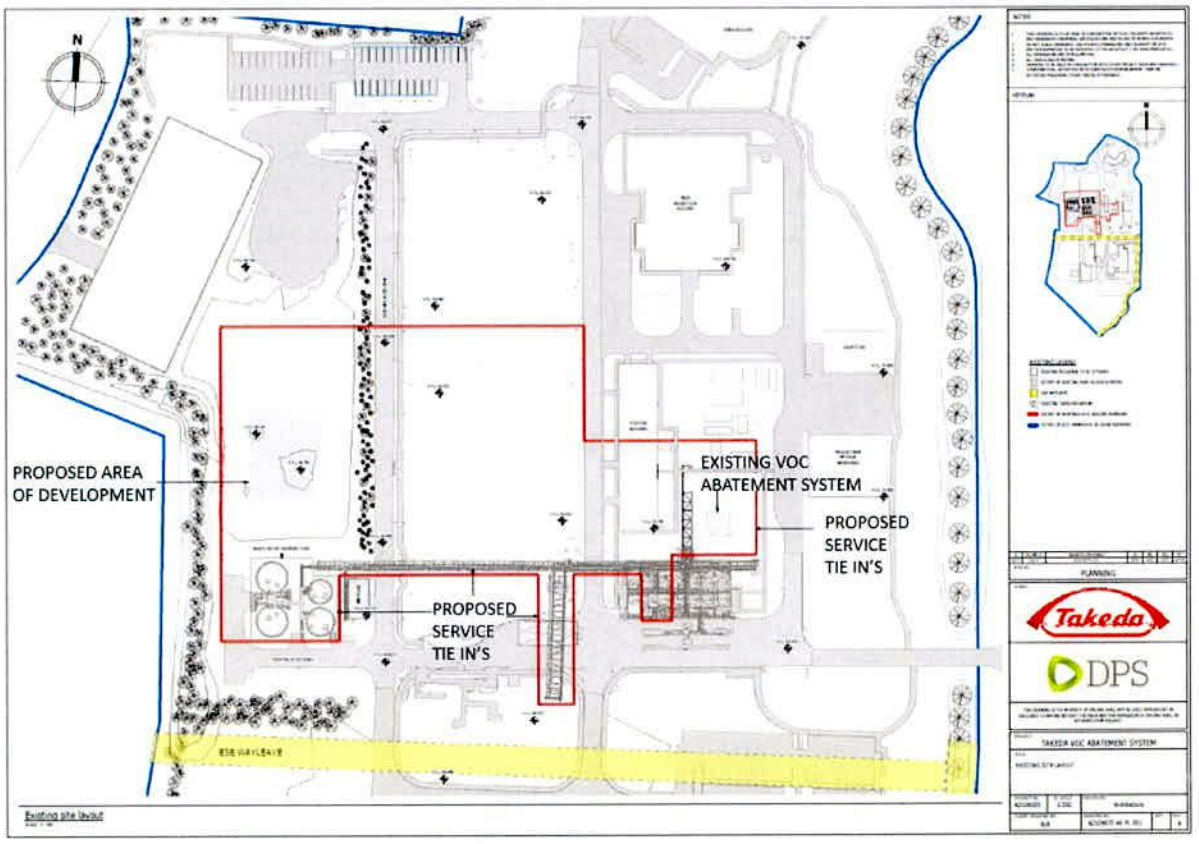
- River Flood Zone in Southeast corner of the site
- Tidal Flood zone (1 in a 1000yr event) across the lower southern part of the site.

Given the relatively small scale of the works and the proposed location on the site, the development results in no appreciable change to the existing landscape and visual character of the site.

2.2 Existing site location

2.3 Takeda Grange Castle is a 16.15-hectare site located in the Grange Castle Business Park accessible via the New Nangor Road positioned between the N7 road to the south and the N4 road to the North. The proposed site area is located towards the middle of the site along the west boundary not visible from the east boundary along the New Nangor road. The site itself is a flat greenfield area made up of approx. 1.5m high construction backfill (from previous construction projects on the site) comprising of gravel, soil and ruderal vegetation. There are no trees, shrubs, or hedgerows on this part of the site.

The existing wastewater treatment plant is located to the south of the proposed development with an existing contractor's compound to the north. Along the east and west boundaries there are established planted berms with trees interspersed among dense hedgerows. All boundary conditions are to be retained (except for one portion of the hedgerow to be removed to give access to the site as detailed in the proposed works below).



Existing site layout - Drawing A21DB035-AE-PL-301

2.4 Proposed site location & summary of development

2.5 Site location

Access to the site location during and after construction will be via the main Takeda entrance gate. The existing internal illuminated access road and footpath allow safe access through the site and the introduction of a new permanent pedestrian crossing to the existing access road will connect the VOC abatement system compound and utilities workshop to the rest of the site.

The VOC abatement system and associated plant will sit within an enclosed fenced compound located beside the single storey utilities workshop. A new one-way access road will circulate around the perimeter of the development connecting to the existing access road in 3 locations. The access road is between 6m and 7m wide to ensure ease of access for emergency and delivery trucks to the area (refer to drawing A21DB035-AE-PL-306 Emergency vehicle tracking layout).

As detailed in section 7.5 below and appendix 5 (flood risk assessment) the site is within flood zone B with a potential risk of a 1 in 1000 or 0.1% AEP year storm event. The ground level for the

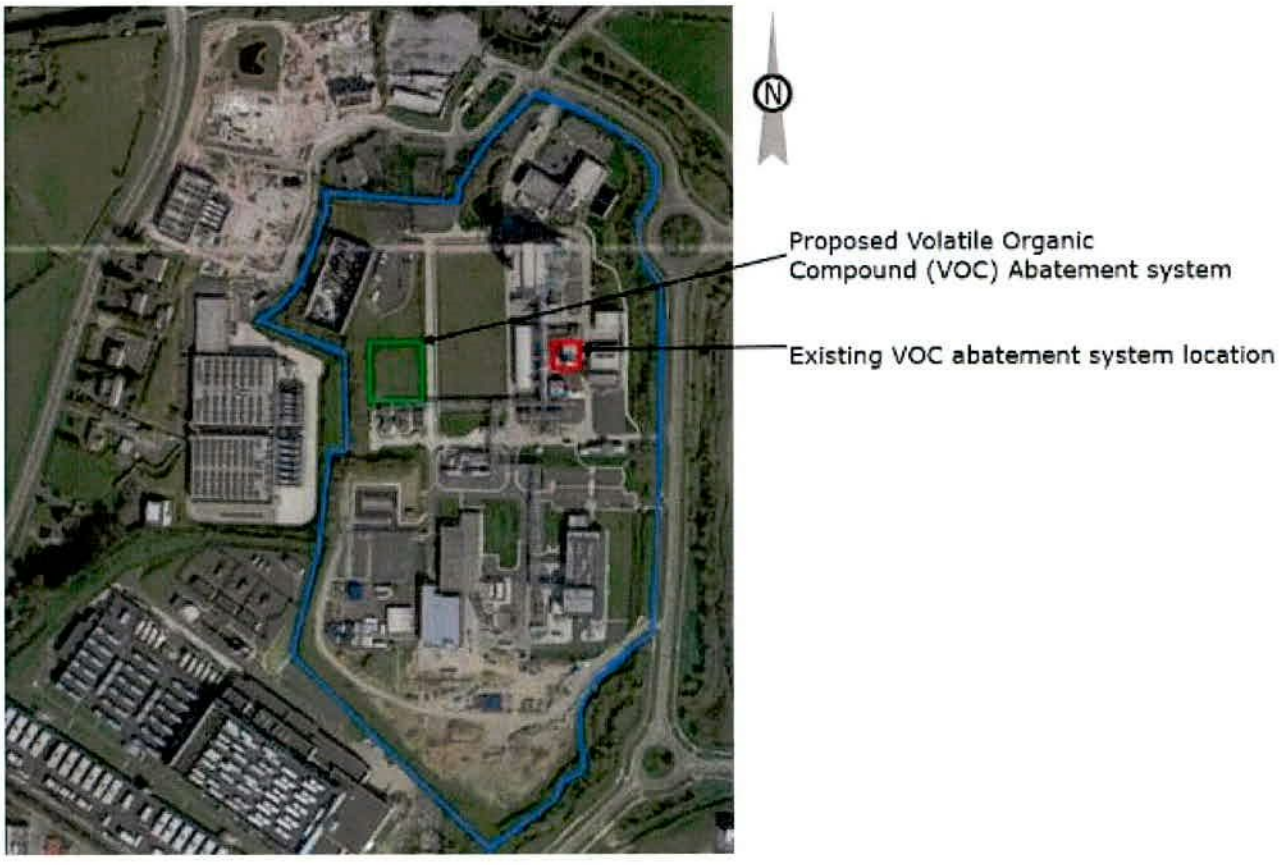
development including the access road will be raised 600mm above the existing adjacent road level. Please refer to section 7.5 below for further detail.

2.6 Schedule of areas - buildings and development

	Overall Length	Overall Width	Gross Area
VOC Abatement System Compound plinth	24.1m	20.3m	489m sq
VOC Abatement system bunded area	22.4m	varies	213m sq
Utilities workshop	15m	9.67m	135m sq (internal floor area)
Contractors compound	58m	58.9m	3420m sq
Proposed hardstanding (access road, footpaths excluding VOC compound)	varies	varies	1276m sq

2.7 VOC abatement systems (existing and proposed)

The existing and proposed VOC abatement system locations are shown on the aerial site images below. The existing abatement system is positioned within a network of utility buildings towards the east of the site.



Aerial photograph of VOC existing and proposed locations

2.8 Utilities Workshop

The building is planned as a single storey steel portal frame building (135m sq) used as a utilities workshop to support the maintenance of the VOC Abatement system and associated site services.

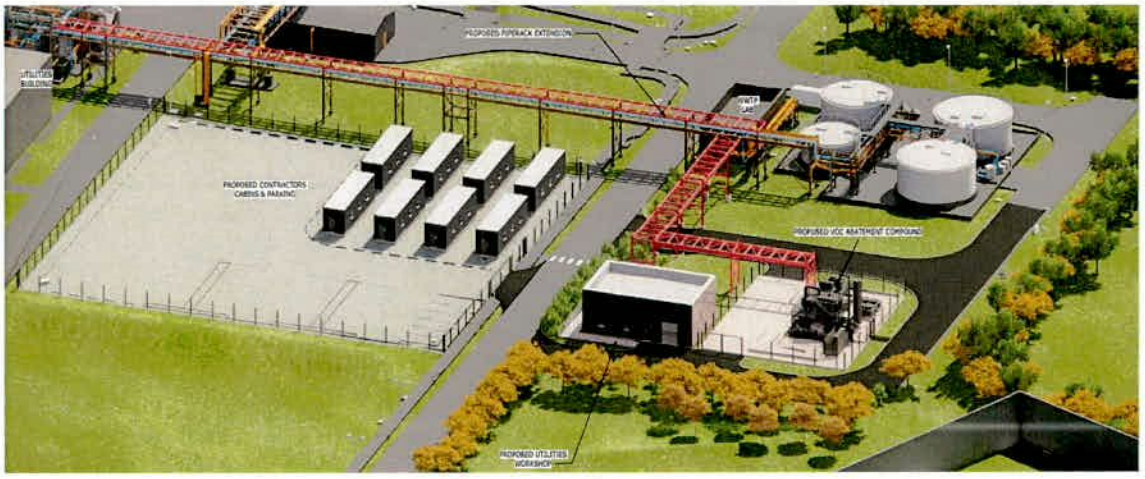
2.9 Pipe rack

A new 55m (L) x 3.2m (W) x 5.6m (H) pipe bridge will extend northwards to the compound from the existing pipe bridge (west-east) connecting natural gas, waste gas, process wastewater and associated services between the tank farm, manufacturing buildings and the new VOC abatement system.

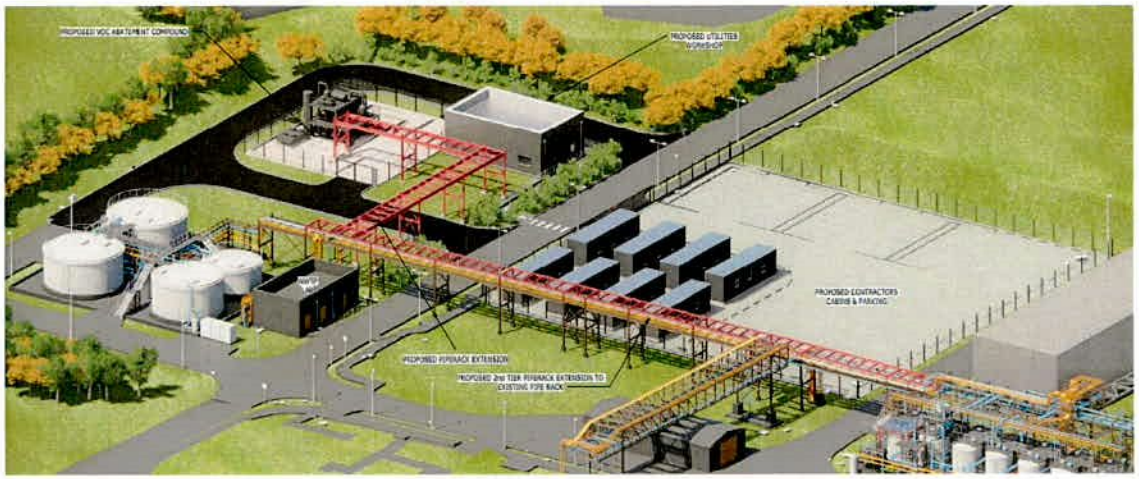
A 2nd tier 118.6m (L) X 3.2M (W) 1.2m (H) will be constructed on top of the existing (west - east) pipe bridge to accommodate the required services.

2.10 Contractors compound

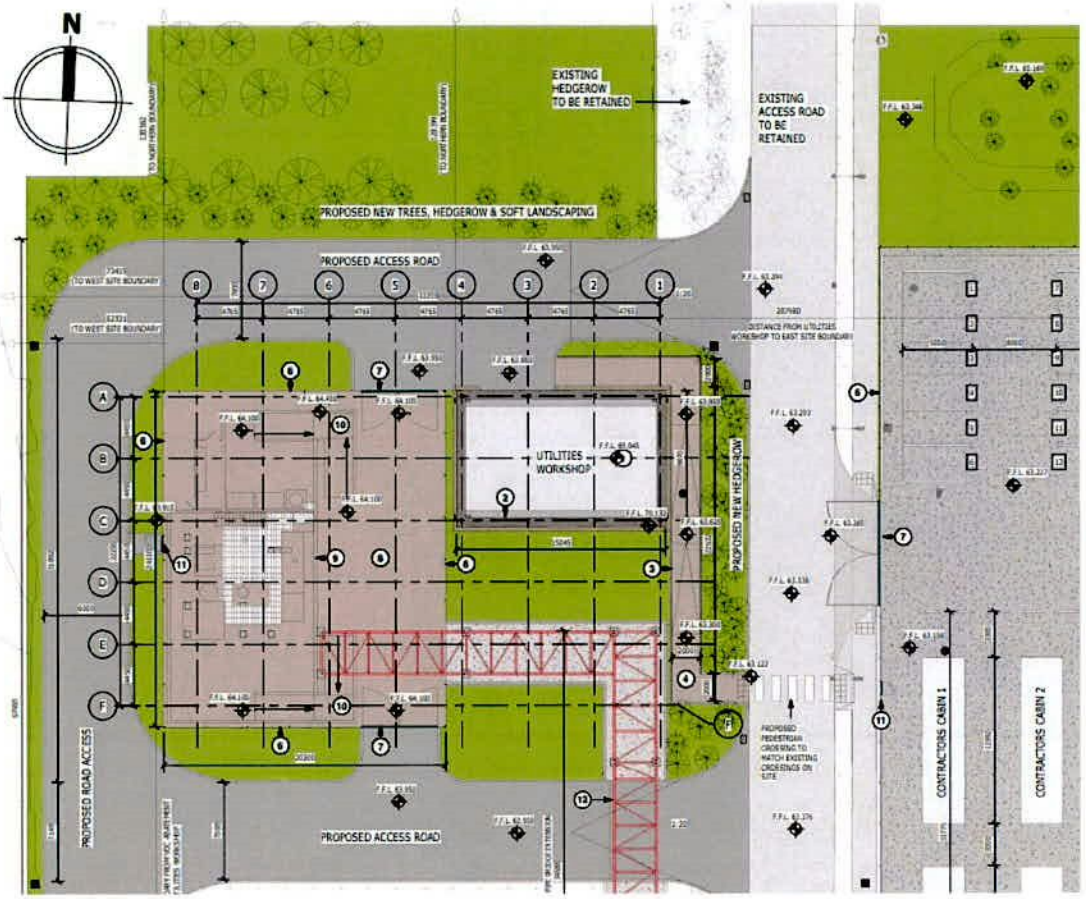
The contractor's compound is positioned adjacent to the proposed development accessible via the existing access road and the proposed pedestrian crossing.



3D - Northwest site view. Drawing A21DB035-AE-PL-352



3D - Southeast site view. Drawing A21DB035-AE-PL-352



Excerpt from Proposed detail site plan - Drawing A21DB035-AE-PL-307

2.11 On-site parking

There are 393 existing employees (103 contractors, 287 full time staff and 2 part time staff) working over 4 shift patterns 7 days a week. Flexible working has reduced the onsite presence of office-based staff. At any time there is no more than a 75% occupancy rate in the existing car park. Currently there are 255 existing parking spaces on the Takeda site broken down as follows: 227 spaces, 11 ambulant accessible and 17 electric vehicle spaces. There are also 33 existing bicycle spaces. Under section 11.4.0 Transport and Mobility of the SDCC development plan 2016-2022 the number spaces recommended are:

- Bicycle spaces - 1 per 200m sq floor area.
- Maximum car parking spaces recommended is 1 per 200m sq manufacturing and warehousing.

Due to the size of the utilities workshop (135m sq) and the intermittent use by 1 additional part time employee there will a negligible impact on the current parking numbers at Takeda Grange Castle. As such there is no plan to provide additional parking & bicycle spaces for this proposed development.

There are existing canteen, changing and showering facilities available to all staff on the Takeda site. The contractor's compound will provide 30 new parking spaces and welfare facilities for construction staff.

3. VOLATILE ORGANIC COMPOUND ABATEMENT SYSTEM TECHNICAL REPORT

3.1 Existing Volatile Organic Compound (VOC) abatement system

The current activated carbon-based VOC abatement system is used to treat the waste gas stream generated by manufacturing production building P1 & P2 and the tank farm vessels. The system which has been in use at the site since it began operation takes considerable time, effort and cost to ensure compliance with Takeda's EPA IE licence requirements.

The abatement system absorbs the VOC's from the vent stream onto the carbon bed including Methanol, THF and Heptane. Dual beds are used, with one bed online for absorption with the other bed off-line for regeneration when saturated with VOC. The carbon bed regeneration is done using steam; VOC's are removed from the carbon bed and collected with the steam condensate for disposal.

The waste gas is also affected by SO2, halogenated acid contents (HCl, HBr), including chlorinated organics as well (dichloromethane, chlorobenzene, etc). The existing system is not considered to use BAT (best available techniques) for current EPA licencing requirements.

The following main utilities are provided to the existing VOC Abatement system:

- Steam (for carbon bed regeneration and heat exchangers)
- Cooling water (for waste gas pre-treatment and steam condenser heat exchangers)
- Nitrogen (for inerting purposes)

The treated gas is released at the existing stack, while the captured VOC's and the steam condensate are collected in a storage tank for subsequent disposal.

The noise level of the main fans within the skid is 80 dB @ 1m.

3.2 Proposed Volatile Organic Compound (VOC) abatement system.

A new VOC abatement system has been requested by Takeda Grange Castle for the treatment of the existing waste gas stream (as described above) coming from manufacturing building P1 & P2 and the tank farm vessels. The proposed VOC Abatement System will process the waste gas according to the current operations, no new waste gas streams are to be added and a production increase is not expected in the future.

The proposed system will work alongside the existing VOC abatement system ensuring the site always operates within EPA licencing limits even when one of the two systems is in maintenance or shutdown mode.

Through a series of reviews and BAT (best available techniques) a thermal oxidiser (TO) was selected as the most suitable abatement technology method for current production requirements. The proposed system provides the highest level of protection to the environment as a whole, taking into account technical and economic considerations as well, fulfilling the key legislative requirements and Best Available Techniques guidelines.

3.3 System components

The new VOC abatement system includes, but is not limited, to the following main equipment:

- Thermal Oxidiser (TO) for VOC oxidation. The Thermal Oxidizer consists of a horizontal cylindrical chamber, through which the waste gases are treated at the specified temperature / time and turbulence to achieve the VOCs oxidation.
- Quench and Caustic Scrubber for acids removal. A caustic Gas Scrubber, installed after the TO, will remove the inorganic acid vapours of HCl/HBr/SO2 contained in the waste gas stream and the additional HCl generated during the oxidation of halogenated VOC.
- Selective Catalytic Reduction for NOx reduction. This involves the injection of Urea into the waste gas stream, reducing nitrogen oxides to nitrogen and water. The main chemical reaction is promoted using a catalyst bed.

3.4 Waste and gas flows

The following main utilities will be provided to the VOC Abatement System:

- Natural gas (for TO). A heat recovery solution has been included in the TO design to reduce the Natural Gas consumption and therefore the carbon footprint of the entire unit.
- Caustic solution and water (for Quench and Scrubber)
- Urea solution (for Selective Catalytic Reduction)

The waste gas, caustic and water will be piped from the existing buildings and tank farm to the new VOC abatement system across the proposed 2nd tier extension to the existing pipe bridge and along the proposed pipe bridge extension into the VOC abatement system compound.

The treated gas is released at the 12m high stack containing:

- .01% VOC's (99.9% of VOC's are removed through the TO process - in accordance with BAT and EPA licencing requirements)
- Oxygen, nitrogen, water vapour and carbon dioxide

The scrubber wastewater is directed to the tank farm and thereafter routed to the wastewater treatment plant via the pipe rack.

3.5 Air quality

The EIA Report presents the assessment of the likely impacts on air quality as a result of the proposed development. Air dispersion modelling of emissions from the new TO was carried out using the United States Environmental Protection Agency's regulatory model AERMOD. The aim of the study was to assess the contribution of operational emissions of nitrogen dioxide (NO2) and total volatile organic compounds (VOC) from the proposed development operating under normal and bypass conditions and existing development to off-site levels of this pollutant. As set out in Chapter 9 of the EIA Report, the results of the modelling assessment determined that emissions from the site will continue to be in compliance with the ambient air quality standards for NO2, environmental assessment levels for VOC and IE Licence emission limit values.

3.6 Noise

The EIA Report also presents the assessment of the likely impacts as a result of noise emissions from the proposed development. As set out in Chapter 10 of the EIA Report, noise modelling of the noise emissions from the new TO and existing building services plant on the TILGC site showed that noise emissions will be within the adopted criterion at the façade of any nearby noise sensitive locations.

The expected noise level of the main equipment within the VOC Abatement System skid is 75 dB @ 1m. The total noise levels expected from the new plant items specifically is well below the noise criterion of 45dB for night-time periods, and therefore also in compliance with daytime and evening time periods.

3.7 Alignment with Best Available Techniques (BAT) and Regulations

Best Available Technique identifies the most appropriate emission reduction technique that provides the highest level of protection to the environment as a whole, taking into account technical and economic considerations. Thermal oxidisation (TO) technology has been selected as meeting BAT limits for multiproduct streams with a relatively small waste stream flow rate and medium/high VOC concentration. Such operating conditions are not recommended for other technologies (Regenerative Thermal Oxidizer, for example, are usually designed for high and constant volume flows with relatively low concentrations of VOC). VOC abatement is achieved by the complete thermal combustion/oxidation of the VOC's in the vent stream. In addition, this TO VOC Abatement System is aligned with BAT due to the presence of halogenated organic compounds in the waste gas.

3.8 Proposed VOC abatement system compound layout.

The proposed VOC abatement system and associated plant will be positioned within an overall utility compound (489m sq) enclosed by a 2.4m high paladin weldmesh black fence. The compound will be accessible via 2 no. vehicular and 1 no. personnel locked gates by trained service personnel only. Within the compound the plinth is separated into two zones: bunded areas and non-bunded circulation space.

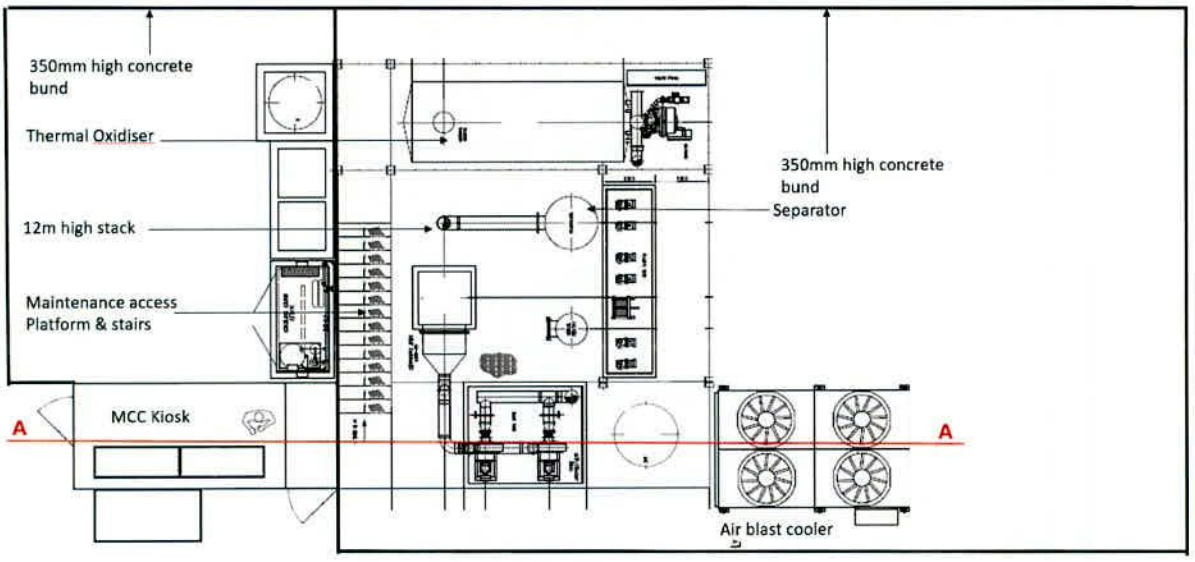
The VOC abatement system, associated plant and Urea tank storage units sit on 150mm high plinths within the 213m sq bunded area. The bund wall is 350mm high with the concrete plinth at falls towards a process drain sump. From the sump, liquid will be pumped up onto the proposed pipe rack over to the existing onsite process drainage and treatment system.

The abatement system measures 7.5m long x 2.8m wide x 6m high (12m high to top of stack). For maintenance of the system, a 2-storey galvanised steel access platform and stairs will give access at 2.5m and 5m from ground level. The personnel gate is positioned opposite the maintenance platform stairs to allow safe egress in the event of an emergency from the compound. The system will be painted RAL 7001, silver grey to match the utilities workshop and nearby services.

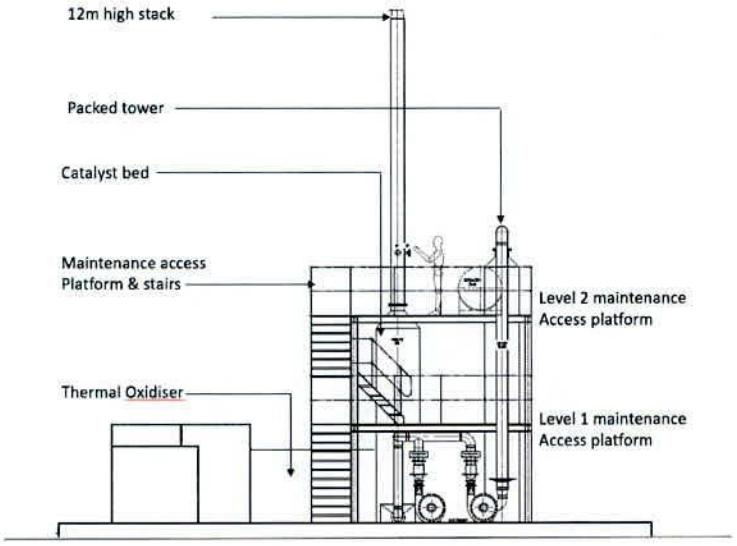
The circulation area of the plinth (278m sq) is drained to the surface water attenuation system via 2 no. Aco drains at the entrance gates. In the event of any contamination the surface water is diverted to the fire water attenuation tank.

Site lighting will extend into this area and along the new access road. The existing pipe bridge will be extended to service the compound.

Example of a (TO) thermal oxidiser VOC abatement system



Proposed Ground level plan of VOC abatement system



Proposed Section A of VOC abatement system

3.9 Works to Pipe Rack

- The existing pipe rack runs along an east to west axis from the tank farm over to the wastewater treatment plant and production buildings. To accommodate the waste gas streams, natural gas supply, electrical cabling, and process wastewater services to the new VOC abatement system a 2nd tier is required to the top of the existing pipe rack measuring 118m (L) X 3.2m (W) X 1.2m (H).
- A new pipe rack measuring 55m (L) x 3.2m (W) x 5.6m (H) will connect the new 2nd tier of the existing pipe rack to the proposed VOC abatement system compound. The new pipe rack will be finished to match existing with a gravel trench under.

3.10 Site signage

Signage will be designed to integrate with the existing type used on site. The new junctions of the proposed access road and pedestrian crossing will be identified through site signage and road markings.

3.11 Site Lighting

The lighting scheme will be designed in accordance with best modern practice as set out in BSEN12461-2 for external lighting. All luminaries shall be fitted with high efficiency light sources to provide good environmental conditions, avoiding light spillage, glare or lighting above the horizontal pane.

As part of the EIA report an ecological survey was carried out to identify if there is a presence of bats on the site. The outcome indicated there is no evidence of bats using the site and as such *"given the relatively low potential for bat commuting on an existing light industrial site with existing level of urban light, the predicted effect on bats is not significant for the operational phase".* Refer to drawing - proposed site lighting layout - A21DB035-E-900 for further detail.

4. UTILITIES WORKSHOP

The Utilities Workshop will be positioned beside the VOC abatement system compound accessible via the proposed access road and pedestrian crossing to the existing access road. The scale, form and finish of the workshop has been replicated from the existing nearby buildings to give an overall rhythm and continuity of design to the site. The height is set to meet functional requirements of the building. All walls, flashings, doors, windows and downpipes will be RAL 7001 silver grey. The walls will be finished with a horizontally laid composite insulated panel system. The roof will be a trapezoidal non-combustible composite insulated panel system at falls towards the 4 no. gutters with external hopper head and downpipes. The roof is not accessible via a stairs or ladder and has a 1100mm high parapet all-round for fall protection and screening. Access will be via MEWP access only.

The building is planned as a single storey steel portal frame building (135m sq) used as a utilities workshop to support the maintenance of the VOC Abatement system and associated site services. Access is via 1 personnel door and 1 large rapid roller equipment door. The building will not be in continuous use and when occupied will be used by 1 person. The workshop accommodates of one open plan area finished with benching, lighting, heating and 1 handwash sink. Heating will be provided by a split air conditioning unit. All Takeda personnel use the existing welfare facilities provided.

3D view C & D. Proposed development. Drawing A21DB035-AE-PL-352

5. CONTRACTORS COMPOUND

The proposed contractors compound measures 58m wide x 58.9m long, 3420m sq. The site is accessed via 1 vehicular and 1 personnel gate directly from the existing access road enclosed by a 2.4m tall black paladin weldmesh fence. The site lighting will extend into this area and the compound will be finished in compacted stone hardcore. The compound will be broken into 3 separate zones: contractor parking (30 spaces), material lay down area and welfare facility/office cabins. One hammer head turning point will be provided for delivery vehicles within the compound.

The compound will be in use for 2 years. After this time the compound will be demolished, and the landscape will be returned to its original state as described in Section 7 landscape below.

6. DRAINAGE

6.1 Process Drainage:

Within the Volatile Organic Compound abatement system plinth there will be two bunded areas (total 213m sq) for the VOC abatement system and the Urea tanks storage area. The concrete bund (designed in compliance with EPA guidance for design of containment bunds) at 350mm high encloses the concrete plinth laid at falls towards a process drainage sump, where any rainwater or potential contamination will be captured by the drainage sump. All equipment & plant within the bund will be fixed to 150mm high concrete plinths. From the sump, liquid will be pumped up onto the proposed pipe rack over to the existing onsite process drainage and treatment system (refer to EIA report submitted as part of this application for details on operation of process drainage system) prior to discharge. No drainage from within the bunded areas will enter the surface water system or the ground directly.

6.2 Foul Drainage:

No new connections to the public foul sewers are proposed. Provision for a new handwash sink within the utilities workshop will be pumped into the existing onsite network. The contractor's compound will accommodate up to 30 contractors (welfare and toilet facilities). A sump is to be constructed within the footprint of the contractor's compound and pumped to local foul water system within the Takeda site. Refer to drawing A21DB035-CV-100 for further detail.

6.3 SuDS

The South Dublin County Council infrastructure and environmental policies and the green & blue infrastructure policies on SuDs will be implemented into the proposed development facilitating direct drainage to the ground reducing the potential impact on the site and the Griffeen river to the south of the development area in flood events.

The following SuDS measures are to be implemented minimising the impact on the downstream storm water network:

- Only where there is a risk of contamination within the development is the surface water fed to the existing surface water management system on site (as described in section 6.4 below). This occurs at the VOC abatement system compound plinth and the utilities workshop entry door aco drains only.

- The new access road is constructed using a permeable asphalt surface.
- The surface water from the utilities workshop roof is fed to a soak pit located to the north of the building.
- Swales will be provided to the perimeter of the VOC abatement system compound.
- Retention and addition of native trees, hedgerows and pollinator friendly planting with the reuse of the existing seedbank from the contractors compound will result in an increase in biodiversity and an overall NET gain to the development.

6.4 Surface water Drainage:

The non-bunded section of the VOC abatement system compound (measuring 276msq) will be fitted with rainwater aco drains leading to the existing on-site storm water management network. Control systems for management of surface water complies with the requirements of the EPA as per discharge license details. The new works will have a negligible impact on the downstream storm water network. Please refer to document Ref A21DB035-CV-001 Engineering Infrastructure Report and drawings A21DB035-CV-100 for further details.

6.5 Flood risk assessment

As part of a previous planning application (REF SD18A/0169, grant date 09/07/2018) for this site, a flood risk assessment (stages 1-3) was prepared (Malachy Walsh and Partners consulting engineers, June 2017 - attached in Appendix 5). It was identified that a 1 in 1000 or 0.1% AEP year storm event has the potential to affect the new development site. The site is therefore in Flood Zone B as defined in the Flood Risk Management Guidelines. This report has been reviewed and reported on as part of chapter 7 " Hydrology" of the EIA report submitted with this planning application.

In response to the recommendations from the flood risk assessment report and the summary in chapter 7 of the EIA report the proposed finished ground level to the VOC abatement system compound and utilities workshop are to be set 64.1 OD, 600mm above the 1% AEP MRFS flood level (typically 500mm above the 1% AEP MRFS flood level in line recommendations of the Greater Dublin Strategic Drainage Scheme. The finished ground level has been set at 600mm above the .05% AEP flood level in line with recommendations from the client's insurer FM Global). The bunds within the VOC abatement system compound plinth are set 350mm above the finished ground level of the compound and utilities workshop (950mm above the 1% AEP MRFS flood level).

The implementation of the Blue infrastructure strategy policies in the form of SuDs, where applicable will be implemented into the proposed development to reduce the potential impact of surface water flooding on the proposed site area.

7. LANDSCAPING

7.1 South Dublin County Council Pre-Planning guidance

As noted by SDCC at the pre planning meeting held on the 26th April 2022 - *"We require landscape proposals that minimise as much as possible the impact of the proposed development and aid its assimilation into the existing landscape in a natural manner".*

Key design issues for the proposed development:

- *1. Protection and retention of existing trees and hedgerows. Maximise retention of existing trees and hedgerows. Mitigation planting for trees / hedgerows requiring removal with OVERALL NET GAIN.*
- *2. Adequate provision of blue/green infrastructure: multifunctional connected landscape that integrates amenity, biodiversity, water treatment and attenuation.*

The development has been designed in accordance with the guidance set out in the South Dublin County Council Development Plan 2016-2022, Green Infrastructure (GI) Network guidance (part of draft 2022-2028 SDCC Dev plan) and the sustainable drainage, explanatory design & evaluation guide 2022. (green and blue infrastructure plan). In addition to this report there is also an arboriculturist report & drawings and a biodiversity, flora and fauna chapter within the EIA report prepared by the project ecologist.

7.2 Existing site area

The existing Takeda campus contains a variety of buildings ranging in height from 6m (Wastewater treatment plant laboratory building) to 37m (P1 production building) set within a 16.15 hectare flat terrain site. The perimeters of the site feature areas of dense hedgerows, trees and planted berms. The proposed site location positioned towards the west boundary is well screened from the boundaries of the overall Takeda site by existing buildings, hedgerows, trees and planted berms. The site is situated approx. 500m east of the ruin of Grange Castle (a protected structure and recorded monument). The boundary to the north and east (along the New Nangor Road) is screened by planted berms, trees and hedgerows. Along the southern site boundary (and along the eastern boundary to the opposite side of the New Nangor road) the Griffeen river forms part of a riparian corridor (Figure 4.3 Key elements of the South Dublin GI network map). The redline boundary is located approximately 290m north of the riparian corridor of the Griffeen river.

7.3 Existing site area for the VOC compound and utilities workshop.

The area is characterised by a flat terrain comprising of backfill (soil, stone and gravel) from other construction projects on the site covered with ruderal vegetation with no trees or hedgerows. To the west boundary of the proposed site location (Redline boundary) there is an wildly planted berm, existing trees and hedgerows to be retained and protected during the works as detailed in the Arboriculturist report and chapter 8 "Biodiversity, flora and fauna" in the EIA report). To the east boundary dividing the proposed site from the existing access road and footpath is an existing hedgerow interspersed with trees.

The predominant species present on the site and boundaries are:

- VOC abatement system and utilities workshop site area -
  Species present includes abundant Rapeseed (Brassica napus subsp. napus), abundant Common Vetch, Common ramping fumitory (Fumaria muralis), Ragwort, (Senecio jacobaea), frequent Red campion (Silene dioica), Broadleaved Dock (Rumex obtusifolius), Dandelion (Taraxacum officinale agg.), Nettle (Urtica dioica), Thistles (Cirsium spp.), Creeping buttercup, Clovers (Trifolium spp.), Lesser burdock (Arctium minus), Ribwort plantain (Plantago lanceolata) and occasional Coltsfoot (Tussilago farfara).
- West boundary - Cherry trees (Prunus serrulata), Birch (Betula pubescens), Willow (Salix spp.), Pine (Pinus spp.) and Dogwood (Cornus spp.). The understorey has limited flora with

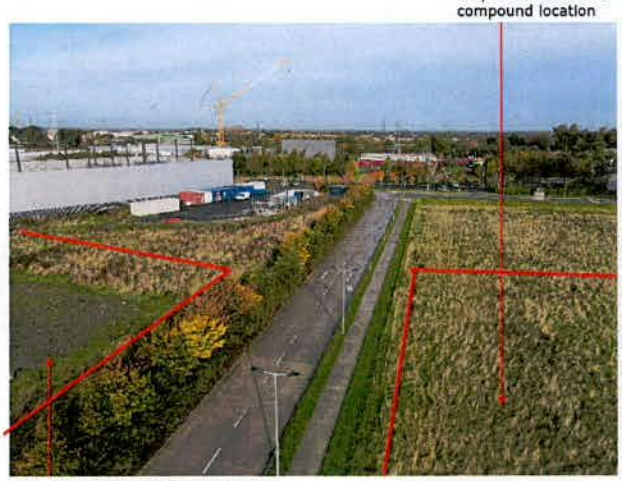
Bramble (Rubus fruticosus agg.) most frequent along with occasional Great willowherb (Epilobium hirsutum) and Creeping buttercup (Ranunculus repens).

- East boundary - The predominant species present is Cherry (Prunus serrulata) with frequent Gorse, Alder (Alnus glutinosa), Blackthorn (Prunus spinosa) and Willow (Salix spp), Field Maple (Acer campestre) and abundant Dogwood (Cornus spp.). The understory has the same species as that of the west boundary in addition to Common knapweed (Centaurea nigra), Cleavers (Galium aparine) and Scarlet Pimpernel (Anagallis arvensis).

Proposed VOC Abatement System compound & utilities workshop location

Proposed Contractors Compound

Proposed contractors compound location



Proposed VOC Abatement System compound & utilities workshop location

View of proposed VOC Abatement System compound & utilities workshop location from wastewater treatment plant platform

Existing site views

7.4 Existing site area for the contractor's compound.

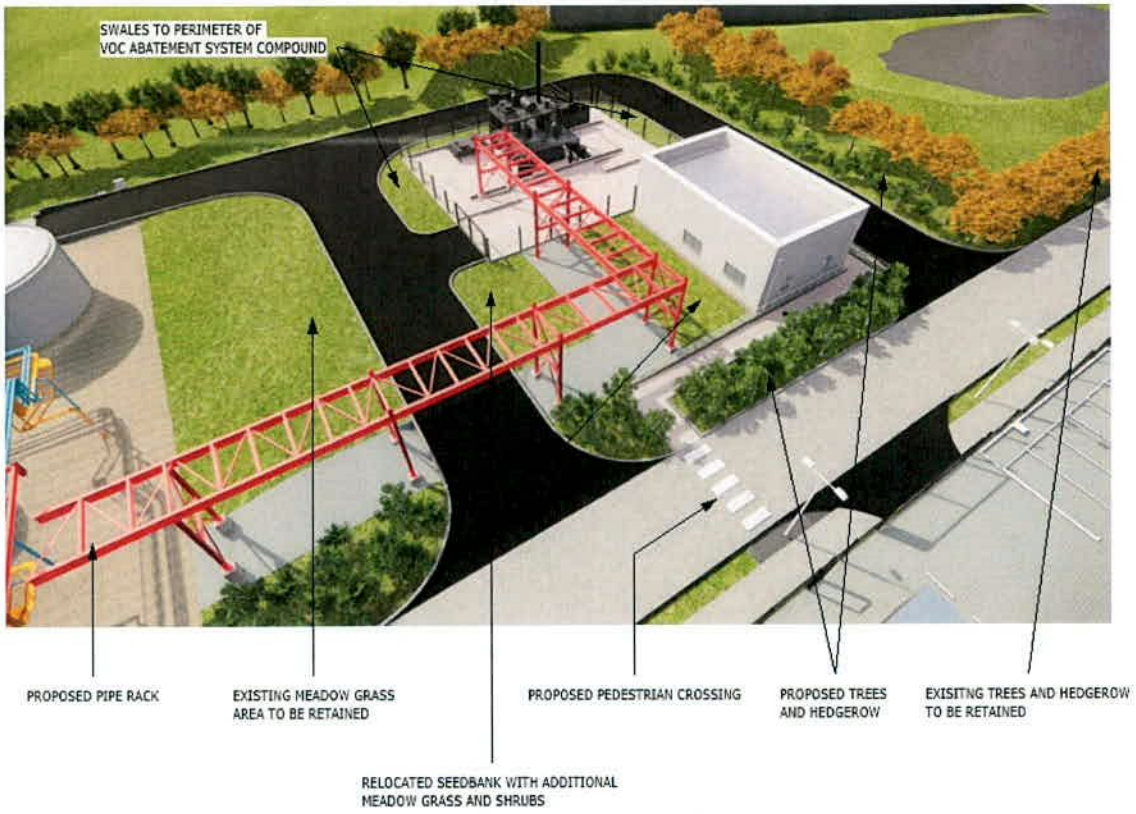
The existing site location for the contractor's compound is a greenfield area that has been planted in grasses predominantly grown wildly for biodiversity with a cut border around the perimeter. Species present include Cocks foot (Dactylis glomerata), Bent (Agrostis spp.), and Meadow grass (Poa spp.). Ribwort plantain (Plantago lanceolata), Creeping buttercup (Ranunculus repens), Daisy

(Bellis perennis), along with Dandelion (Taraxacum spp.), Common Vetch (Vicia sativa agg.) and Common Mouse-ear (Cerastium fontanum ssp. vulgare).

7.5 Proposed Landscaping scheme for VOC abatement system compound & utilities workshop

The landscaping proposal for this development is to extend and reinforce the existing landscape achieving a seamless connection between the two. To achieve this the following measures are to be implemented:

- Important natural features such as existing hedgerows and trees are to be retained (localised removal only for access points into the development as described below) and reinforced with additional planting of native pollinator friendly shrub species, trees, hedgerows and grasses resulting in a net overall gain.
- The topsoil and seedbank from the proposed contractor's compound area (3420m sq) will be carefully removed, stored and planted (as described in section 7.8 below) to all soft landscaping areas of the new development to restore this part of the site promoting biodiversity and creating habitats for pollinators. It will be reinforced where required with meadow grass to encourage the natural growth of pollinator friendly species such as dandelions, clover, celandines, buttercup and primroses.
- SUDS will be introduced in the form of swales to the new access road, soft landscaping to the perimeter of the development, additional trees and hedgerows, permeable hardstanding and a soakaway for the surface water from the utilities workshop (described in further detail in section 6.3).



PROPOSED NORTH-WEST AERIAL VIEW from drawing A21DB035-AE-PL-332

7.6 Proposed planting schedule

Species	Common Name	Size	Quantities
TREES			
Betula pendula -BP	Silver Birch	5 NO.	10-12%
Salix cinerea subsp. oleifolia - SC	Grey Willow	5 NO.	
Acer Campestre - AC	Field Maple	6 NO.	
HEDGEROW			
Crataegus monogyna	Hawthorn	b/r 90-120cm ht	12-15%
Prunus spinosa	Blackthorn	b/r 90-120cm ht	
Corylus avellana	Common Hazel	b/r 90-120cm ht	
Salix caprea	Goat Willow	b/r 90-120cm ht	
***EXISTING SEEDBANK (from excavated contractors compound area) to be replanted to entire soft landscaping areas including* understorey of new trees and hedgerows, open area south of utilities workshop & new planted berm (north of contractors compound)**			
Poa spp	Meadow Grass		65-70%
Dactylis glomerata	Cocks foot		
Agrostis spp	Bent		
Ranunculus repens	Creeping buttercup		
Bellis perennis	Daisy		
Vicia sativa agg	Common Vetch		
SOFT LANDSCAPING grass seed			
Poa spp	Meadow Grass	Seed	10-20%
SOFT LANDSCAPING shrubs			
Nepeta spp	Catmint	2 lt 15-20cm	1-2%
Rosemarinus officinalis	Rosemary	5 ltr 20-30cm	
Geranium macrorrhizum	Cranesbill	2 ltr 20-40cm	

Screenshot from drawing A21DB035-AE-PL-304 Proposed landscaping layout

The existing construction backfill is to be removed and disposed of offsite by a licenced waste management company. The existing trees and hedgerows along the east boundary are to be retained and protected during the works.

One continuous section of existing hedgerow and trees are to be removed along the existing service road 46m long x 5m wide to facilitate the 2 new service road access points and pedestrian crossing.

The volume of hedgerow and trees to be removed will be replanted plus approx. 20m long x 5m deep hedgerow and approx. 16 proposed trees to be added along the new access road and along the eastern elevation of the utilities workshop resulting in an overall net gain of approx. 70%.

Access road and footpath:

- The surface of the new access road will be permeable asphalt.
- A 2m wide brushed concrete footpath will be provided giving access to the Utilities workshop and access road. A permanent pedestrian crossing will be provided to match the existing pedestrian crossings on the site (fitted with appropriate signage) giving access from the proposed contractors compound and the rest of the site over to the VOC compound and workshop.
- Swales will be planted with low maintenance grasses between the VOC abatement system plinth and the new access road planted with low maintenance grass.

VOC Abatement system compound:

- The proposed compound 489m2 will be finished in concrete hardstanding. The perimeter will be enclosed by a 2.4m high quality "black paladin weldmesh fence" to match the newer service enclosures on the site. The compound will be locked, accessible only by approved Takeda service personnel via 2 no. double vehicular gates and 1 no. pedestrian gate.
- The base of the VOC abatement system compound will be finished as a concrete plinth at falls either to the aco drains leading to the surface water attenuation tank or within the bunded area to the process water sump as described under section 6 drainage above.

Existing Paladin weldmesh black fencing on site - Proposed fencing to match

Utilities workshop:

- Due to the proximity of the utilities workshop to the VOC abatement system it is not practical to install a sedum or moss green roof system due to the risk to fire safety in the event of the roof drying out. In lieu of a green roof, the surface water from the roof will feed directly into a soakaway positioned north west of the VOC abatement system compound adjacent to the new

hedgerow. The area over the soakaway will be planted with native grasses and flowers as listed in the planting schedule on landscape drawing A21DB035-AE-PL-304.

7.7 Visual Impact assessment

As part of the EIA report submitted with this application, a visual impact study was carried out (Chapter 11, landscape and visual) using external reference points as the basis of assessment. The outcome of the study noted *"Aside from the proposed stack, many of the proposed constructed elements on site will not rise c. 7m above the surrounding existing ground levels. Thus, much of the existing vegetation and built infrastructure within the site will heavily screen the majority of the Proposed Development from surrounding receptors".* Please refer to Chapter 11 Landscape and Visual, and associated photomontages of the EIA report for further information.

Images taken from Chapter 11, EIA report Landscape impact assessment

7.8 Proposed Landscaping scheme for contractor's compound

The contractor's compound will be in use for 2 years. After this time the compound will be removed, and the site returned to its original state. To facilitate the compound, it is proposed that the seedbank (measuring 3420m sq) be carefully removed and reused around the new areas of soft landscaping to the VOC abatement system compound and utilities building. The excavated topsoil will be retained in the form of a berm 55m long x 11m deep x approx. 2.3m high to the north of the new compound. The berm will be be set at a 1 in 2 gradient to the side slopes. The remaining seedbank will be applied to the berm in addition to Meadow grass (Poa spp.) to encourage the natural growth of pollinator friendly species such as dandelions, clover, celandines, buttercup and primroses. The berm will help shield the contractor's compound from the site's main entrance to the north of the site.

The surface finish of the compound will be a permeable compacted stone fitted with a geotextile filter membrane permitting free drainage to the soil below. A 2.4m high black Paladin weldmesh fence will enclose the compound with access via a locked double gate and a single personnel gate.

Once the contractor's compound is no longer in use, the cabins, fencing, drainage tie in's, lighting and hardcore will be removed. The planted berm and soil will be carefully spread (with any additional virgin topsoil required) over the area to return the landscape to its original condition. Additional planting of the original native grasses will be carried out (to encourage the natural growth of pollinator friendly species such as dandelions, clover, celandines, buttercup and primroses).

7.9 Phasing and timing of planting works

Site levelling and seeding works will be completed during the dryer summer months following the completion of the building works. The seedbank from the contractor's compound area will be carefully removed and stored on site as per the guidance of the project ecologist (stored in stockpiles no higher than .5m to the grassed area north of the proposed contractors compound) . Following this the landscape planting will take place during the planting season between the

months of November to March. These works should take approx. 4-6 weeks and will be carried out by a qualified landscape contractor.

All native plant species proposed will be subject to the advice and recommendations of the Project Ecologist, to ensure best fit with the environment and biodiversity enhancement. Given the relatively small scale of the works and the proposed location on the site, the development results in no appreciable change to the existing landscape and visual character of the site. Landscaping drawings, an arboriculturist report and survey drawings as noted in appendix 4 and the (chapter 8) EIA report (submitted with this planning application) all form part of this application.

8. CONSTRUCTION MANAGEMENT PLAN

8.1 General

The Client will appoint a Competent Construction Team to manage the project. This Construction team will have responsibility for ensuring that the project is executed in accordance with the EIA report. The Construction Team will manage and monitor all the mitigations reporting to the Client.

The project team will develop a Construction Environmental Management Plan (CEMP) which will address all the aspects of the EIA report as they pertain to Construction. This document will be included in the Tendering of the Construction Works Packages and will inform all Contractors of the requirements. During the procurement process the Client and/or their consultants will ensure the Contractors have sufficient experience to mitigate the risks outlined in the EIA report. Following award, the Contractors will develop their own Plans and mitigations. These will be reviewed for alignment with the CEMP/EIA report by the Construction Management Team. The Construction team will review the individual task Risk Assessments and Method Statements (RAMS) for alignment with requirements. Tasks will be monitored daily.

8.2 Site access

Access to the site for contractors and materials is via the existing main entrance gate along the Northern boundary accessible via the New Nangor road. This gate is continuously monitored by the security cabin.

8.3 Contractors parking

The contractor's compound will provide 30 spaces for construction workers accessible via the main entrance gate.

8.4 Welfare Compound (Contractors compound)

The project has allowed for a construction welfare compound, noted here as the contractor's compound including parking, offices, toilets and changing facilities for up to 30 personnel. The compound will be enclosed by a 2.4m high timber hoarding accessible via a locked vehicular and personnel gate. The compound is positioned directly opposite the VOC abatement system compound accessible via a new permanent pedestrian crossing to the internal access road. This crossing will give safe access to the construction area during the works and for Takeda personnel

once the works are complete. The Compound will be established at the beginning of the project timeline

The Construction Team will manage the compound ensuring alignment with regulations including Covid-19 regulations at any given time.

8.5 Traffic Management

Construction personnel numbers are low and will not present an impact to the traffic in the area. Truck movements for incoming and outgoing materials will be scheduled to be continuous throughout the day to minimise impact. Specific requirements will be captured in the CEMP.

9. APPENDIX 1 - LIST OF ARCHITECTURAL DRAWINGS

DRAWING NO.	DRAWING TYPE	TITLE.	REVISION
A20DB071-AE-PL-000	DRAWING LIST	DRAWING LIST	
A21DB035-AE-PL-300	ARCHITECTURAL LAYOUT	OS SITE LOCATION MAP,	B
A21DB035-AE-PL-301	ARCHITECTURAL LAYOUT	EXISTING SITE LAYOUT,	B
A21DB035-AE-PL-302	ARCHITECTURAL LAYOUT	PROPOSED SITE LAYOUT	B
A21DB035-AE-PL-304	ARCHITECTURAL LAYOUT	PROPOSED LANDSCAPING LAYOUT	B
A21DB035-AE-PL-306	ARCHITECTURAL LAYOUT	PROPOSED VECHICLE TRACKING SITE LAYOUT	B
A21DB035-AE-PL-307	ARCHITECTURAL ELEVATIONS	PROPOSED DETAIL SITE PLAN	E
A21DB035-AE-PL-314	ARCHITECTURAL PLAN & SECTIONS	PROPOSED UTILITIES WORKSHOP PLAN AND SECTIONS	C
A21DB035-AE-PL-321	ARCHITECTURAL ELEVATIONS	PROPOSED UTILITIES WORKSHOP ELEVATIONS	C
A21DB035-AE-PL-322	ARCHITECTURAL ELEVATIONS	EXISTING SITE CONTIGUOUS ELEVATIONS,	B
A21DB035-AE-PL-324	ARCHITECTURAL ELEVATIONS	PROPOSED CONTIGUOUS ELEVATIONS,	C
A21DB035-AE-PL-331	ARCHITECTURAL SECTIONS	PROPOSED SITE SECTIONS,	C
A21DB035-AE-PL-332	ARCHITECTURAL SECTIONS	PROPOSED LANDSCAPING CROSS SECTIONS AND DETAILS SHEET	B
A21DB035-AE-PL-353	3D IMAGES	PROPOSED SITE 3D VIEWS	B

10. APPENDIX 2 - LIST OF CIVIL & STRUCTURAL DRAWINGS

DRAWING NO.	DRAWING TYPE	TITLE.	REVISION
A21DB035-CV-100	CIVILS LAYOUT	PROPOSED FOUL AND SURFACE WATER DRAINAGE LAYOUT	B
A21DB035-CV-500	CIVILS DETAILS	TYPICAL DRAINAGE DETAILS	B

11. APPENDIX 3 - LIST OF ELECTRICAL SITE LIGHTING DRAWINGS

DRAWING NO.	DRAWING TYPE	TITLE.	REVISION
A21DB035-EE-900	ELECTRICAL LAYOUT	SITE PLAN - EXTERNAL LIGHTING LAYOUT	B

12. APPENDIX 4 - LIST OF ARBORICULTURAL DRAWINGS & REPORT

DRAWING NO.	DRAWING TYPE	TITLE.	REVISION
220515-P-10	SITE LAYOUT	TREE SURVEY PLAN	
220513-P-11	SITE LAYOUT	TREE REMOVALS AND PROTECTION PLAN	
220513-PD-11	REPORT	ARBORICULTURAL REPORT	

13. APPENDIX 5 - ARBORICULTURAL REPORT AND TREE SURVEY

Arboricultural Report

Tree Survey,

Arboricultural Impact Assessment &

Arboricultural Method Statement

In relation to the development proposal at:

Takeda Ireland Ltd.

Grange Castle Business Park

Dublin 22

On behalf of:

Takeda Ireland Ltd.

June 2022

220513-PD-11

CHARLES MCCORKELL
ARBORICULTURAL CONSULTANCY

Contents

Section 1: Arboricultural Impact Assessment

1 Summary

1.1 This arboricultural report has been instructed by Takeda Ireland Ltd. (the 'Applicant').

1.2 The proposal is for the construction of a new VOC abatement system, associated services, and a supporting utilities workshop at Takeda Ireland Ltd., Grange Castle Business Park, Dublin 22 (the 'Application Site').

1.3 This report includes:

- an assessment of the trees, their quality and value in accordance with BS 5837:2012 - Trees in relation to design, demolition and construction;
- the site context and observations on the trees;
- local planning policies relevant to the consideration of trees on the site;
- the impact of the proposed development upon the tree population in and around the site;
- methods of reducing impacts on trees; and
- measures to be taken to protect trees during the proposed works.

1.4 My conclusions are that the proposed development is achievable in both arboricultural terms and in relation to local planning policy as it relates to trees.

1.5 The proposal will require the partial removal of one C Category tree group (G2). These losses have been assessed and will have an insignificant impact on the character and appearance of the local area and landscape due to their low quality.

1.6 Sufficient space for new tree planting is available within the site. New planting can mitigate the loss of trees and enhance the visual appearance and amenities of the site.

2 Introduction

Instructions

2.1 This arboricultural report has been instructed by Takeda Ireland Ltd. to provide information to assist all parties involved in the planning process to make balanced judgements with regard to arboricultural features in relation to the proposed development at Takeda Ireland Ltd., Grange Castle Business Park, Dublin 22.

Development proposal

2.2 The proposal is for the construction of a new VOC abatement system, associated services, and a supporting utilities workshop.

Qualification and experience

2.3 This report has been prepared by Charles McCorkell. Charles is a Chartered Arboricultural Consultant dealing with trees in relation to all forms of human activity, including the built environment. He is a Professional Member of the Institute of Chartered Foresters, a Professional Member of the Arboricultural Association, a qualified professional tree inspector (LANTRA), and has a BSc Honours Degree in Arboriculture from the University of Central Lancashire.

Scope and limitations

2.4 The survey undertaken is not a health and safety assessment of trees; however, trees identified as imminently dangerous will have been highlighted and recommendations made, where appropriate.

2.5 The contents of this report are the copyright of Charles McCorkell Arboricultural Consultancy and may not be distributed or copied without the author's permission.

Methodology and guidance

2.6 The author of this report has referred to *British Standard 5837: Trees in relation to design, demolition and construction (2012)* which provides a methodology for the assessment of trees and other significant vegetation on development sites.

2.7 BS 5837 (2012) is intended to assist decision making with regard to existing and proposed trees and sets out the principles and procedures to be applied to achieve a harmonious relationship between existing and new trees and structures that can be sustained for the long term.

2.8 The BS 5837 (2012) recommends the National Joint Utilities Group (NJUG) document *Guidelines for the planning, installation and maintenance of utility apparatus in the proximity to trees.* Volume 4, issue 2. London: NJUG, 2007, as a normative reference for guidance on the installation of utilities within proximity to trees.

Definitions

2.9 **Root Protection Area (RPA)** – a layout design tool indicating the area surrounding a tree that contains sufficient rooting volume to ensure the survival of the tree.

2.10 **Tree Protection Zone (TPZ)** – an area based on the RPA in m^2 identified by an arboriculturist, to be protected during development, including demolition and construction work, by the use of barriers and/or ground protection fit for purpose to ensure the successful long-term retention of a tree.

Supporting information

2.11 This report should be read in conjunction with the following supporting documents attached to this report.

Document	Reference	Location
Arboricultural Method Statement	N/A	Section 2
Tree Schedule	220513-PD-10	Appendix A
Tree Survey & Constraints Plan	220513-P-10	Appendix B
Tree Removals & Protection Plan	220513-P-11	Appendix B

3 Observations & Context

Site visit

3.1 The site was visited by Charles McCorkell on 9 June 2022.

3.2 The purpose of the visit was to survey trees located on and adjacent to the site which may be of significance to the proposed development.

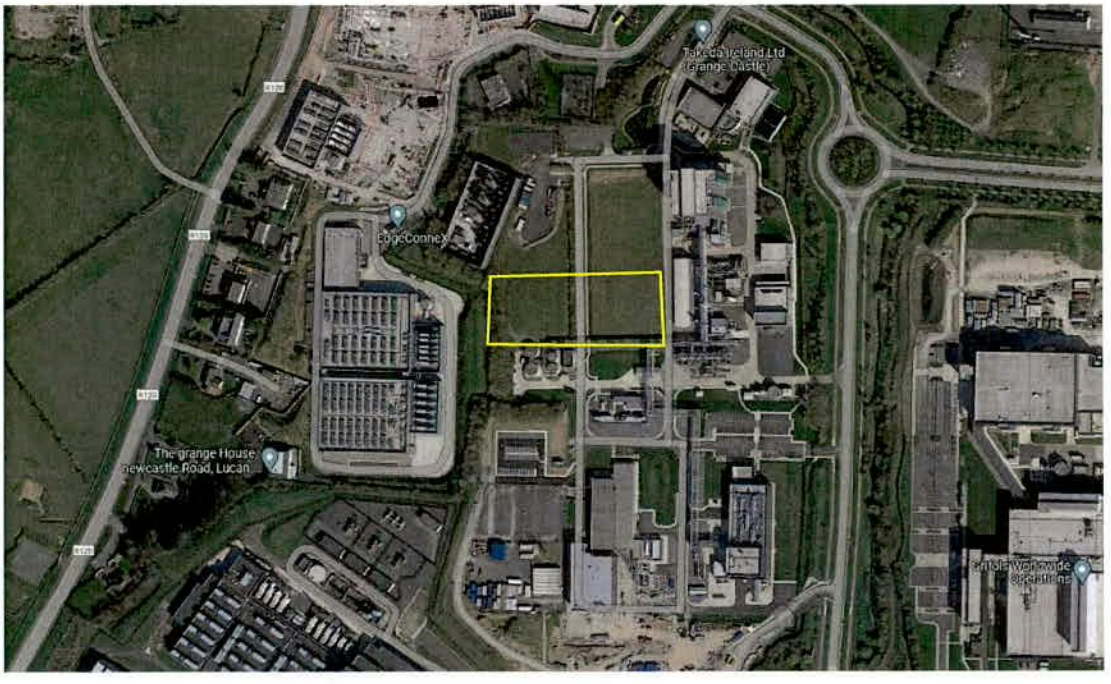
3.3 The survey was carried out in accordance with BS 5837:2012 and from ground level only.

Site location and description

3.4 The Application Site is located within the grounds of Takeda Ireland Ltd. (Map 1). It contains a raised area of made ground which is situated between a mixed tree belt (G1) to the west and a tree and shrub group (G2) to the east.

3.5 Trees within G1 are of an early-mature age and have been historically topped. As a collection, the trees are a valuable landscape feature but the pruning works undertaken have reduced their overall quality to that of Category C.

3.6 Group G2 contains a mix of semi-mature trees with an understorey of dogwood and gorse shrubs. There are a small number of dead trees within the group which have been out-competed by more dominant trees. The group is a Category C due to its low quality and value.



Map 1 (Google 2022): *Yellow line highlighting the survey area within the site.*

View of the site and trees

Photo 1: *View of tree group G1 from the raised mound within the site to be developed.*

Photo 2: *View of the tree group G2 from the raised mound within the site to be developed.*

4 Local Planning Policy

Development Plan 2016-2022

4.1 The current South Dublin County Council Development Plan 2016-2022 contains several policies that relate to trees. These include:

G2 Objective 5

To integrate Green Infrastructure as an essential component of all new developments;

G2 Objective 9

To preserve, protect and augment trees, groups of trees, woodlands and hedgerows within the County by increasing tree canopy coverage using locally native species and by incorporating them within design proposal and supporting their integration into the Green Infrastructure network;

HCL15 Objective 3

To protect existing trees, hedgerows, and woodlands which are of amenity or biodiversity value and/or contribute to landscape character and ensure that proper provision is made for their protection and management in accordance with Living with Trees: South Dublin County Council's Tree Management Policy 2015-2020.

Development Plan 2022-2028

4.2 The Draft County Development Plan 2022-2028 contains the following policies that relate to trees and are to be considered:

GI1 Objective 1

To establish a coherent, integrated and evolving GI Network across South Dublin County with parks, open spaces, hedgerows, trees including public street trees and native mini woodlands (Miyawaki-Style), grasslands, protected areas and rivers and streams and other green and blue assets forming strategic links and to integrate and incorporate the objectives of the GI Strategy throughout all relevant land use plans and development in the County.

GI5 Objective 3

To ensure compliance with the South Dublin Climate Change Action Plan and the provisions of the Council's Tree Management Strategy.

- Increase the County's tree canopy cover by promoting annual planting, maintenance preservation and enhancement of trees, woodlands and hedgerows within the County using locally native species and supporting their integration into new development.

GI5 Objective 6

To provide more tree cover across the county, in particular to areas that are lacking trees.

NCBH11 Objective 3

To protect and retain existing trees, hedgerows, and woodlands which are of amenity and/or biodiversity and/or carbon sequestration value and/or contribute to landscape character and ensure that proper provision is made for their protection and management taking into account Living with Trees: South Dublin County Council's Tree Management Policy (2015-2020) or any superseding document and to ensure that where retention is not possible that a high value biodiversity provision is secured as part of the phasing of any development to protect the amenity of the area.

Tree Management Policy 2015-2020

4.3 The South Dublin County Council Tree Management Policy 'Living with Trees' 2015-2020 contains information within Chapter 7 Trees and Development that relates to the retention, protection and planting of trees on development sites. Relevant points within this section include:

- The Council will use its powers to ensure that where it is conductive with the objectives of the County Development Plan, and other planning objectives there is maximum retention of trees on new development sites.
- In the processing of planning applications, the Council will seek the retention of trees of high amenity / environmental value taking consideration of both their individual merit and their interaction as part of a group or broader landscape feature.
- On construction sites all work must be in accordance with British Standard 5837 (2012): Trees in Relation to Design, Demolition and Construction – Recommendations.
- The Council will promote the replacement of trees removed to facilitate approved planning and development of urban spaces, buildings, streets, roads, infrastructural projects and private development sites.

5 Analysis of the Proposal in Respect of Trees

Arboricultural Impacts

5.1 ***Loss of trees*** – The proposal will require the partial removal of one C Category tree group (G2). Details of the proposed removals are specified within the Tree Schedule at Appendix A and the extent of the group to be removed is shown on the Tree Removals Plan at Appendix B.

5.2 The trees and shrubs to be removed are of low quality and value only and their removal will not have a negative impact on the character and appearance of the local surrounding area and landscape.

5.3 The proposal contains sufficient space for new tree and shrub planting to be carried out. Such planting can mitigate the removal of trees and contribute to the existing canopy cover across the site.

5.4 ***Pruning works*** – Crown pruning works have been proposed for the trees within group G2 which are situated adjacent to the development. The works proposed are specified within the Tree Work Schedule at Appendix A and include crown lifting and reducing lateral branches that are extending into the construction area. These works have been assessed and will not have a negative impact on the condition or appearance of the trees concerned.

5.5 ***Construction operations*** – The construction of the development will not require excavation or other works within the RPAs of retained trees. No special measures are therefore required to prevent root damage; however, it will be necessary to ensure that site operations do not cause damage to trees or the soil environment upon which they rely.

5.6 ***Tree protection measures*** – Trees can be successfully protected during the proposed development works by using robust fencing measures which comply with the recommendations outlined within BS 5837:2012. The location and specification of tree protection measures are highlighted in the Tree Protection Plan at Appendix B.

Arboricultural mitigation

5.7 The site contains sufficient space to carry out new high-quality tree and hedgerow planting that can mitigate the proposed removals and initial loss of canopy cover.

5.8 New planting should take into consideration the character of the local landscape and aim to enhance the tree and hedge cover for the future.

6 Discussion & Conclusion

General Change

6.1 In visual terms, the proposed removals will not have a significant impact on the character and appearance of the local surrounding area and landscape. The trees and shrubs to be removed are of low quality and value only and can be adequately replaced with new high-quality planting elsewhere on the site.

Proposal in relation to local planning policy

6.2 The proposed development complies with local planning policies as they relate to trees. Although removals are required to facilitate the development, these are not considered to be important in terms of the character and appearance of the surrounding local area due to their low quality.

6.3 The proposal has been assessed in accordance with best practice BS5837:2012 and provided the recommendations, as detailed within this report, are followed, all retained trees can be successfully protected for the duration of construction.

Conclusion

6.4 The proposal has been assessed in accordance with BS 5837:2012. Provided the recommendations and methods of work, as outlined within this report, are adhered to, the proposed development can be successfully carried out without having a negative impact on the character or appearance of the surrounding landscape and local area.

Section 2: Arboricultural Method Statement

Introduction

This report has been prepared in accordance with British Standard 5837: Trees in relation to design, demolition and construction – Recommendations (2012) which provides a methodology for the assessment and protection of trees and other significant vegetation on development sites.

Sequence of Operations

- Proposed tree works.
- Installation of tree protection measures.
- Enabling works, including the installation of a site compound.
- Construction, including the installation of drainage and services.
- Landscaping.

Alternative sequences can be discussed and agreed upon with the local authority and project manager if required.

Supervision

All key / critical activities that will affect trees during construction will be inspected and monitored by the approved arboricultural consultant.

- Inspection of tree works and protection measures prior to the commencement of works; and
- Supervision during any other works that may affect retained trees.

Arboricultural Method Statement

Scope	Methodology
Tree Works	Please refer to the Tree Schedule at Appendix A for a list of all proposed tree works. The location of trees to be removed is highlighted in the Tree Removals Plan at Appendix B. It is the responsibility of the Site Manager to ensure all tree works have been approved by the local planning authority. All tree works will be carried out by a reputable arboricultural contractor in accordance with the recommendations given in BS 3998:2010 – Tree Work Recommendations.

	All tree works should be carried out in accordance with Section 40 of the Wildlife Act 1976 and Section 46 of the Wildlife (Amendment) Act 2000. It is the responsibility of the arboricultural contractor to ensure that no protected species are harmed whilst carrying out site clearance or tree surgery works.
Tree Protection	The position of protective fencing for construction is shown on the Tree Protection Plan at Appendix B. Protective fencing must be constructed and installed using the BS5837:2012 fencing specification as detailed on the Tree Protection Plan at Appendix B. Alternatives to those shown must be agreed in advance by the client approved, arboricultural consultant. No materials or equipment other than those required to erect protective fencing will be delivered to the site before the fencing is installed. Signs will be fixed to every third panel stating, *'Tree Protection Area Keep Out – Any incursion into the protected area must be with the agreement of the local authority or arboricultural consultant'.* The main contractor will inform the local authority and the arboricultural consultant that tree protection is in place before site clearance works commence. No alteration, removal or repositioning of the tree protection will take place during construction without the prior consent of the arboricultural consultant.
General Principals to Avoid Damage to Trees	All tree works will be carried out in accordance with the recommendations given in BS 3998 (2010). No fires will be permitted within 20m of the crown of any tree. No changes in soil levels will take place within the tree protection zones without the prior written consent of the local authority. No materials, vehicles, plant or personnel will be permitted into the tree protection zones at any time without the prior consent of the arboricultural consultant. Any liquid materials spilt on site will be immediately cleared up and removed from the site. If liquid fuel or cement products are spilt within 2m of the tree protection zone, the contractor will report the incident to the arboricultural consultant immediately.

	The contractor will report any damage to trees or shrubs, whether caused by construction activities or from any other cause, to the arboricultural consultant immediately.
Landscape Operations	All landscape operations within the protected area will be carried out by hand, using hand tools only. No dumping of spoil or rubbish, parking of vehicles or plant, storage of materials or temporary accommodation will be undertaken within the TPZs. Soil levels will not be increased or reduced within the RPAs of trees without prior agreement from the arboricultural consultant.

Appendix A - Schedule

Document	Reference	Revision
Tree Schedule	220513-PD-10	-

220513-PD-10-Tree schedule

CHARLES MCCORKELL
ARBORICULTURAL CONSULTANCY

220513 - Takeda Ireland Ltd

Tree ID	No.	Species	Height (m)	Stem diameter (cm)	No. of Stems	CROWN SPREAD (m) N	NE	E	SE	S	SW	W	NW	Crown clearance (m)	L.B. (m)	Life stage	Condition Notes / Recommendations	Survey date	RPA (m^2)	RPR (m)	Life expectancy (yrs)	BS Category
Group G1	1	Acer platanoides (Norway Maple)	10.0	25 AVE	1									0.0		Early Mature	Structural condition Fair. Physiological condition Fair. Early-mature tree group growing on a raised mound. A large number of the trees have been historically topped which has reduced their quality and produced weakly attached vertical regrowth. The tree group is an important landscape feature that provides screening. Height of trees vary with the maximum being between 10-12m. Stem diameter recorded was average for the group. Quantities of trees not recorded, only species mix. Lift low canopy - Specified extent. - Crown lift or reduce overhanging laterals to provide sufficient clearance for construction.	09/06/2022	28.3	3.0	20-40	C2
	1	Betula pendula (Silver Birch)																				
	1	Carpinus betulus (Hornbeam)																				
	1	Cerasus avium (Wild Cherry)																				
	1	Fraxinus excelsior (Ash)																				
	1	Laurocerasus officinalis (Cherry Laurel)																				
	1	Tilia sp. (Lime sp.)																				

Stem **green** Estimated value
Stem **AVE** Average stem diameter for tree groups
Stem **COM** Combined stem diameter in accordance with BS5837
L.B. Height of lowest branch attachment (m) - where relevant

The survey information in this schedule has been gathered following a BS5837 survey for planning purposes. Where hazardous trees have been noted recommendations for works may have been made but this survey cannot be relied upon as a full health and safety assessment of the trees.

Generated By MyTREES tree management software

Printed on 16/06/22 (BS5837 Tree Schedule (with recs) - tables)

220513 - Takeda Ireland Ltd

Tree ID	No.	Species	Height (m)	Stem diameter (cm)	No. of Stems	CROWN SPREAD (m) N	NE	E	SE	S	SW	W	NW	Crown clearance (m)	L.B. (m)	Life stage	Condition Notes / Recommendations	Survey date	RPA (m^2)	RPR (m)	Life expectancy (yrs)	BS Category
Group G2	1	Tilia sp. (Lime sp.)	5.0	12 AVE	1									0.0		Semi Mature	Structural condition Fair. Physiological condition Fair. Semi-mature tree group with an understorey of dogwood and gorse. Small number of dead trees which have been out competed. Quantities of trees not recorded, only species mix. Height and stem diameter are average for group. Fell - Ground level. - Fell section of group as shown on the Tree Removals Plan to facilitate the development.	09/06/2022	6.5	1.4	20-40	C2
	1	Swida sanguinea (Common Dogwood)																				
	1	Prunus sp. (Cherry sp.)																				
	1	Castanea sativa (Sweet Chestnut)																				
	1	Betula pendula (Silver Birch)																				
	1	Acer campestre (Field Maple)																				

Stem **green** Estimated value
Stem **AVE** Average stem diameter for tree groups
Stem **COM** Combined stem diameter in accordance with BS5837
L.B. Height of lowest branch attachment (m) - where relevant

The survey information in this schedule has been gathered following a BS5837 survey for planning purposes. Where hazardous trees have been noted recommendations for works may have been made but this survey cannot be relied upon as a full health and safety assessment of the trees.

Generated By MyTREES tree management software

Printed on 16/06/22 (BS5837 Tree Schedule (with recs) - tables)

Table 1 of BS5837 (2012) **Cascade chart for tree quality assessment**

Category and definition	Criteria (including subcategories where appropriate)			Identification on plan
Trees unsuitable for retention (see note)				
Category U Those in such a condition that they cannot realistically be retained as living trees in the context of the current land use for longer than 10 years	* Trees that have a serious, irremediable, structural defect, such that their early loss is expected due to collapse, including those that will become unviable after removal of other category U trees (e.g. where, for whatever reason, the loss of companion shelter cannot be mitigated by pruning) * Trees that are dead or are showing signs of significant, immediate, and irreversible overall decline * Trees infected with pathogens of significance to health and/or safety of other trees nearby, or very low quality trees suppressing adjacent trees of better quality NOTE Category U trees can have existing or potential conservation value which it might be desirable to preserve; see 4.5.7			**RED**
	1 Mainly arboricultural qualities	**2 Mainly landscape qualities**	**3 Mainly cultural values, including conservation**	
Trees to be considered for retention				
Category A **Trees of high quality** with an estimated remaining life expectancy of at least 40 years	Tree that are particularly good examples of their species, especially if rare or unusual; or those that are essential components of groups or formal or semi-formal arboricultural features (e.g. the dominant and/or principal trees within an avenue).	Trees, groups or woodlands of particular visual importance as arboricutural and/or landscape features.	Trees, groups or woodlands of significant conservation, historical, commemorative or other value (e.g. veteran trees or wood-pasture).	**GREEN**
Category B **Trees of moderate quality** with an estimated remaining life expectancy of at least 20 years	Trees that might be included in category A, but are downgraded because of impaired condition (e.g. presence of significant though remediable defects, including unsympathetic past management and storm damage), such that they are unlikely to be suitable for retention for beyond 40 years; or trees lacking the special quality necessary to merit the category A designation.	Trees present in numbers, usually growing as groups or woodlands, such that they attract a higher collective rating than they might as individuals; or trees occurring as collectives but situated so as to make little visual contribution to the wider locality.	Trees with material conservation or other cultural value.	**BLUE**
Category C **Trees of low quality** with an estimated remaining life expectancy of at least 10 years, or young trees with a stem diameter below 150 mm	Unremarkable trees of very limited merit or such impaired condition that they do not qualify in higher categories.	Trees present in groups or woodlands, but without this conferring on them significantly greater collective landscape value; and/or trees offering low or only temporary/transient landscape benefits.	Trees with no material conservation or other cultural value.	**GREY**

Appendix B - Plans

Document	Reference	Revision
Tree Survey & Constraints Plan	220513-P-10	-
Tree Removals & Protection Plan	220513-P-11	-

CHARLES MCCORKELL
ARBORICULTURAL CONSULTANCY

Address: 12 Churchfield Grove, Ashbourne, Co. Meath

Email: charles@cmarbor.com

Tel: +353 85 843 7015

Web: www.cmarbor.com

14. APPENDIX 6 - FLOOD RISK ASSESSMENT

Malachy Walsh and Partners

Consulting Engineers

Cork | Tralee | Limerick | London

Takeda Development
Grange Castle Business Park

Flood Risk Assessment

on behalf of
PM Group

Project	Document	Revision	Issue	Prepared	Checked	Date
17895	6001	F	Planning	Sean Doyle	Micheál Fenton	June 2017

Table of Contents

List of Figures

List of Tables

List of Abbreviations

RFRA	Regional Flood Risk Assessment
SFRA	Strategic Flood Risk Assessment
FRA	Flood Risk Assessment
CFRAM	Catchment Flood Risk And Management
SUDS	Sustainable Urban Drainage Systems
WSL	Water Surface Level
AEP	Annual Exceedance Probability
MRFS	Mid-Range Future Scenario
HRFS	High Range Future Scenario

1 General

1.1 Introduction

This Flood Risk Assessment (FRA) report has been prepared on behalf of PM Group for a commercial development at Grange Castle Business Park on behalf of Takeda Ireland.

The site location map is shown in Figure 1 below.

Figure 1 – Site location map[1]

1.2 Objectives

The purpose of the report is to establish the flood risk associated with the existing site and the proposed development and, if appropriate, to recommend mitigation measures to prevent any increase in flood risk within or outside the site.

The report has been prepared in the context of *The Planning System and Flood Risk Management – Guidelines for Planning Authorities, November 2009*, published by the Office of Public Works and the Department of Environment, Heritage and Local Government. Flood Risk Assessments are carried out at different scales by different organisations. The hierarchy of assessment types are Regional (RFRA), Strategic (SFRA) and Site-specific (FRA). This report is site-specific.

[1] Map reproduced from Ordnance Survey Ireland by permission of the Government, licence number EN 00115716.

1.3 Site description

The site forms part of the Grange Castle Business Park. The river system within the business park has undergone considerable modifications from the original regime as it appears on the old 25" OS maps.

The original and current river layouts are shown in Figure 2. The River Griffeen now runs along the southeast boundary of the site, crosses under the business park road and continues north towards the Grand Canal. The direction of flow is from south to north.

The new river channel to the east of the site has a large cross-sectional area but it is somewhat smaller on the southeast boundary. The overall bed gradient is in the order of 1/250.

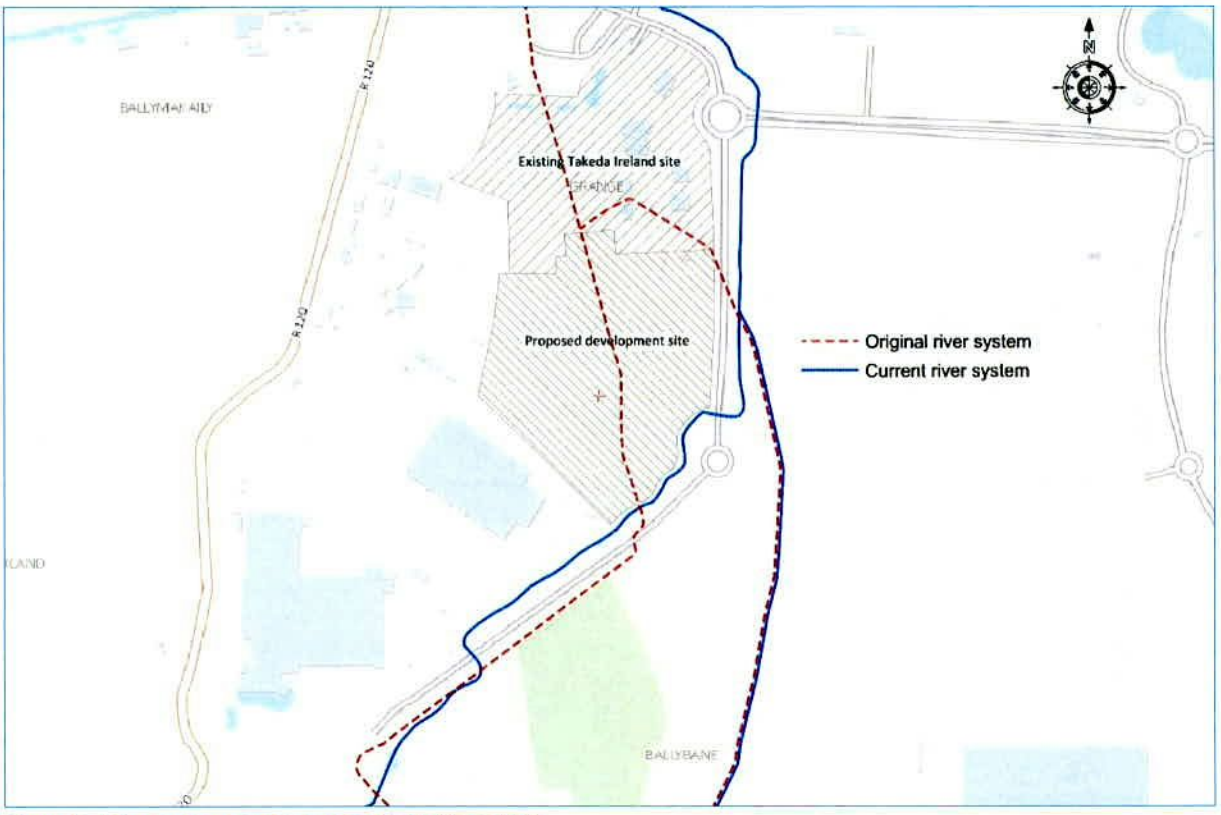


Figure 2 – River system at Grange Castle Business Park

1.4 Methodology

The Flood Risk Management Guidelines document outlines three stages in the assessment of flood risk as follows:

- *Stage 1 Flood risk identification* – to identify whether there may be any flooding or surface water management issues related to a plan area or proposed development site that may warrant further investigation;
- *Stage 2 Initial flood risk assessment* – to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to determine what surveys and modelling approach is appropriate to match the spatial resolution required and complexity of the flood risk issues. The extent of the risk of flooding should be assessed which may involve preparing indicative flood zone maps. Where existing river or coastal models exist, these should be used broadly to assess the extent of the risk of flooding and potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures; and
- *Stage 3 Detailed risk assessment* – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures. This will typically involve use of an existing or construction of a hydraulic model or a river or coastal cell across a wide enough area to appreciate the catchment wide impacts and hydrological processes involved.

This report includes all three stages of assessment.

2 Flood risk identification (Stage 1)

Possible sources of flood risk were identified by

- Walkover survey of the business park along the river route;
- Topographical survey of the site;
- Examination of available information on the OPW website (www.floodmaps.ie);
- Reference to the Baldonnel Fluvial Flood Extents and Flood Depth maps which form part of the Eastern CFRAM Study.

The Summary Local Area Report for the area on the OPW web site, http://www.floodmaps.ie (Figure 3), shows two records of flooding in the Grange area for a storm event on the 5th of November 2000. The first is in the Lucan area which is to the north of the Grand Canal and downstream of the business park. That flood was associated with the River Griffeen. The second event was at the junction of the R134 and R120 regional roads which is to the southwest of the business park and close to the River Griffeen.

The Eastern CFRAM Study maps for the Baldonnel area, which were prepared by the OPW and RPS Consultants, were issued in July 2016. The flood extents map (E09BAL_EXFCD_F0_10), which is included in Figure 4, shows the predicted flood extents for the 10%, 1% and 0.1% Annual Exceedance Probability (AEP) flood events. These are the extents that are likely to be equalled or exceeded once in a 10, 100 or 1,000-year period respectively. The flood depths map (E09BAL_DPFCD001_F0_10) is shown in Figure 5. The calculations are based on current predicted flow rates without taking the effects of future climate change into account.

The Takeda site is shown as being inundated for the 0.1% AEP flood event but not for the 1% AEP flood event for the current climate scenario. According to the CFRAM maps, the site is in Flood Zone B as defined in the Flood Risk Management Guidelines.

The flood extents and flood depth maps both have an abrupt boundary at the north end of the Takeda site which coincides with the location of an existing earth mound at this location. This suggests that the overland flow towards the north is assumed to terminate at this point and that the flood water is impounded by the mound. However, the mound is a landscaping feature rather than a flood defence and could be breached or undermined in the event of an extreme flood. In this instance, the flood would extend into the existing Takeda Ireland facility immediately to the north of the proposed new Takeda development.

OPW *National Flood Hazard Mapping*

Summary Local Area Report

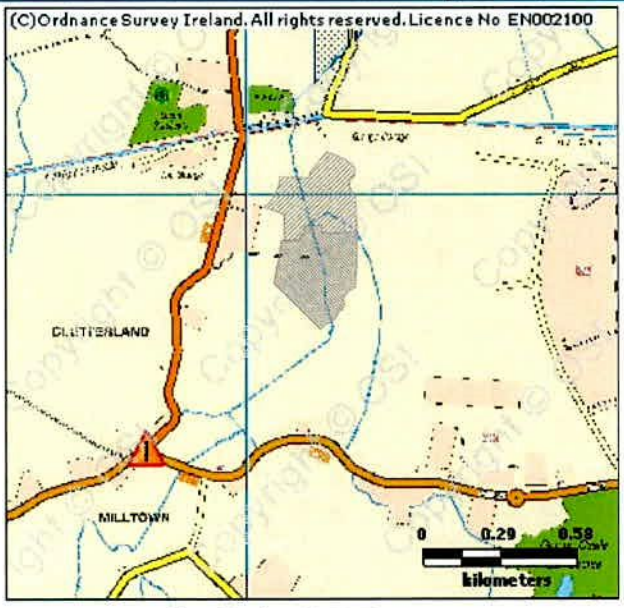
This Flood Report summarises all flood events within 2.5 kilometres of the map centre.

The map centre is in:

County: Dublin

NGR: O 032 315

This Flood Report has been downloaded from the Web site www.floodmaps.ie. The users should take account of the restrictions and limitations relating to the content and use of this Web site that are explained in the Disclaimer box when entering the site. It is a condition of use of the Web site that you accept the User Declaration and the Disclaimer.



Map Scale 1:24,142

Map Legend	
	Flood Points
	Multiple / Recurring Flood Points
	Areas Flooded
	Hydrometric Stations
	Rivers
	Lakes
	River Catchment Areas
	Land Commission *
	Drainage Districts *
	Benefiting Lands *

* Important: These maps do not indicate flood hazard or flood extent. Thier purpose and scope is explained in the Glossary.

2 Results

1. Griffeen November 2000 — Start Date: 05/Nov/2000
County: Dublin — Flood Quality Code:1
Additional Information: Photos (6) Reports (9) Press Archive (6) More Mapped Information

2. Peamount R134 R120 junction Nov 2000 — Start Date: 05/Nov/2000
County: Dublin — Flood Quality Code:3
Additional Information: Reports (1) Press Archive (1) More Mapped Information

Report Produced: 01-Dec-2016 13:04

Figure 3 – OPW Summary Local Area Report

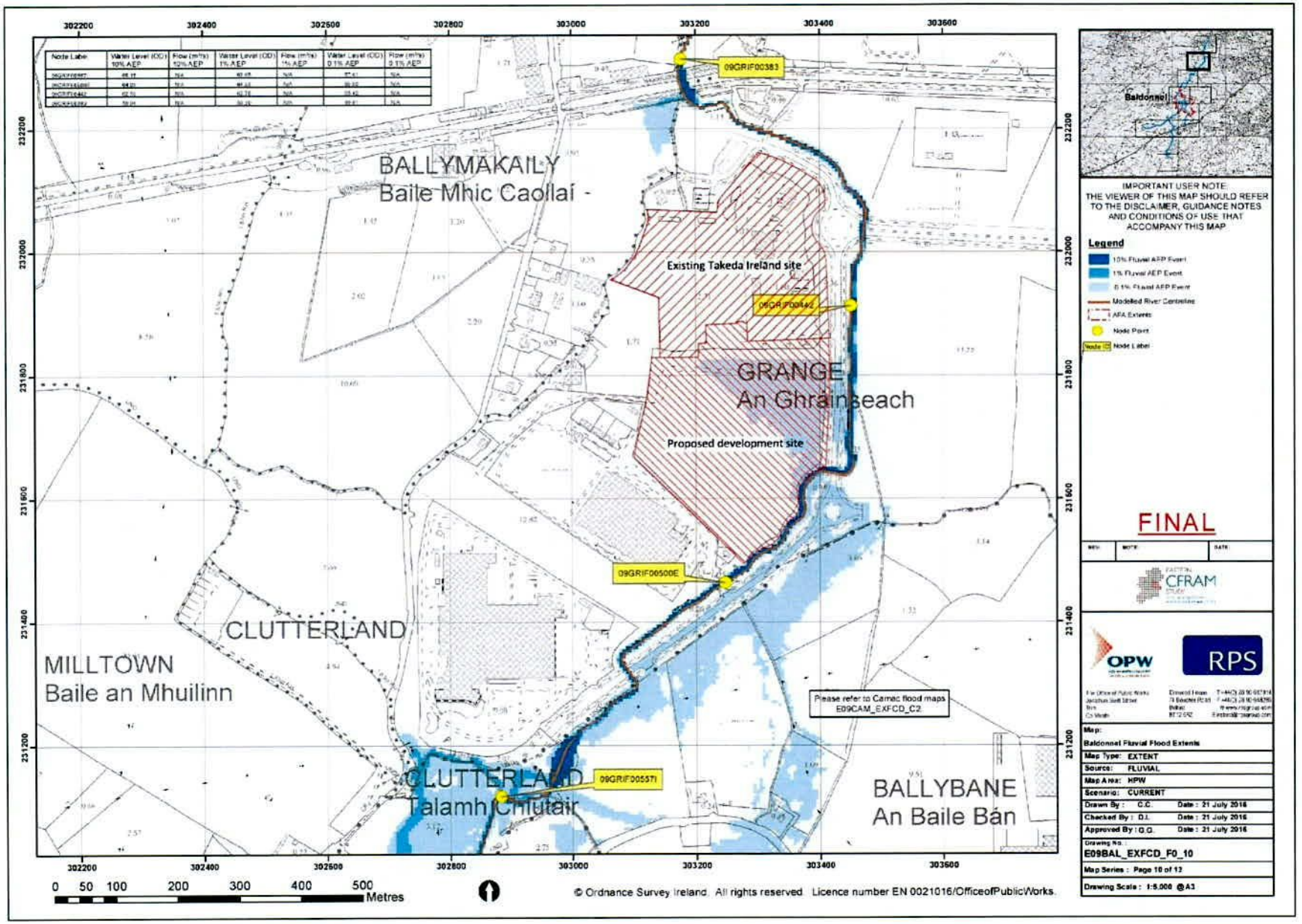


Figure 4 – Eastern CFRAM Study, Baldonnel Fluvial Flood Extents map

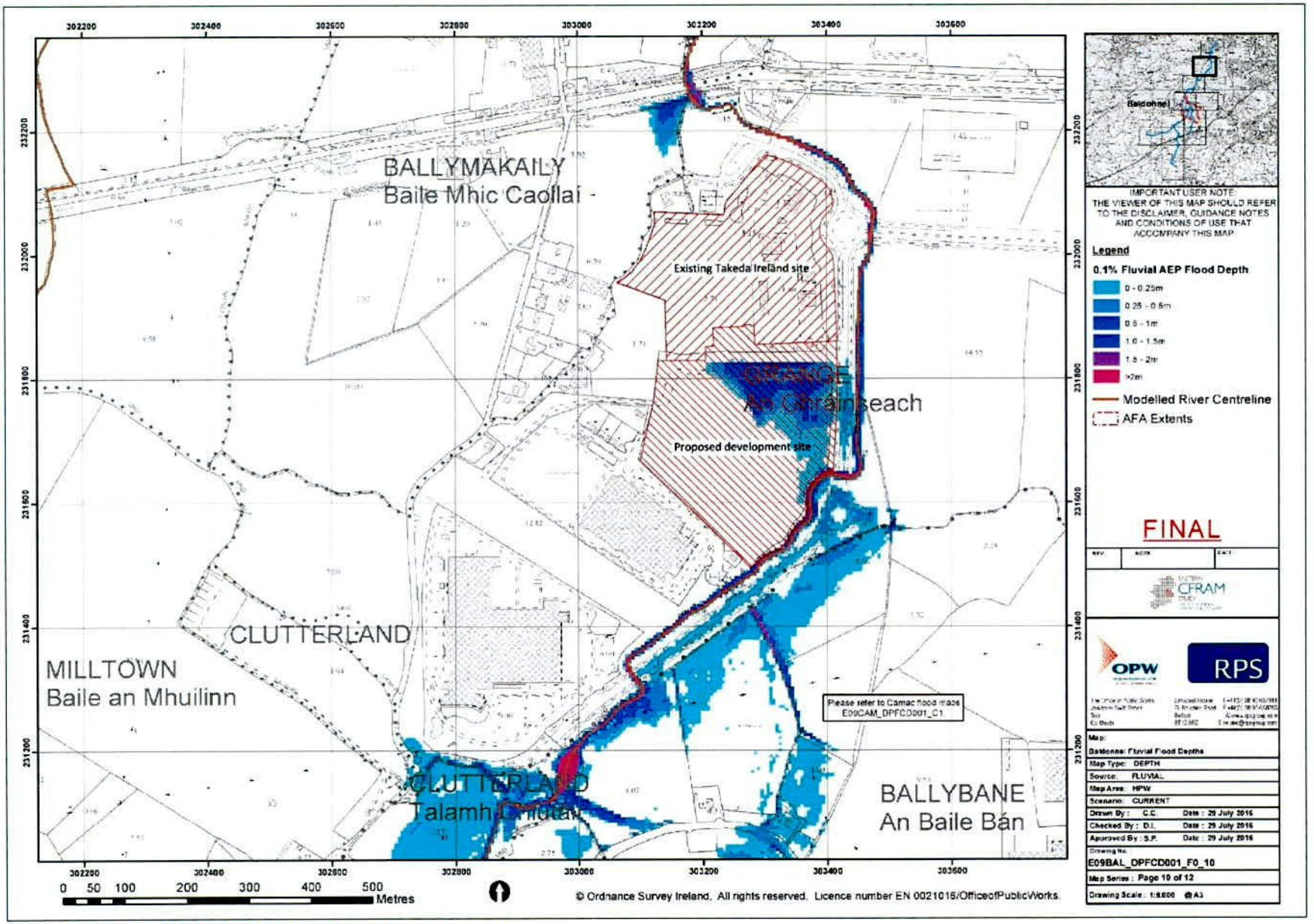


Figure 5 – Eastern CFRAM Study, Baldonnel Fluvial Flood Depths map

3 Initial flood risk assessment (Stage 2)

The purpose of the Initial Flood Risk Assessment is to ensure that the relevant flood risk sources are identified to determine if a Stage 3 Detailed Flood Risk Assessment is required and if so that they can be addressed appropriately.

3.1 Flooding sources

The potential sources of flooding and their relevance to the flood risk to the site are outlined in the following sub-sections.

3.1.1 River flooding

River flooding occurs when the capacity of a river channel is exceeded and water flows onto the adjacent land or flood plain. The River Griffeen is adjacent to the site and can be regarded as the main source for potential flooding. The Stage 1 assessment identified that there is a potential flood risk at this site. For this reason, it will be necessary to complete a Stage 3 - Detailed Flood Risk Assessment.

3.1.2 Overland flow

Overland or pluvial flow occurs when rainfall intensity exceeds the infiltration capacity of the ground. The excess water flows overland to the nearest watercourse or results in ponding in low areas or upstream of physical obstructions. It is most likely to occur following periods of sustained rainfall when the ground surface becomes saturated. Overland flow can also occur due to river flooding where the overbank flow from a point upstream runs across the site before returning to the river channel further downstream. This type of flooding is not uncommon and can occur where there is no direct risk from an adjacent or nearby river channel.

It was observed during the site walkover that there may be potential for overland flow at the Takeda site due to overtopping of the River Griffeen at the southeast boundary of the site. The site falls away towards the north from the riverbank at this location and therefore cannot contain the flow in such an event. This issue must be considered in the design of the proposed new Takeda development.

3.1.3 Estuarial flooding

Estuarial or tidal flooding occurs when the peak flow in a river coincides with extreme high tides resulting in abnormally high water surface levels in the lower reaches of a river channel. The River Griffeen at this location is remote from the coast and is above the 60 metre OS contour. Tidal effects do not have to be considered for this site.

3.1.4 Groundwater flooding

Groundwater flooding occurs when the water table rises to the level of the ground surface due to rainfall and flows out over the surface. This is normally associated with karst bedrock. Groundwater flooding occurs relatively slowly and poses a low hazard to people. The Geological Survey of Ireland (GSI) maps identify the bedrock as *'Dinantian Impure Upper Limestones'* with *'Limestone Till'* subsoils. However, there is no evidence of turloughs or other karst features in the area. The risk of groundwater flooding is considered negligible.

3.1.5 Flooding from the site drainage system

As with any new development, flooding from the site drainage system could occur due to inadequate design of the new storm water drainage network. Flooding downstream of a development could occur due to increased concentration times and discharge from impermeable areas. Design of the site drainage system is outside of the scope of this flood risk assessment; however, it is recommended that the design of the drainage system for the development incorporates appropriate Sustainable Urban Drainage Systems (SUDS).

3.1.6 Summary of flood risks

The potential for flooding of the site directly from the River Griffeen or indirectly due to overland flow as identified above are the primary sources of flood risk to the site. A detailed Stage 3 Flood Risk Assessment will therefore be required to establish the extent of the risk and to determine the appropriate minimum floor level for the proposed development.

3.2 Appraisal of availability and adequacy of existing Information

Table 3.1 below includes a summary list of existing information and the availability and adequacy of the data.

Information	Availability	Adequacy/Comments
Topographical survey of proposed development site	Yes	Information is suitable for use in the assessment but needs to be extended to include river data.
Eastern CFRAMS Hydrology Report	Yes	Published in 2016, this is a comprehensive and up to date hydrological assessment of the catchment. This will form key inputs to any hydraulic modelling.
Eastern CFRAMS Flood Maps	Partial	Flood extent and depth maps are available for the current climate scenario. They are not currently available for future scenarios.
Eastern CFRAMS river cross section data	No	OPW does not normally supply this information for private developments.
River and bridge topography/survey data - Clifton Scannell Emerson Associates Consulting Engineers	Yes	Clifton Scannell Emerson Associates Consulting Engineers provided design details for the river channel and culverts. Additional surveying was carried out on the channel as-constructed and the culvert soffit levels were confirmed.

Table 1 – Availability and adequacy of existing information

As indicated on the table above, substantial information exists in relation to the Griffeen River which can be used in a Stage 3 flood risk assessment. Clifton Scannell Emerson Associates Consulting Engineers (CSEA) provided design drawings of the river channel and culverts. Additional surveying was carried out to determine the as-constructed channel profile and cross-sections. The culvert details provided by CSEA were sufficient and did not require further surveying; however, the survey included confirmation of the upstream and downstream soffit levels.

Based on the information available and an assessment of the existing site and proposed development, it has been determined that a hydraulic model of the river and development site needs to be created in the Stage 3 flood risk assessment to provide a full appraisal of the existing flood risk and the potential impact of the development.

3.3 Flood zone mapping

As outlined in the Stage 1 assessment, the Eastern CFRAM Study includes flood extent and depth maps for the current scenario. The maps indicate that a portion of the site is in Flood Zone B. It would therefore have a moderate probability of flooding in the current scenario. The Stage 3 FRA will confirm the existing flood zones.

3.4 Requirements for a Stage 3 FRA

A Stage 3 detailed flood risk assessment has been carried out to provide a quantitative appraisal of the potential flood risk to the site and to examine the potential impact of the development on flood risk elsewhere. The assessment focuses on the risk of flooding from the River Griffeen River since this is the only source that has been identified as a potential risk to the site. The other possible sources of flooding are of low or zero risk.

The detailed flood risk assessment required the construction of a hydraulic model of the River Griffeen and flood plains. The hydrological assessment carried out in the Eastern CFRAMS was used for design flows together with supplementary independent assessments. Any relevant mitigation measures will be reviewed and residual risks will be assessed.

The Stage 3 FRA is used to establish the flood levels at the site and to assess the options available to mitigate flood risk. Recommendations are also made on the minimum finished floor levels for the proposed buildings.

4 Detailed Flood Risk Assessment (Stage 3)

4.1 Flow calculations

Flow calculations were carried out based on storm hydrographs for two design storm events. These are:

- the 1% AEP storm event including a 20% increase for the Mid-Range Future Scenario (MRFS) climate change effects. The peak flow in the hydrograph is 18.98 m^3/second;
- the 0.5% AEP storm event excluding climate change effects. The peak flow in the hydrograph is 18.36 m^3/second.

The most onerous of the results of these analyses was used to determine flood risk and recommended finished floor levels for the proposed development.

Climate change effects for the High Range Future Scenario (HRFS) are represented by a 30% increase in flow rate; however, the HRFS increase is not considered in this analysis.

Flow calculations were also carried out for the 1% and 0.1% AEP current climate scenario storm events to determine the flood zoning for the site as defined in the Flood Risk Management Guidelines. The peak flow rates for these were 15.82 m^3/second and 25.96 m^3/ second respectively.

4.2 Hydraulic model

The hydraulic analysis was carried out using HEC-RAS combined 1D and 2D modelling. The 1D model is used for the river channel to determine the water surface profile and the 2D model is used for flood plain storage or overland flow areas, which in this case in the Takeda site. When the water level in the river channel exceeds the river bank level, the overflow is automatically input to the 2D model. The 2D model calculates the distribution and depth of overflow based on the profile of the terrain. The design flow is represented by a hydrograph where the flow increases gradually to a peak value and decreases as the storm event recedes. The storage volume in the river channel and flood plain reduces the peak flow rate in the river. This differs significantly from a steady flow calculation which represents an equilibrium state and does not take the effects of storage or overflow into account.

In January 2017, iO Geometrics Limited carried out a survey of the channel and overbank areas of the River Griffeen over a length of 1,344m. The survey extent was from the Grand Canal to a point 250 metres upstream of the southern boundary of the proposed development. A total of 28 sections were surveyed. These were used to create the geometry model in HEC-RAS. Additional cross sections were interpolated by the software to give a total of 95 cross sections for use in the analysis. The interpolated sections are used to avoid changes in velocity head that would be too large to accurately determine the energy gradient. The cross sections are numbered from downstream to upstream with the section names corresponding to the distance from the upstream boundary. The sections are plotted in HEC-RAS from left to right facing downstream.

Four existing culverts were included in the model. The culverts are numbered 1 to 4 starting with Culvert 1 at the downstream end opposite the entrance to the existing Takeda Ireland facility. Culvert 2 and Culvert 3 are at the roundabouts to the north and south of the proposed Takeda site respectively, and Culvert 4 is at the entrance to the Microsoft site. The culvert locations are shown in Figure 6 below.

The geometry of these was based on design information provided by CSEA Consulting Engineers. The upstream and downstream soffit levels were confirmed as part of the iO Geometrics survey.

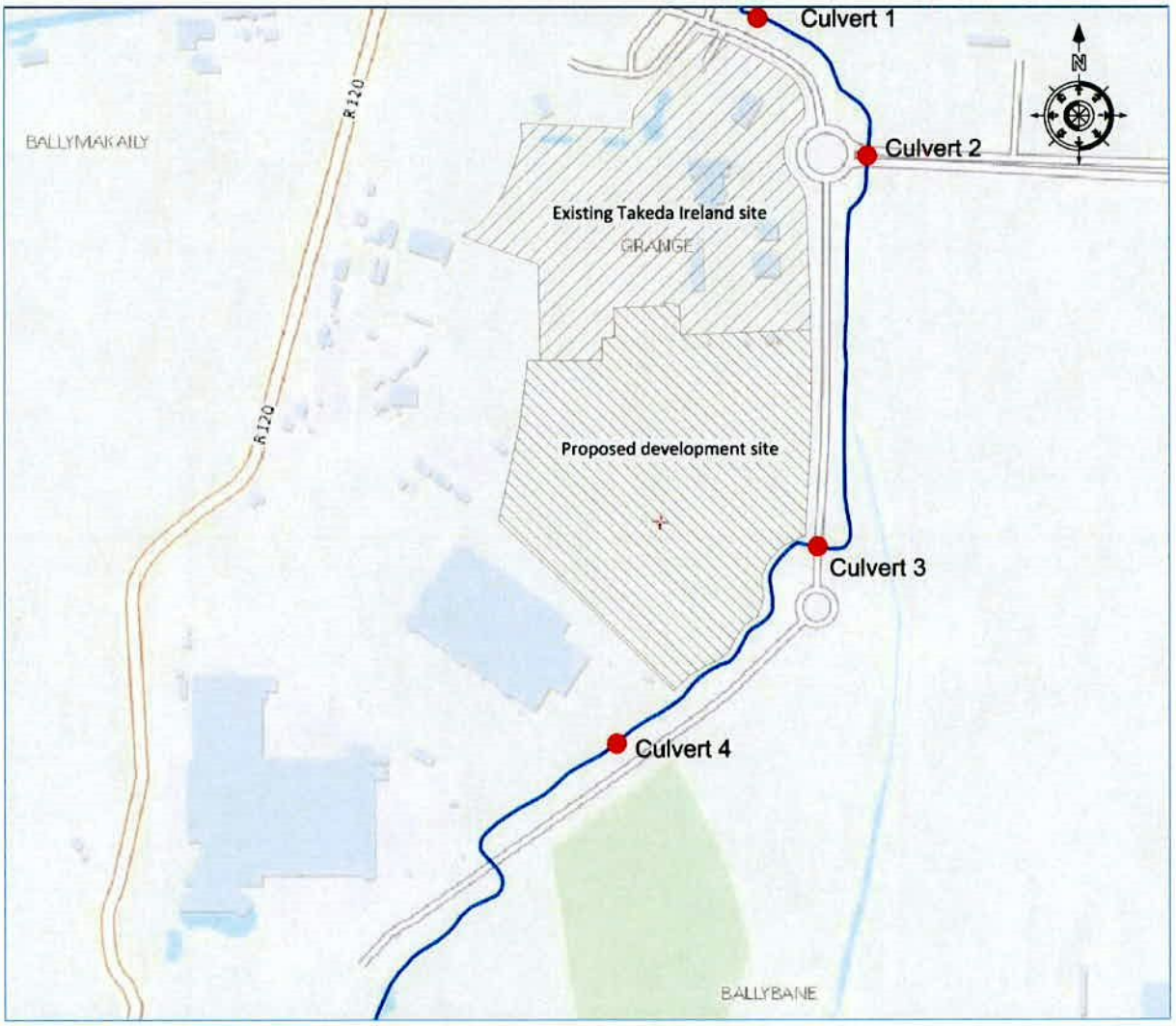


Figure 6 – Existing culvert locations

4.3 Results of analysis

4.3.1 Flood zones

The Flood Risk Management Guidelines document defines three flood zone types as follows:

Flood Zone A – where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding);

Flood Zone B - where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1,000 and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding); and

Flood Zone C - where the probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1,000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

The flood zones are defined without taking the effects of future climate change into account.

The analysis shows that the site is not subject to flooding for the current 1% AEP flood event (Figure 7) but is inundated for the current 0.1% AEP event (Figure 8). The site is therefore in Flood Zone B.

Figure 7 – Flood depth on existing site for 1% AEP current scenario flood event

Figure 8 – Flood depth on existing site for 0.1% AEP flood event

4.3.2 Justification test

Table 3.1 of the Flood Risk Management Guidelines defines three vulnerability classes and indicates the land uses and types of development that are generally included in each. Table 3.2 of the guidelines, which is reproduced here as Table 2, indicates the vulnerability classes that are appropriate to each flood zone. Developments that are not listed as being appropriate require a Justification Test. At planning application stage the appropriate test is the Development Management Justification Test which is described in Chapter 5 of the guidelines.

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Table 2 – Matrix of vulnerability versus flood zone

Commercial and industrial buildings be considered as less vulnerable development and therefore appropriate to Flood Zones B and C. The application site is in Flood Zone B and is therefore considered to be appropriate. A Justification Test is not required in this case.

4.3.3 Flood levels

The analysis confirms that the riverbank overtops the left bank (north side) of the river at the southern boundary of the site for both the 1% MRFS (Figure 9) and 0.5% current (Figure 10) flood hydrographs. This is due to the relatively shallow depth of the river channel at this location and the head loss that occurs at Culvert 3 which is on the north side of the roundabout adjacent to the site. The overflow runs overland through the proposed site, through the existing Takeda Ireland site and returns to the river channel immediately downstream of Culvert 1.

The maximum water surface level within the proposed building footprint is 64.11 mOD for the 1% AEP MRFS flood event and 64.15 mOD for the 0.5% AEP current flood event.

Figure 9 – Flood depth on existing site for 1% AEP MRFS flood event

Figure 10 – Flood depth on existing undeveloped site for 0.5% AEP flood event

4.4 Mitigation measures

The existing river channel immediately upstream of Culvert 3 is much shallower than it is elsewhere and for the design flow the water surface level is close to or above riverbank level. Culvert 3 is set down into the channel and the water surface level (WSL) reaches the soffit level at a relatively low flow of 6 m^3/sec. Elsewhere the channel is deep and the bridge soffits at Culvert 2 and 3 are above WSL (the channel at Culvert 1 is also deep but the bridge soffit is low and is below the design WSL).

At the design flow, Culvert 3 is submerged and the WSL difference between upstream and downstream is 0.44 metres. When the WSL reaches the soffit, the culvert capacity decreases because of the reduced hydraulic radius (increased friction loss). However, the level difference across the culvert causes a surcharge that increases the flow rate and this compensates to some extent for the increased friction loss. Nonetheless the WSL at the design flow rate is high enough to overtop the riverbank and flow into the Takeda site.

Three possible solutions have been identified to protect the proposed Takeda development from flooding:

- Retain the existing flow regime and set the finished floor level of the new building above the flood level. This does not protect the existing Takeda Ireland site which would still be subject to flooding due to overland flow when the riverbank is overtopped.
- Replace Culvert 3 to reduce the flood level upstream
- Channelize the flow upstream of Culvert 3

4.4.1 Retain existing flow regime

The proposed development will be in the path of the overland flow for the design flood events. The water surface level within the footprint of the proposed development would be up to 64.15 mOD with depths of up to 0.50 metres. Finished floor levels are normally set 0.50 metres above the 1% AEP MRFS flood level. This is a typical minimum requirement and is in line with the recommendations of the Greater Dublin Strategic Drainage Scheme. However, it is understood that the insurers require the floor levels to be set 0.60 metres above the 0.5% (1 in 200-year) AEP flood level excluding a climate change factor.

The 0.5% AEP current flood event results in the highest recommended finished floor level of 64.75 OD (64.15 mOD water surface level plus a freeboard of 0.60 metres.) The requirement for the 1% AEP flood event is slightly lower at 64.61 mOD (64.11 mOD water surface level plus 0.50 metre freeboard.)

The required finished floor level would therefore be 64.75 mOD.

With the new development in place the overland flow path will change locally but will still continue north to return to the river immediately downstream of Culvert 1. In order to ensure that the flow path through the site is not impeded by the presence of the new development it is recommended that a clear flow path is maintained through the site to the west of the proposed new building. However, this is likely to restrict the development of the remainder of the site to the west of the proposed new development. Also, it is not clear at this stage how this would be implemented within the existing Takeda Ireland site.

Figure 11 – Flood depth on existing Takeda site for 1% AEP MRFS event with new development

If the existing flow regime is retained with the new building in place, the existing Takeda Ireland development will still be at risk of flooding due to overland flow if the riverbank is overtopped upstream of Culvert 3. The removal of the landscape embankment will exacerbate the vulnerability of this area. Figure 11 – Flood depth on existing Takeda site for 1% AEP MRFS event with new developmentFigure 11 shows the flood depth and extent for the 0.5% AEP flood event. The flood level at the buildings coincides with the finished floor level of 63.60 mOD.

The water surface profile in the river and the profile summary table from the HEC-RAS model for the maximum water level in the 1% MRFS unsteady flow (2D) analysis are shown in Appendix A.

4.4.2 Replace Culvert 3

Replacing Culvert 3 to give a soffit level 1 metre higher than the existing soffit would increase the flow area and prevent the culvert from flowing full. This is not feasible because the total depth from the existing soffit to road surface is only about 1.2 metres.

Alternatively, a 9.2 metres wide replacement culvert (3 metres wider than the existing) would reduce the WSL upstream below riverbank level but it would still operate under drowned conditions. However, the WSL upstream would still be close to overtopping and we would not consider this to be a robust solution.

The water surface profile in the river and the profile summary table for the widened Culvert 3 from the HEC-RAS model for the 1% MRFS steady flow (1D) analysis are shown in Appendix B. The steady flow is the peak flow value from the unsteady flow hydrograph.

4.4.3 Channelization of the flow

The flow could be contained within the river channel at the Takeda southern boundary by raising the riverbank on both sides up to 65.50 mOD at the culvert, with the level increasing slightly in the upstream direction. The bridge parapet would also have to be raised to this level. This would channelize the flow and prevent overtopping at the design flow. The increased bank level would extend upstream for 200 metres which coincides with the Takeda southern boundary.

The water surface profile in the river and the profile summary table from the HEC-RAS model for the 1% AEP MRFS and 0.1% AEP steady flow (1D) analysis are shown in Appendix C. The steady flow in each case is the peak flow value from the unsteady flow hydrograph.

4.5 Potential impacts of flooding elsewhere

If Culvert 3 is replaced or the river is channelized as described above, all of the flow will be retained within the river channel. If remedial measures to the river channel are not implemented, the overflow from the river will flow through the site and return to the river immediately downstream of Culvert 1. This is the case with or without the new development in place. In both situations the peak flow at Culvert 1 will be the same. Consequently, there would be no increase in flood risk to property downstream regardless of which solution is adopted.

With the river channelized, the 1% MRFS water surface level would increase by 40 mm immediately upstream of Culvert 4 but would still be below the soffit level. In the extreme case of the 0.1% flood event the flow would still be contained within the channel up to the upstream boundary of the modelled reach, at which point it is not influenced by the channelization. The channelization of the river would therefore not increase flood risk to property upstream, either within or beyond the extent of the hydraulic model.

5 Summary and conclusions

The analysis confirms that proposed development is in Flood Zone B which is appropriate for this type of development. However, the site is at risk of flooding for the 1% MRFS and the 0.5% current flood scenarios and remedial measures must be implemented to mitigate this risk.

Three options have been identified to mitigate the flood risk which require further consideration and discussion with South Dublin County Council.

The recommended finished floor level for the new Takeda building is **64.75 mOD** which complies with the recommendations of the Greater Dublin Strategic Drainage Scheme and the developer's insurers. If the site is not protected by replacing Culvert 3 or channelizing the flow adjacent to the southern boundary of the site, it is recommended that a clear flow path is maintained through the site for the overflow from the river during an extreme flood event.

The solutions identified for flood mitigation would not increase flood risk to property upstream or downstream of the site.

6 References

The Planning System and Flood Risk Management – Guidelines for Planning Authorities, Office of Public Works and the Department of Environment, Heritage and Local Government, November 2009.

OPW *Planning and Development Flood Policy*, published on www.flooding.ie

OPW *Flood Hazard Mapping*, www.floodmaps.ie

National Preliminary Flood Risk Assessment (NFRA) Report, Office of Public Works, August 2011.

Eastern CFRAM Study, Office of Public Works and RPS

Ireland and the IPCC 4th Assessment Report, Irish Committee on Climate Change, 2007.

Flood Studies Report, Volumes I-V, Natural Environmental Research Council (NERC), 1975.

Appendix A
- 2D model results for 1% AEP MRFS (existing flow regime)

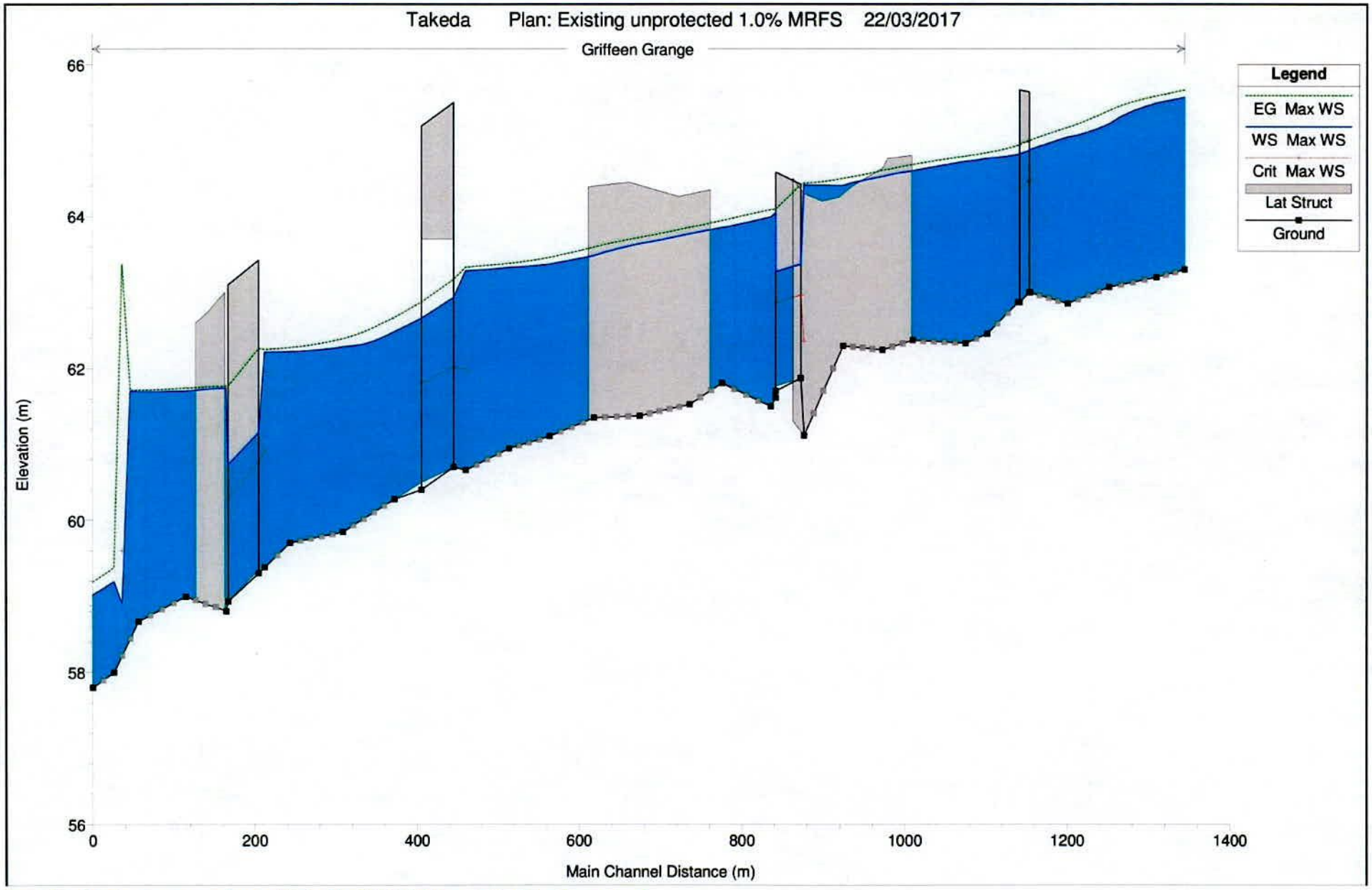


Figure 12 – Maximum water surface profile for the 1% MRFS 2D model (existing flow regime)

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
18.98	63.30	65.57		65.67	0.002450	1.39
18.98	63.27	65.54		65.64	0.002383	1.38
18.98	63.23	65.51		65.61	0.002335	1.37
18.98	63.20	65.49		65.58	0.002314	1.36
18.98	63.17	65.44		65.55	0.002627	1.45
18.98	63.14	65.39		65.51	0.003099	1.55
18.98	63.10	65.31		65.46	0.003831	1.68
18.98	63.07	65.22		65.39	0.005140	1.87
18.98	63.02	65.16		65.33	0.004902	1.84
18.98	62.96	65.11		65.27	0.004510	1.79
18.98	62.91	65.07		65.22	0.003996	1.70
18.98	62.85	65.04		65.17	0.003388	1.60
18.98	62.89	65.00		65.13	0.003450	1.58
18.98	62.93	64.96		65.09	0.003604	1.58
18.98	62.96	64.92		65.05	0.003824	1.58
18.98	63.00	64.88	64.47	65.00	0.004008	1.56
Bridge						
18.98	62.87	64.81		64.93	0.003415	1.53
18.98	62.73	64.79		64.89	0.002814	1.42
18.98	62.59	64.77		64.86	0.002201	1.30
18.98	62.46	64.76		64.84	0.001702	1.19
18.98	62.39	64.74		64.81	0.001699	1.20
18.98	62.33	64.72		64.79	0.001499	1.17
18.98	62.34	64.70		64.77	0.001578	1.20
18.98	62.35	64.68		64.75	0.001693	1.22
18.98	62.36	64.65		64.73	0.001814	1.24
18.98	62.36	64.62		64.70	0.001915	1.26
18.98	62.37	64.60		64.68	0.001983	1.26
Lat Struct						
18.98	62.33	64.58		64.65	0.001937	1.22
18.98	62.28	64.55		64.63	0.002095	1.21
18.98	62.24	64.52		64.60	0.002232	1.25
18.98	62.26	64.5		64.57	0.002442	1.21
18.97	62.27	64.47		64.55	0.002155	1.20
18.93	62.28	64.44		64.52	0.002057	1.25
18.84	62.30	64.40		64.50	0.002261	1.37
18.95	62.00	64.40		64.48	0.001638	1.18
19.09	61.70	64.41		64.46	0.001137	1.01
18.96	61.41	64.41		64.44	0.000753	0.85
18.21	61.11	64.41	62.36	64.44	0.000453	0.69
Bridge						
18.21	61.61	64.04		64.09	0.001046	0.99
18.2	61.50	63.99		64.09	0.002148	1.39
18.2	61.58	63.95		64.05	0.002349	1.41

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
18.2	61.65	63.92		64.02	0.002493	1.40
18.2	61.73	63.88		63.98	0.002538	1.38
18.2	61.81	63.85		63.94	0.002469	1.33
18.2	61.71	63.82		63.91	0.002267	1.30
Lat Struct						
18.2	61.62	63.80		63.88	0.002160	1.27
18.2	61.53	63.77		63.85	0.002145	1.26
18.2	61.50	63.74		63.83	0.002215	1.27
18.2	61.47	63.72		63.80	0.002218	1.28
18.2	61.44	63.69		63.77	0.002195	1.29
18.2	61.41	63.66		63.75	0.002059	1.28
18.2	61.38	63.64		63.72	0.001946	1.26
18.2	61.37	63.61		63.69	0.002035	1.30
18.2	61.36	63.57		63.66	0.002218	1.35
18.2	61.36	63.53		63.63	0.002430	1.40
18.2	61.35	63.48		63.60	0.002771	1.48
18.2	61.29	63.45		63.56	0.002596	1.44
18.2	61.23	63.43		63.53	0.002476	1.40
18.2	61.17	63.40		63.49	0.002393	1.36
18.2	61.11	63.37		63.46	0.002341	1.33
18.2	61.07	63.36		63.43	0.001853	1.24
18.2	61.02	63.34		63.41	0.001493	1.17
18.2	60.98	63.33		63.40	0.001225	1.10
18.2	60.94	63.33		63.38	0.001028	1.04
18.2	60.87	63.31		63.37	0.001020	1.05
18.2	60.80	63.30		63.36	0.000977	1.04
18.2	60.73	63.29		63.34	0.000899	1.02
18.2	60.66	63.28	61.99	63.33	0.000794	0.99
Bridge						
18.19	60.28	62.48		62.67	0.004958	1.92
18.19	60.19	62.41		62.61	0.005238	1.94
18.19	60.11	62.36		62.54	0.005118	1.89
18.19	60.02	62.32		62.48	0.004467	1.78
18.19	59.93	62.30		62.43	0.003539	1.63
18.19	59.85	62.28		62.39	0.002661	1.45
18.19	59.82	62.26		62.36	0.002286	1.38
18.19	59.79	62.25		62.33	0.001929	1.29
18.19	59.76	62.23		62.31	0.001599	1.21
18.19	59.73	62.22		62.29	0.001312	1.13
18.19	59.7	62.22		62.27	0.001071	1.05
18.19	59.54	62.21		62.26	0.000775	0.93
18.19	59.38	62.21	60.92	62.25	0.000570	0.83
Bridge						
18.19	58.8	61.74		61.77	0.000303	0.68

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
Lat Struct						
18.28	58.85	61.74		61.76	0.000348	0.70
18.6	58.90	61.73		61.76	0.000444	0.76
18.97	58.94	61.71		61.75	0.000616	0.83
18.97	58.99	61.70		61.74	0.000663	0.88
18.97	58.91	61.70		61.73	0.000557	0.83
18.97	58.83	61.69		61.72	0.000460	0.77
18.97	58.75	61.69		61.72	0.000378	0.72
18.97	58.67	61.69		61.71	0.000313	0.66
18.97	58.44	61.70		61.71	0.000125	0.51
18.97	58.22	58.89	59.6	63.37	0.407305	9.37
18.97	58.00	59.19		59.38	0.007669	2.03
18.97	57.90	59.10		59.28	0.007414	2.00
18.97	57.80	59.02	58.88	59.19	0.006881	1.94

Table 3 - Maximum water surface profile for the 1% MRFS 2D model (existing flow regime)

Appendix B
- 1D model results for 1% AEP MRFS (Culvert 3 widened)

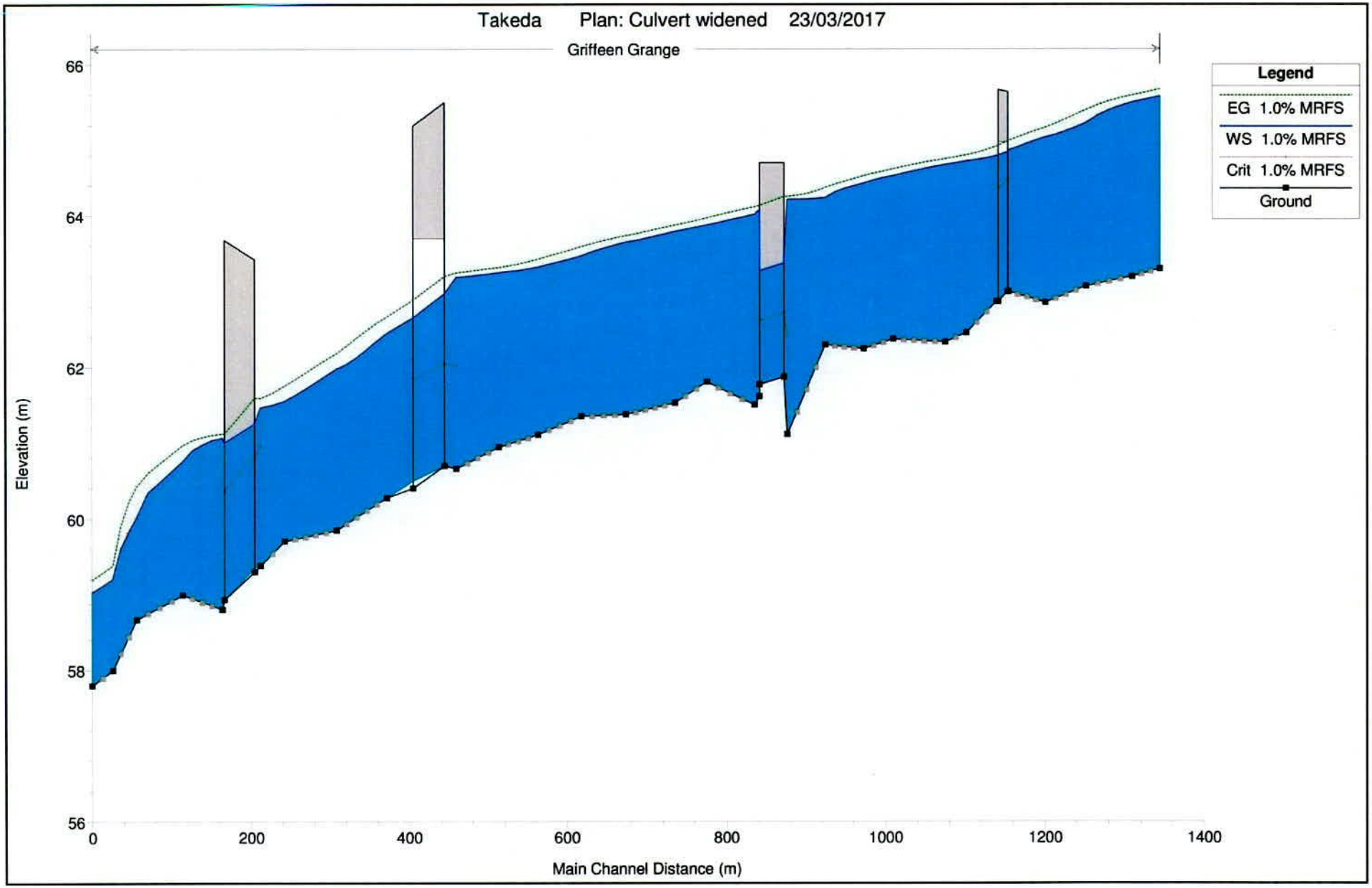


Figure 13 – Water surface profile for the 1% MRFS 1D model (Culvert 3 widened)

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
18.98	63.27	65.55		65.65	0.002316	1.37
18.98	63.23	65.53		65.62	0.002270	1.36
18.98	63.2	65.50		65.59	0.002251	1.35
18.98	63.17	65.45		65.56	0.002552	1.43
18.98	63.14	65.40		65.52	0.003005	1.53
18.98	63.10	65.33		65.47	0.003709	1.66
18.98	63.07	65.23		65.40	0.004984	1.85
18.98	63.02	65.17		65.34	0.004757	1.82
18.98	62.96	65.12		65.28	0.004415	1.77
18.98	62.91	65.07		65.22	0.003960	1.70
18.98	62.85	65.04		65.17	0.003416	1.6
18.98	62.89	65.00		65.13	0.003497	1.59
18.98	62.93	64.96		65.08	0.003675	1.59
18.98	62.96	64.91		65.04	0.003937	1.6
18.98	63.00	64.86	64.47	64.99	0.004169	1.59
Bridge						
18.98	62.87	64.79		64.92	0.003615	1.57
18.98	62.73	64.76		64.87	0.003045	1.46
18.98	62.59	64.74		64.83	0.002425	1.35
18.98	62.46	64.72		64.80	0.001891	1.24
18.98	62.39	64.70		64.78	0.001887	1.25
18.98	62.33	64.68		64.75	0.001673	1.22
18.98	62.34	64.65		64.73	0.001778	1.25
18.98	62.35	64.62		64.70	0.001899	1.28
18.98	62.36	64.59		64.68	0.002065	1.31
18.98	62.36	64.56		64.65	0.002234	1.33
18.98	62.37	64.53		64.62	0.002387	1.36
18.98	62.33	64.50		64.59	0.002357	1.32
18.98	62.28	64.47		64.56	0.002534	1.33
18.98	62.24	64.43		64.53	0.002689	1.37
18.98	62.26	64.40		64.49	0.003129	1.37
18.98	62.27	64.36		64.45	0.002995	1.37
18.98	62.28	64.31		64.42	0.002987	1.43
18.98	62.30	64.24		64.37	0.003679	1.64
18.98	62.00	64.23		64.33	0.002630	1.40
18.98	61.70	64.22		64.29	0.001799	1.19
18.98	61.41	64.22		64.27	0.001182	1.00
18.98	61.11	64.22	62.4	64.25	0.000743	0.84
Bridge						
18.98	61.61	64.08		64.13	0.001063	1.00
18.98	61.50	64.02		64.12	0.002169	1.42
18.98	61.58	63.98		64.09	0.002360	1.43
18.98	61.65	63.94		64.05	0.002498	1.43
18.98	61.73	63.91		64.01	0.002546	1.40

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
18.98	61.81	63.88		63.97	0.002494	1.36
18.98	61.71	63.85		63.94	0.002306	1.33
18.98	61.62	63.82		63.91	0.002211	1.30
18.98	61.53	63.79		63.88	0.002207	1.29
18.98	61.50	63.76		63.85	0.002304	1.31
18.98	61.47	63.73		63.82	0.002323	1.32
18.98	61.44	63.70		63.79	0.002313	1.33
18.98	61.41	63.67		63.76	0.002189	1.32
18.98	61.38	63.65		63.74	0.002078	1.30
18.98	61.37	63.61		63.71	0.002195	1.35
18.98	61.36	63.57		63.67	0.002415	1.40
18.98	61.36	63.53		63.64	0.002687	1.47
18.98	61.35	63.47		63.59	0.003134	1.57
18.98	61.29	63.43		63.55	0.003001	1.53
18.98	61.23	63.39		63.51	0.002926	1.50
18.98	61.17	63.36		63.47	0.002900	1.48
18.98	61.11	63.32		63.43	0.002916	1.45
18.98	61.07	63.30		63.39	0.002340	1.37
18.98	61.02	63.28		63.36	0.001901	1.29
18.98	60.98	63.26		63.34	0.001567	1.22
18.98	60.94	63.25		63.32	0.001317	1.15
18.98	60.87	63.23		63.30	0.001314	1.16
18.98	60.80	63.21		63.28	0.001259	1.16
18.98	60.73	63.20		63.26	0.001154	1.13
18.98	60.66	63.19	62.02	63.25	0.001010	1.09
Bridge						
18.98	60.28	62.44		62.66	0.005889	2.07
18.98	60.19	62.34		62.58	0.006844	2.17
18.98	60.11	62.23		62.49	0.007827	2.25
18.98	60.02	62.13		62.39	0.008203	2.26
18.98	59.93	62.04		62.28	0.007675	2.18
18.98	59.85	61.97		62.18	0.006315	2.02
18.98	59.82	61.89		62.10	0.006505	2.04
18.98	59.79	61.80		62.01	0.006633	2.06
18.98	59.76	61.71		61.93	0.006638	2.06
18.98	59.73	61.63		61.84	0.006506	2.04
18.98	59.70	61.55		61.75	0.006172	1.99
18.98	59.54	61.50		61.66	0.004486	1.78
18.98	59.38	61.47	60.96	61.59	0.003175	1.57
Bridge						
18.98	58.80	61.07		61.12	0.001041	1.04
18.98	58.85	61.03		61.10	0.001565	1.17
18.98	58.90	60.98		61.08	0.002457	1.39
18.98	58.94	60.90		61.04	0.003699	1.62

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
18.98	58.99	60.75		60.97	0.007494	2.04
18.98	58.91	60.62		60.85	0.007998	2.12
18.98	58.83	60.48		60.73	0.008612	2.21
18.98	58.75	60.34		60.60	0.008546	2.26
18.98	58.67	60.01	60.01	60.42	0.015312	2.84
18.98	58.44	59.82	59.82	60.22	0.014940	2.78
18.98	58.22	59.60	59.60	59.90	0.011133	2.44
18.98	58.00	59.20		59.38	0.007381	2.00
18.98	57.90	59.11		59.28	0.007094	1.97
18.98	57.80	59.03	58.88	59.19	0.006663	1.92

Table 4 - Maximum water surface profile for the 1% MRFS 1D model (Culvert 3 widened)

Appendix C

- 1D model results for 1% AEP MRFS and 0.1% AEP (river channelized)

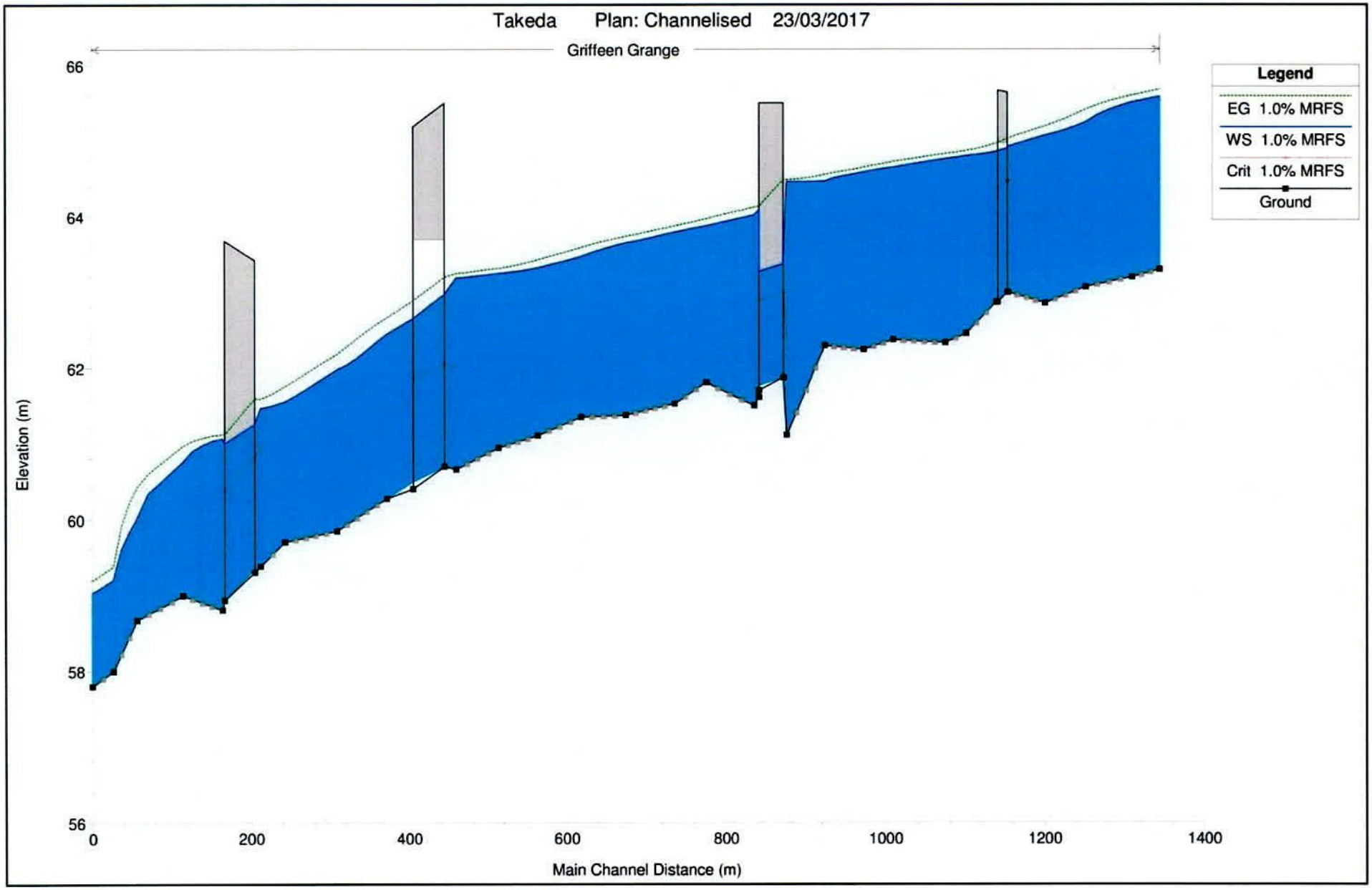


Figure 14 – Water surface profile for the 1% MRFS 1D model (river channelized)

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
18.98	63.27	65.56		65.65	0.002283	1.36
18.98	63.23	65.53		65.63	0.002234	1.35
18.98	63.20	65.51		65.60	0.002212	1.34
18.98	63.17	65.46		65.56	0.002501	1.42
18.98	63.14	65.41		65.52	0.002933	1.52
18.98	63.10	65.34		65.48	0.003596	1.64
18.98	63.07	65.24		65.41	0.004763	1.82
18.98	63.02	65.19		65.35	0.004501	1.79
18.98	62.96	65.14		65.29	0.004136	1.73
18.98	62.91	65.10		65.24	0.003681	1.65
18.98	62.85	65.07		65.19	0.003150	1.56
18.98	62.89	65.03		65.15	0.003165	1.54
18.98	62.93	65.00		65.12	0.003257	1.52
18.98	62.96	64.96		65.08	0.003402	1.51
18.98	63.00	64.92	64.47	65.04	0.003497	1.48
Bridge						
18.98	62.87	64.86		64.97	0.003027	1.47
18.98	62.73	64.83		64.93	0.002508	1.36
18.98	62.59	64.81		64.89	0.001985	1.26
18.98	62.46	64.80		64.87	0.001557	1.16
18.98	62.39	64.78		64.85	0.001557	1.16
18.98	62.33	64.76		64.83	0.001376	1.14
18.98	62.34	64.74		64.81	0.001446	1.16
18.98	62.35	64.72		64.79	0.001552	1.18
18.98	62.36	64.70		64.77	0.001646	1.19
18.98	62.36	64.67		64.75	0.001717	1.20
18.98	62.37	64.65		64.72	0.001841	1.22
18.98	62.33	64.63		64.70	0.001716	1.16
18.98	62.28	64.61		64.68	0.001851	1.15
18.98	62.24	64.58		64.65	0.002224	1.17
18.98	62.26	64.56		64.62	0.002097	1.13
18.98	62.27	64.54		64.60	0.001792	1.12
18.98	62.28	64.51		64.58	0.001722	1.18
18.98	62.30	64.46		64.55	0.001954	1.32
18.98	62.00	64.46		64.53	0.001418	1.13
18.98	61.70	64.46		64.51	0.000993	0.96
18.98	61.41	64.46		64.49	0.000682	0.82
18.98	61.11	64.46	62.4	64.49	0.000459	0.70
Bridge						
18.98	61.61	64.08		64.13	0.001061	1.00
18.98	61.50	64.02		64.12	0.002185	1.42
18.98	61.58	63.98		64.09	0.002374	1.44
18.98	61.65	63.94		64.05	0.002507	1.43
18.98	61.73	63.91		64.01	0.002551	1.40

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
18.98	61.81	63.88		63.97	0.002494	1.36
18.98	61.71	63.85		63.94	0.002306	1.33
18.98	61.62	63.82		63.91	0.002211	1.30
18.98	61.53	63.79		63.88	0.002207	1.29
18.98	61.50	63.76		63.85	0.002304	1.31
18.98	61.47	63.73		63.82	0.002323	1.32
18.98	61.44	63.70		63.79	0.002313	1.33
18.98	61.41	63.67		63.76	0.002189	1.32
18.98	61.38	63.65		63.74	0.002078	1.30
18.98	61.37	63.61		63.71	0.002195	1.35
18.98	61.36	63.57		63.67	0.002415	1.40
18.98	61.36	63.53		63.64	0.002687	1.47
18.98	61.35	63.47		63.59	0.003134	1.57
18.98	61.29	63.43		63.55	0.003001	1.53
18.98	61.23	63.39		63.51	0.002926	1.50
18.98	61.17	63.36		63.47	0.002900	1.48
18.98	61.11	63.32		63.43	0.002916	1.45
18.98	61.07	63.30		63.39	0.002340	1.37
18.98	61.02	63.28		63.36	0.001901	1.29
18.98	60.98	63.26		63.34	0.001567	1.22
18.98	60.94	63.25		63.32	0.001317	1.15
18.98	60.87	63.23		63.30	0.001314	1.16
18.98	60.80	63.21		63.28	0.001259	1.16
18.98	60.73	63.20		63.26	0.001154	1.13
18.98	60.66	63.19	62.02	63.25	0.001010	1.09
Bridge						
18.98	60.28	62.44		62.66	0.005889	2.07
18.98	60.19	62.34		62.58	0.006844	2.17
18.98	60.11	62.23		62.49	0.007827	2.25
18.98	60.02	62.13		62.39	0.008203	2.26
18.98	59.93	62.04		62.28	0.007675	2.18
18.98	59.85	61.97		62.18	0.006315	2.02
18.98	59.82	61.89		62.10	0.006505	2.04
18.98	59.79	61.80		62.01	0.006633	2.06
18.98	59.76	61.71		61.93	0.006638	2.06
18.98	59.73	61.63		61.84	0.006506	2.04
18.98	59.70	61.55		61.75	0.006172	1.99
18.98	59.54	61.5		61.66	0.004486	1.78
18.98	59.38	61.47	60.96	61.59	0.003175	1.57
Bridge						
18.98	58.80	61.07		61.12	0.001041	1.04
18.98	58.85	61.03		61.10	0.001565	1.17
18.98	58.90	60.98		61.08	0.002457	1.39
18.98	58.94	60.90		61.04	0.003699	1.62

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
18.98	58.99	60.75		60.97	0.007494	2.04
18.98	58.91	60.62		60.85	0.007998	2.12
18.98	58.83	60.48		60.73	0.008612	2.21
18.98	58.75	60.34		60.60	0.008546	2.26
18.98	58.67	60.01	60.01	60.42	0.015312	2.84
18.98	58.44	59.82	59.82	60.22	0.01494	2.78
18.98	58.22	59.60	59.60	59.90	0.011133	2.44
18.98	58.00	59.20		59.38	0.007381	2.00
18.98	57.90	59.11		59.28	0.007094	1.97
18.98	57.80	59.03	58.88	59.19	0.006663	1.92

Table 5 - Maximum water surface profile for the 1% MRFS 1D model (river channelized)

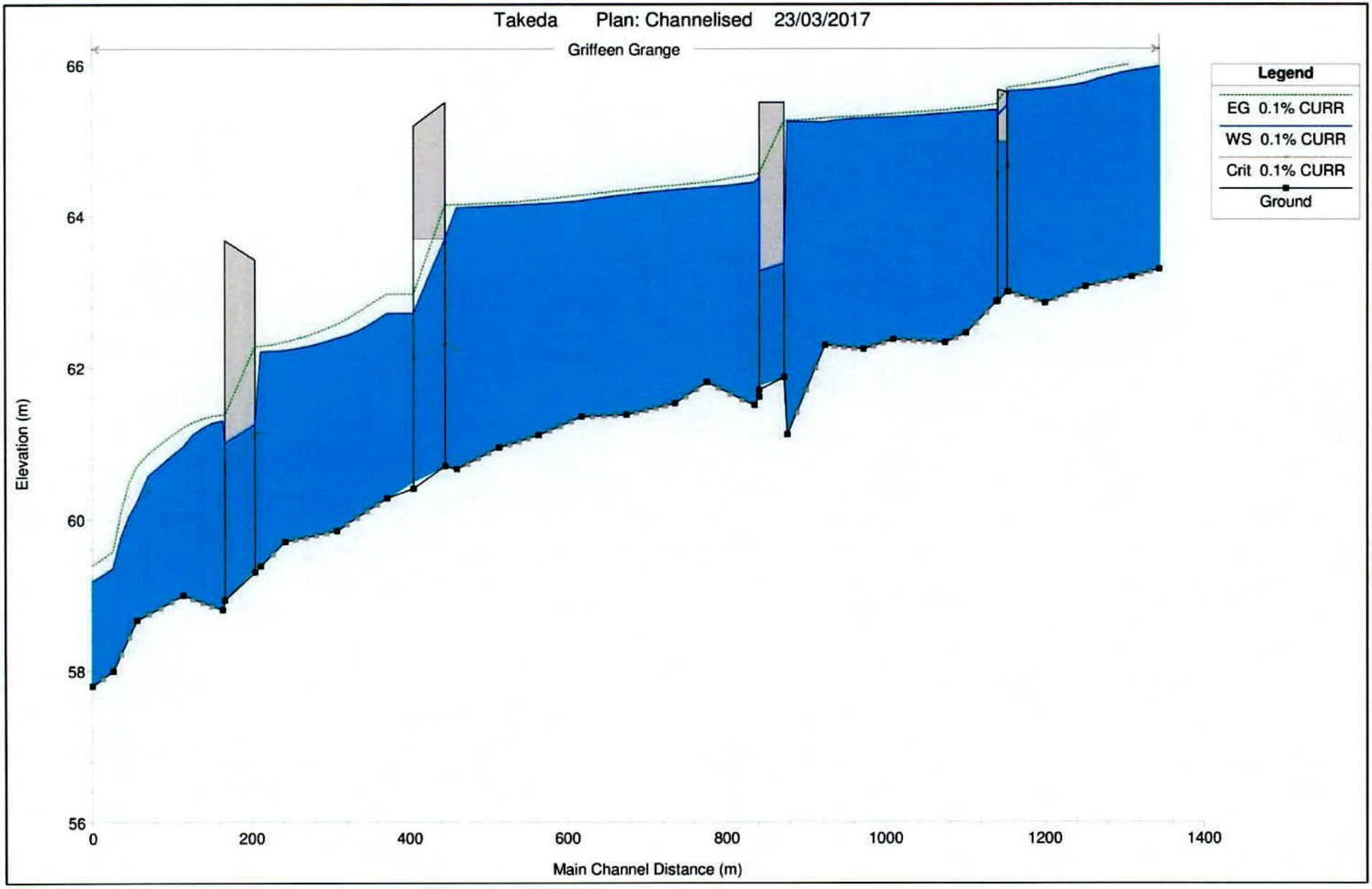


Figure 15 – Water surface profile for the 0.1% 1D model (river channelized)

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
25.96	63.27	65.95		66.05	0.001754	1.35
25.96	63.23	65.94		66.03	0.001702	1.34
25.96	63.20	65.92		66.01	0.001668	1.32
25.96	63.17	65.88		65.98	0.001806	1.38
25.96	63.14	65.85		65.95	0.002000	1.44
25.96	63.10	65.81		65.92	0.002266	1.51
25.96	63.07	65.76		65.89	0.002659	1.60
25.96	63.02	65.73		65.85	0.002358	1.54
25.96	62.96	65.71		65.82	0.002097	1.46
25.96	62.91	65.69		65.79	0.001785	1.38
25.96	62.85	65.68		65.77	0.001523	1.32
25.96	62.89	65.67		65.75	0.001415	1.24
25.96	62.93	65.66		65.73	0.001293	1.15
25.96	62.96	65.65		65.71	0.001152	1.07
25.96	63.00	65.65	64.67	65.70	0.000999	0.99
Bridge						
25.96	62.87	65.40		65.48	0.001477	1.22
25.96	62.73	65.39		65.46	0.001266	1.14
25.96	62.59	65.38		65.44	0.001046	1.08
25.96	62.46	65.37		65.42	0.000885	1.02
25.96	62.39	65.36		65.41	0.000941	1.00
25.96	62.33	65.35		65.40	0.000849	0.96
25.96	62.34	65.34		65.39	0.000813	0.96
25.96	62.35	65.33		65.38	0.000784	0.96
25.96	62.36	65.32		65.37	0.000760	0.96
25.96	62.36	65.31		65.36	0.000741	0.96
25.96	62.37	65.30		65.35	0.000728	0.95
25.96	62.33	65.30		65.34	0.000617	0.87
25.96	62.28	65.30		65.33	0.000570	0.82
25.96	62.24	65.29		65.32	0.000563	0.78
25.96	62.26	65.28		65.31	0.000500	0.80
25.96	62.27	65.27		65.31	0.000487	0.84
25.96	62.28	65.26		65.30	0.000527	0.93
25.96	62.30	65.23		65.29	0.000669	1.08
25.96	62.00	65.24		65.28	0.000479	0.92
25.96	61.70	65.24		65.27	0.000353	0.79
25.96	61.41	65.24		65.27	0.000262	0.68
25.96	61.11	65.24	62.67	65.26	0.000197	0.59
Bridge						
25.96	61.61	64.51		64.56	0.000827	0.99
25.96	61.50	64.44		64.55	0.001619	1.45
25.96	61.58	64.42		64.52	0.001585	1.41
25.96	61.65	64.40		64.50	0.001507	1.36
25.96	61.73	64.39		64.47	0.001369	1.28

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
25.96	61.81	64.38		64.45	0.001150	1.17
25.96	61.71	64.37		64.43	0.001042	1.14
25.96	61.62	64.36		64.42	0.000968	1.12
25.96	61.53	64.35		64.41	0.000923	1.10
25.96	61.50	64.33		64.39	0.000956	1.09
25.96	61.47	64.32		64.38	0.001003	1.09
25.96	61.44	64.31		64.37	0.001059	1.09
25.96	61.41	64.30		64.36	0.001122	1.09
25.96	61.38	64.28		64.34	0.001146	1.09
25.96	61.37	64.26		64.33	0.001121	1.11
25.96	61.36	64.24		64.31	0.001124	1.14
25.96	61.36	64.22		64.29	0.001158	1.18
25.96	61.35	64.20		64.28	0.001233	1.22
25.96	61.29	64.19		64.26	0.001111	1.18
25.96	61.23	64.18		64.24	0.001016	1.13
25.96	61.17	64.17		64.23	0.000940	1.09
25.96	61.11	64.16		64.21	0.000879	1.05
25.96	61.07	64.15		64.20	0.000750	1.00
25.96	61.02	64.15		64.19	0.000649	0.96
25.96	60.98	64.14		64.18	0.000570	0.93
25.96	60.94	64.14		64.18	0.000508	0.90
25.96	60.87	64.13		64.17	0.000511	0.90
25.96	60.80	64.12		64.16	0.000508	0.90
25.96	60.73	64.12		64.16	0.000495	0.89
25.96	60.66	64.11	62.24	64.15	0.000473	0.88
Bridge						
25.96	60.28	62.72		62.97	0.005989	2.24
25.96	60.19	62.63		62.89	0.006487	2.29
25.96	60.11	62.54		62.81	0.006560	2.28
25.96	60.02	62.48		62.72	0.006132	2.20
25.96	59.93	62.42		62.64	0.005293	2.07
25.96	59.85	62.39		62.57	0.004255	1.90
25.96	59.82	62.34		62.51	0.003870	1.84
25.96	59.79	62.30		62.46	0.003435	1.76
25.96	59.76	62.27		62.42	0.002977	1.67
25.96	59.73	62.25		62.37	0.002536	1.58
25.96	59.70	62.23		62.34	0.002130	1.48
25.96	59.54	62.22		62.31	0.001575	1.33
25.96	59.38	62.21	61.15	62.28	0.001175	1.19
Bridge						
25.96	58.80	61.30		61.37	0.001236	1.23
25.96	58.85	61.26		61.36	0.001683	1.34
25.96	58.90	61.20		61.33	0.002819	1.55
25.96	58.94	61.11		61.28	0.003918	1.82

Q total	Minimum channel elevation	Water surface elevation	Critical water surface level	Energy gradient level	Energy gradient slope	Velocity
25.96	58.99	60.95		61.21	0.007205	2.24
25.96	58.91	60.83		61.10	0.007556	2.30
25.96	58.83	60.70		60.99	0.007897	2.36
25.96	58.75	60.57	60.38	60.87	0.008106	2.41
25.96	58.67	60.22	60.22	60.70	0.014608	3.05
25.96	58.44	60.03	60.03	60.47	0.014099	2.93
25.96	58.22	59.76	59.76	60.09	0.010485	2.62
25.96	58.00	59.35		59.57	0.007358	2.22
25.96	57.90	59.26		59.48	0.007092	2.19
25.96	57.80	59.18	59.00	59.39	0.006669	2.15

Table 6 - Maximum water surface profile for the 0.1% 1D model (river channelized)

Appendix D
- Topographical information used for the hydraulic modelling

Topographical information

The following information in digital format was used to create the HEC-RAS model for the hydraulic analysis of the River Griffeen, the overbank areas and the Takeda site.

Source	File
PM Group	IE0311985_30_SK_0020_A_Draft1.pdf
iO Geomatics	1263_T_3D_Rev0.dwg
	1274_CS_Rev0.dwg
Clifton Scannell Emerson Associates	03_032_C003-C004-C005 Proposed River Layout Revision A.dwg
	03_032_C031 Standard Section through culvert 1.dwg
	GRIF0003.csv
	GRIF0006.csv
	GRIF0012.csv
	GRIF0017.csv
	GRIF0025.csv
	GRIF0031.csv
	GRIF0037.csv
	GRIF0046.csv
	GRIF0052.csv
	GRIF0057.csv
	GRIF0062.csv
	GRIF0068.csv
	GRIF0074.csv
	GRIF0078.csv
	GRIF0084.csv
	GRIF0085.csv
	GRIF0088.csv
	GRIF0093.csv
	GRIF0097.csv
	GRIF0101.csv
	GRIF0108.csv
	GRIF0110.csv
	GRIF0114.csv
	GRIF0116.csv
	GRIF0120.csv
	GRIF0125.csv
	GRIF0131.csv