APPENDICES

Appendix 1
SuDS

Appendix 2
Flood Risk Assessment

SuDS Strategy Briefing Document

Table of Contents

1.0. INTRODUCTION

1.1 Background

Fingal County Council is in the process of preparing a Local Area Plan for Baldoyle - Stapolin for the period 2012-2018 which will provide a 6 year statutory framework which will inform and guide development.

Waterman Moylan have been appointed by Fingal County Council to carry out a Sustainable Drainage Systems (SuDS) strategy to inform the Local Area Plan.

It is the responsibility of each applicant for planning permission to provide appropriate SuDS as part of their proposed development for which permission is sought. This report sets out a strategy for the preparation of SuDS design for each phase of development within the LAP lands and for the lands as a whole.

1.2. Objective of this Report

This report is a working briefing document intended to assemble the background information, objectives, and criteria for the development of a SuDS strategy for the Baldoyle-Stapolin LAP lands.

2. BALDOYLE STAPOLIN SITE LOCATION AND DESCRIPTION / CHARACTERISTICS.

2.1 Site Location

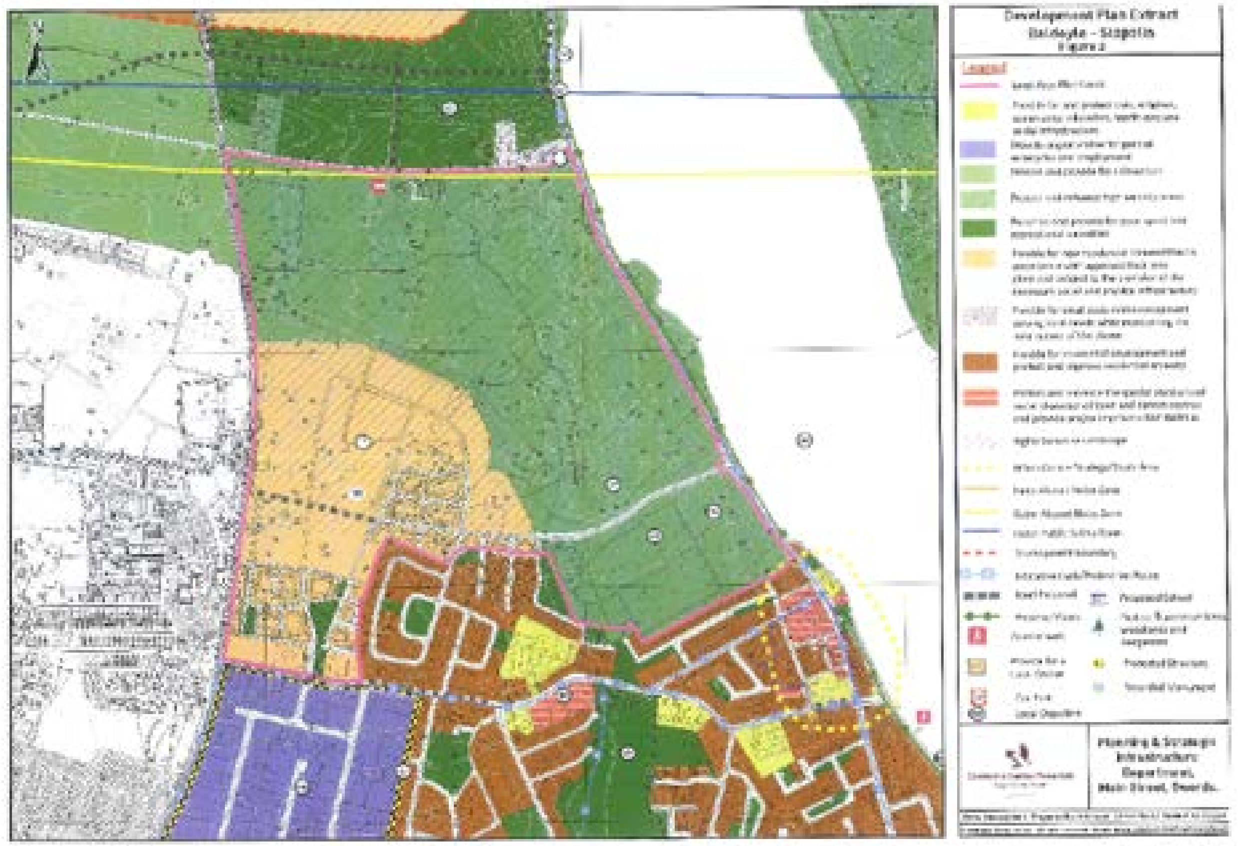
The Baldoyle–Stapolin Local Area Plan (LAP) lands are located within south east Fingal. The lands are bound to the east by the coast road and Baldoyle Estuary, to the west by the Dublin – Belfast Railway line which is also the Fingal / Dublin City boundary, to the north by Mayne Road and Portmarnock South LAP lands, and to the south by Baldoyle village.

2.2. Site Description

The LAP lands total approximately 118 Ha. of which approximately 37 Ha. are zoned Objective RA to provide for new residential communities in accordance with approved local area plan and approximately 81 Ha. zoned Objective HA to protect and enhance high amenity areas.

The site currently comprises of agricultural and natural coastal landscape lands in the north and east of the LAP lands, playing fields in the south east and the partially developed residential zoned lands in the southwest.

Figure 2.1: LAP Zoned Lands



Residential development on the zoned lands is currently as follows:-

Completed dwelling units	640
Dwelling units under construction	205
Committed development with Planning Permissions	1,289

2.3. Topography

The overall site falls from a level of approximately 10m OD Malin at the south west boundary to approximately 3m OD Malin along the Coast Road boundary to the east.

The lands zoned for development fall from approximately 10m OD Malin at the south west boundary to approximately 4m OD Malin to the east and north.

2.4. Hydrology

The subject lands lie in the catchment of the Mayne River which discharges to the Baldoyle Estuary at the north east of the lands.

Surface water from the east side of the lands, which is undeveloped, drains via existing watercourses that discharge to the River Mayne approximately 325 meters upstream of where the Mayne outfalls to Baldoyle Estuary.

The east and south east of the lands are partially developed and discharge through a sewer system which in turn discharges to the River Mayne approximately 700 metres upstream of the Baldoyle Estuary.

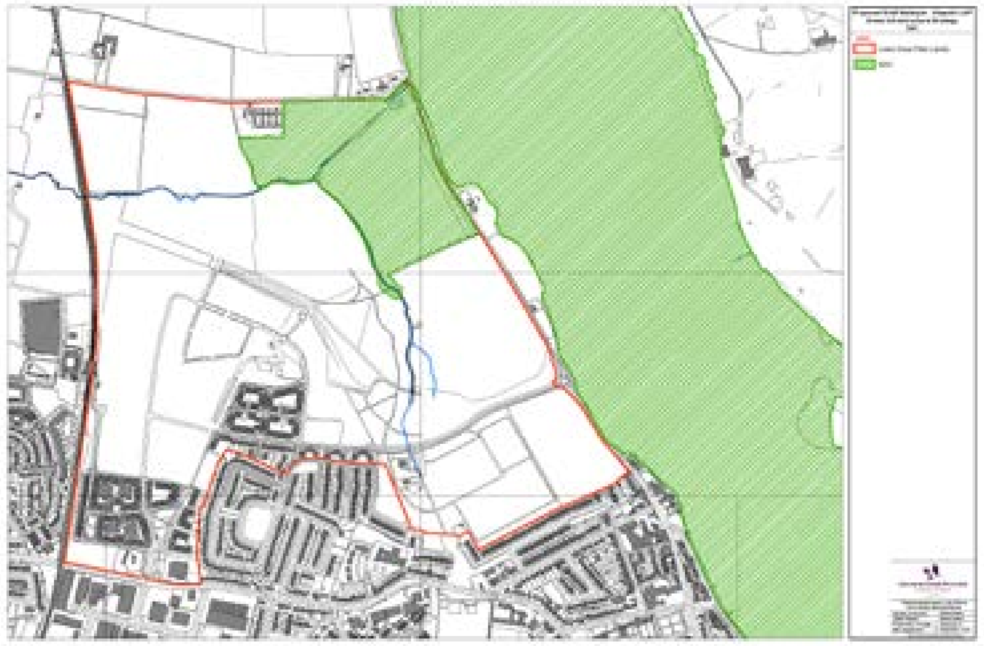
The majority of the rest of the site is flat, low lying, marsh land that lies within the tidal and River Mayne flood plain.

Trial pits have been excavated and suggest a possible water table at a maximum depth of 2.0m. However, due to the nature of the site, it is possible that water tables and water bearing gravel lenses are present at various levels throughout the development lands.

2.5. Baldoyle Estuary

The Baldoyle Estuary is a Natura 2000 site and is designated as a Special Protection Area and a Candidate Special Area of Conservation under the Birds and Habitats Directives respectively. It is also a Ramsar site recognised as being a wetland of international importance, while nationally it is a proposed National Heritage Area. It is also a statutory Nature Reserve. Figure 2.1 below indicates the extent of the SAC into the LAP lands.

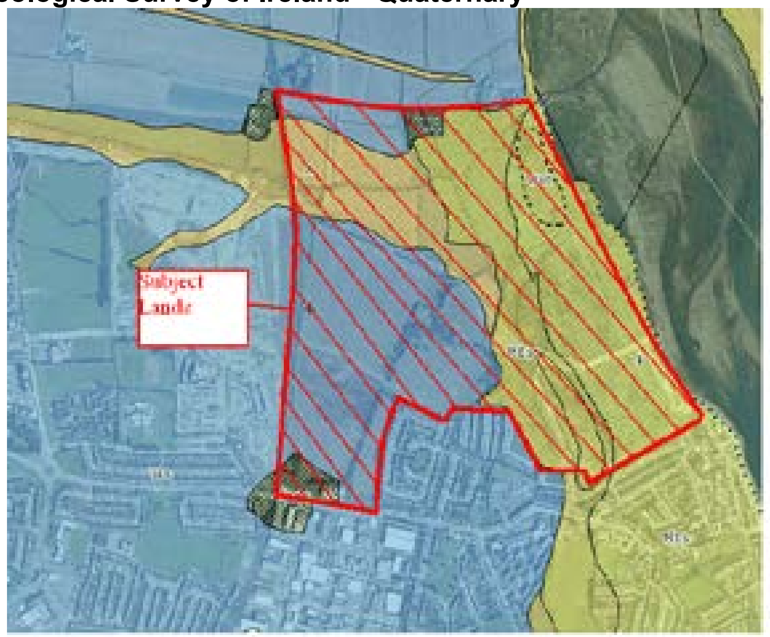
Figure 2.1: Extent of SAC



2.6. Geology and Geotechnical

From the Geological Survey of Ireland the quaternary soil type for the area zoned for development is described as Limestone Tills (TLs), as shown below in Figure 2.2.

Figure 2.2: GSI Geological Survey of Ireland - Quaternary



As shown on below Figure 2.3, the Geological Survey of Ireland shows the site lying on a locally important aquifer with bedrock which is moderately productive only in local zones.

Figure 2.3: GSI Geological Survey of Ireland – National Draft Gravel Aquifer Map

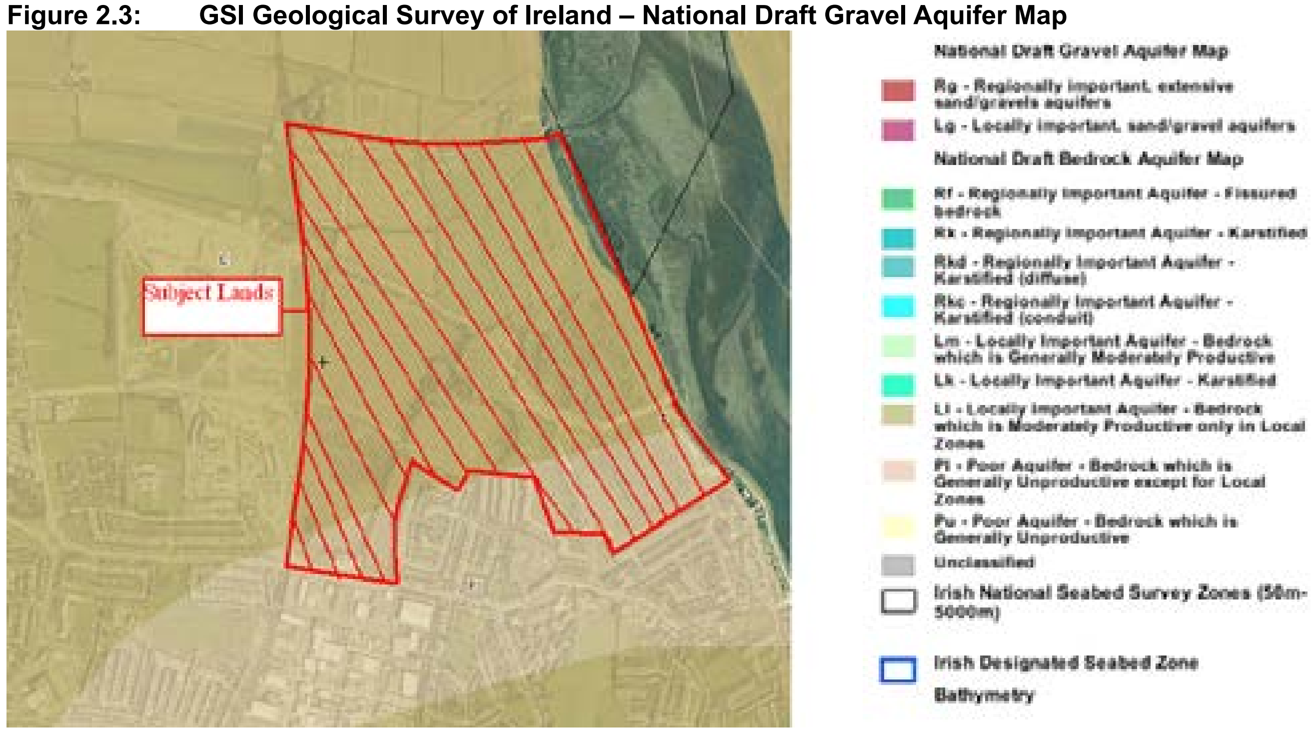
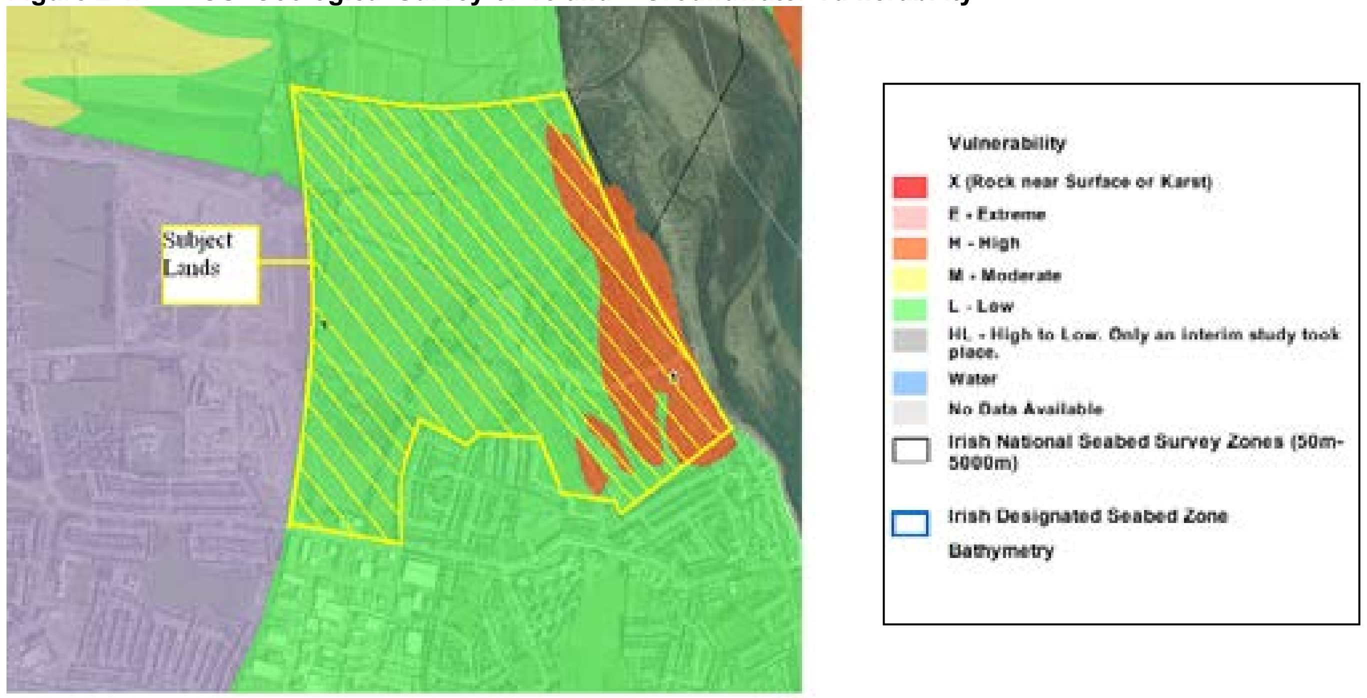


Figure 2.4 below indicates the aquifer for the majority of the site has a low vulnerability. A portion along the eastern side of the lands, which is not proposed for development, has ground water with high vulnerability.

Figure 2.4: GSI Geological Survey of Ireland – Groundwater Vulnerability



Site Investigation trial pits excavated in July 2007 in the Baldoyle – Stapolin Phase 6 site confirmed the soil is generally a firm brown gravely clay to a depth of approximately 2.0m with stiff black sandy gravely clay underneath to a depth of at least 2.6m. This soil type is typical of a moderate infiltration potential which suggests a Soil Type of 3.

This indicates that infiltration techniques may not be suitable on the subject site. However, it is recommended that site investigations be carried out to confirm the soil type for each proposed development.

3. THE DEVELOPMENT

3.1. Existing Development

The lands zoned for development currently have approximately 640 No. units constructed and a further 205 No. units under construction.

3.2. Proposed Development

As part of the 2013-2019 LAP it is proposed to provide for between 1,500 and 2,000 no. dwellings on the LAP lands.

Under the original Action Area Plan (2001) development was previously split into 6 Phases. Phase 1 to the south (Myrtle) has been completed while approximately 205 units remain to be completed in Phase 2, Red Arches to the south east. The Sequencing and Phasing of the development has been reviewed part of this LAP with development now being broken into a total 3 Growth areas within which detailed phasing has been set out. Two Independent Growth Areas are so provided within which development can occur independent of the other area. (See Section 6 of the LAP for further details).

Figure 3.1: Phasing of Development

The main roads and infrastructure, including the surface water network, have been substantially constructed. Surface water from the existing phases and network is to be diverted / intercepted through SuDS devices where possible, before discharging to a new regional permanent water body.

It is proposed to implement full SuDS design in the phases not yet constructed, including draining to a regional permanent water body.

A Surface Water Management Train approach is to be adopted in the design of the proposed surface water drainage regime for the subject lands by utilising suitable SuDS mechanisms in providing Source, Site and Regional Control.

4 SuDS STRATEGY OUTLINE

4.1. General

This briefing document sets out the criteria used to define and assess the SuDS strategy proposed for the Baldoyle – Stapolin LAP. The report describes the criteria on which the design and construction of any storm water related works within the LAP lands shall be based. These criteria shall include the requirements of the following:-

- This SuDS Strategy
- The (GDSDS) 'Greater Dublin Strategic Drainage Study'
- The CIRIA 'Sustainable Urban Drainage Systems' Manual C697

Details of general strategies, SuDS constructions and selection criteria are contained in Appendix A of this report.

4.2. Water Quality

Given the sensitivity of the receiving environment for storm water runoff from the LAP lands it is considered that the criterion for Water Quality is the overriding factor in the design of the storm water system.

All development within the LAP area must implement a SuDS Strategy which addresses water quality, water quantity, amenity and diversity. A SuDS strategy should adopt a Surface Water Management Train approach in the design of the proposed surface water drainage regime by utilising suitable SuDS mechanisms in providing Source, Site and Regional Control.

Interception storage is also to be provided on site where possible; however, the nature of the soil may not facilitate infiltration.

Treatment storage is required on site and should be provided within SuDS devices such as filter drains, bio-retention areas, tree pits and permanent water bodies.

4.3. Storm Water Attenuation & Tidal Effects

The site is located adjacent to the tidal estuary at Baldoyle and as there is no downstream development before outfalling to the Irish Sea, it is not required to provide full attenuation for the 100 year return storm as per the requirements in Section 6.6, Volume 2, of the GDSDS.

In addition the lands discharge into salt wetlands which are the flood estuary of the Mayne River and extend over approximately 40 hectares (100 year flood plain).

The principle issue therefore is the quality of water discharge from the LAP lands and not the quantity of water discharged to the estuary.

However, as the outfall sewer is subject to influence from high tides due to tide locking it is necessary to consider the appropriate storage of surface water during high tides when surface water discharge rates will be limited at the outfall to the sea.

The Mayne River is tide locked during extreme high tide events and for this assessment it is assumed that the tide lock may be closed for a period of up to 6 hours. It was agreed to review the storage of surface water flows from the subject site during these times.

The worse case scenario occurs when the flood plain is tide locked and a fluvial event occurs. If a significant storm event occurred during this tide lock the outfall is surcharged and a conservative approach is used by assuming there is no outfall rate from the site during the entire 6 hours of tide lock. Table 4.0 below gives the volumes of water discharged from the site based on several rainfall events with return periods up to the 100 year event:

Table 4.0: 6 Hour Attenuation during Tide Lock

Return Period	Rainfall (mm)	Attenuation Volume Required
1 Year	20mm	3,670m³
5 Year	28mm	5,230m³
10 Year	32mm	6,000m³
30 Year	41mm	7,500m³
50 Year	45mm	8,300m³
100 Year	52mm	9,500m³

The storage volumes were obtained by simulation using Micro Drainage with the following design parameters:-

- Zoned Lands = 37.0 Hectares
- Hardstanding Area = 18.5 Hectares (50%)
- Soil Type = 3 (based on a moderate infiltration potential indicated by the site investigations as outlined in Section 2.6)
- Climate Change = 15%
- Discharge Rate = 0 l/s (due to tide lock)
- M5-60 value = 15.70mm (automatically given by the storage design software based on the chosen site location)
- 'r' ratio = 0.3 (automatically given by the storage design software based on the chosen site location)

It should be noted that the volumes assessed above do not take into account the runoff that would have occurred during the six hour storm event if the lands were undeveloped and therefore do not represent the amount of attenuation required if the site were to be subject to the GDSDS attenuation criteria. The volumes have been estimated to establish the order of magnitude of the volumes of water that may be generated during a six hour tide lock condition.

Based on the assumption that in a 100 year event the runoff from the developed lands is increased by 100% compared to the runoff from a green field site then the additional storm water that may be discharged to the flood plain during a 6 hour storm with tide locking is of the order of 4,750m³. This quantity of water would result in an increase in level of the 40 ha flood plain of approximately 12mm.

In order to address the water quality issues it is proposed to provide a wetland area capable of retaining up to 2,775m³ of permanent water to provide for treatment storage (15mm rainfall on the entire existing and proposed hardstanding areas).

The wetlands will provide treatment and removal of pollutants from surface water.

The wetlands should have an average permanent water level of approximately 300mm over an area of approximately 9,250m².

In addition the volume of treatment storage required and the retention time within the wetlands will determine the shape and size of the proposed wetlands.

Storm events should be allowed to overflow into the River Mayne flood plain. This will result in the River Mayne flood plain (approximately 400,000m² east of the railway line for the FEM-FRAM 100 year event) absorbing the remaining run-off from the development. This will raise the level of the flood plain by 2.5mm for every additional 1,000m³ of runoff from the subject site.

The preferred location for regional wetlands is generally at the lower end of the site and immediately upstream of the outfall / receiving waters. For the subject site the optimum location for the wetlands would be to the north of the lands zoned for development along side the proposed new outfall sewer. The impact of the wetlands on the landscape, ecology and flood plain should be minimised. It is proposed that the wetlands be located outside of the FEM-FRAM 10 year flood plain.

There is also an opportunity to locate a wetlands area for treatment storage to the east of the lands zoned for development.

Refer to the SuDS Strategy General Arrangement drawing in Appendix C for the proposed locations of the wetlands.

4.4. Public Open Space

Open spaces within the lands zoned for development should be utilised to provide surface water treatment and storage during flood events with lands zoned to *protect and enhance high amenity areas* being used as a secondary option or for regional control.

4.5. Outfall and North Fringe Sewer

The existing development on the LAP lands currently drains to an outfall sewer which was constructed at a low level to allow it pass under the North fringe Sewer. The invert level of the outfall sewer as it passes under the North Fringe Sewer is approximately 0.75m OD Malin.

The remainder of the lands, zoned Objective RA, which have not yet been developed on also have their surface water network constructed and connecting to the existing outfall sewer.

Due to the low level of the outfall sewer it is not feasible to divert the surface water from this network to the proposed regional wetlands which are proposed at a higher level.

It is recommended, that where feasible and subject to detail design, all new developments should be drained separately to the regional wetlands via a new surface water network capable of passing over the North Fringe Sewer and draining to the proposed wetlands.

This new network will need to pass over the North Fringe Sewer at an invert level of approximately 4.0m OD Malin. This will require the northern portion of the development to be raised to ensure adequate cover for the new surface water network. The level of the North Fringe Sewer (and the level of the North Fringe Watermain) will need to be confirmed at the proposed crossing point.

Where feasible and subject to detail design, it is also recommended that surface water form the existing development should be intercepted and diverted to the new surface water network and ultimately the regional wetlands. This will ensure that we provide maximum regional treatment to surface water from both the proposed and existing developments.

As part of the existing development will not be able to drain to the proposed wetlands, the volume of the wetlands should be sized appropriately to the area draining to it.

All outfalls must be protected against surcharging from the River Mayne and from the sea.

5. BALDOYLE – STAPOLIN SuDS SELECTION

5.1 General

As part of the detail design of the drainage systems within the Baldoyle - Stapolin LAP lands, all surface water design and construction works shall be based on the SuDS Strategy, incorporating an integrated approach to the management of runoff from each phase of development, neighbourhood and the LAP lands as a whole.

The selection of suitable and appropriate SuDS techniques to be incorporated into the SuDS train for any specific site depends on the objectives and on the site conditions.

The type and location of SuDS to be selected should be based on the following:

- Land Use Characteristics
- Site Characteristics
- Catchment Characteristics
- Quantity and Quality Performance Requirements
- Amenity and Environmental Requirements
- Economics and Maintenance

5.2 Land Use Characteristics

Land use characteristics introduce additional constraints on the suitability of the SuDS constructions. These characteristics are discussed in Section 3 of this report.

In summary the key land use characteristics that impact on the selection of SuDS are:-

- Urban development
- Car parks
- Roads
- Housing
- Parks
- Existing development
- Existing surface water system
- High amenity zoned salt lands

5.3 Site Characteristics

Site characteristics are critical in determining which SuDS techniques are best suited to drain and treat the surface water drainage. The characteristics of the Baldoyle-Stapolin LAP lands are discussed in Section 2 of this report.

In summary the key site characteristics that impact on the selection of SuDS are:-

- Space required
- Coastal and tidal outfall
- Sensitive salt wetlands
- Low permeability with some gravels
- High water table

5.4 Catchment Characteristics

The lands lie within the River Mayne catchment which discharges to the Baldoyle Estuary. As outlined in section 2.5 the Baldoyle Estuary is a sensitive and protected area. Surface water discharging to the Estuary should have a high level of SuDS implemented resulting in a low risk of pollution.

In summary the key catchment characteristics that impact on the selection of SuDS are:-

- Drainage Sub Catchment Area
- Flat site with an average gradient of 1:150
- Discharge to Sensitive Area (Baldoyle Estuary)

5.5 Quantity and Quality Performance Requirements

To quantify and rank the environmental benefits of the various SuDS element, a decision criteria score system has been developed. A rating system has been provided with each criteria been given a rate from 1 to 5. In order to assess the importance and benefits of each SuDS element scores are given to each technique. These scores are multiplied with the weighting factor (0 for not required, 1 for desired, 2 for essential) assessed for the specific lands. The below Table 3.1 shows gives the matrix of results and totals the score for each SuDS element.

In summary the key quantity and quality characteristics that impact on the selection of SuDS are:-

- Pollutant removal
- Water quality
- Groundwater recharge
- Flow rate control

5.6 Amenity and Environmental Considerations

The provision of open spaces and pocket parks within the development lands will lend itself to areas for SuDS features. Permanent water features such as local retention ponds may be utilised to provide upstream attenuation and treatment storage.

The perimeter or low lying areas planted areas should be utilised to provide bioretention systems that convey and treat the surface water.

The high amenity zoned lands could also be utilised as a wetlands area, providing treatment storage for the surface water runoff from the developed lands. Careful consideration must be given to the location and impact of any enhanced wetlands area.

In summary the key amenity and environmental characteristics that impact on the selection of SuDS are:-

- Safety
- Pond premium
- Aesthetics
- Wildlife habitat and ecology
- Community acceptance

5.7 Economics and Maintenance

Maintenance must be considered when selecting SuDS techniques. Some SuDS techniques are less onerous than others with regard to frequency of maintenance, equipment required, accessibility and personnel responsible.

For SuDS at source control the responsibility generally lies with the private house / block owner. Maintenance should not require heavy machinery and should be easily accessible.

Maintenance of SuDS at site control varies but is generally carried out by the local authority. Ideally this should involve occasional maintenance that is easily accessible and may require light machinery.

Maintenance of regional SuDS control may require heavy machinery but should be designed to require remedial works infrequently. Again these are generally under the charge of the Local Authority.

For regional controls such as ponds and wetlands a Management, Monitoring and Maintenance regime will need to be prepared and operated. Designers should also assess all foreseeable risks during construction and maintenance and the design must minimise them by avoidance, reduction and mitigation.

In summary the key economic and maintenance characteristics that impact on the selection of SuDS are:-

- Life span
- Initial cost
- Maintenance cost
- Maintenance expertise

5.8 Selection of SuDS Controls

Various SuDS techniques have been rated under each of the above headings outlined in Sections 5.2 to 5.7. These tables are given in Appendix B. The SuDS techniques rated in each of the tables in Appendix B are listed below:

<u>Source Control</u>
- Pervious Pavements
- Bioretention Areas
- Filtration Strips
- Water Butts
- Rainwater Harvesting Systems

<u>Site Controls</u>
- Pervious Pavements
- Bioretention Areas
- Filtration Trenches
- Swales
- Petrol Interceptor

<u>Regional Controls</u>
- Wet Ponds
- Stormwater Wetlands

A total score has been given to each SuDS technique produced by combining the score from each of the tables in Appendix B. A matrix table is provided below in Table 5.1 which combines the total score for each SuDS technique.

Table 5.1: Decision Criteria for Selecting SUDS Techniques

Technique	Land Use Characteristics	Site Characteristics	Catchment Characteristics	Quality and Quantity Performance	Amenity and Environment	Economics and Maintenance	Total
Pervious pavements	24	15	16	12	12	8	**87**
Bioretention	26	21	18	15	16	9	**105**
Filter drains	28	21	15	13	12	8	**97**
Grassed filter strips	27	14	15	10	15	9	**90**
Swales	27	14	14	10	13	10	**88**
Infiltration devices	18	13	16	12	10	7	**76**
Infiltration basin	16	10	15	12	11	7	**71**
Extended detention basin	26	13	12	8	13	10	**82**
Wet ponds	26	18	15	13	20	9	**101**
Stormwater wetlands	27	19	17	17	22	9	**111**
On-/off line storage	17	17	13	4	9	12	**72**

5.9 Implementation of SuDS

Various SuDS techniques have been rated under each of the above headings shown in Table 5.1 above and Appendix B.

Due to the requirement for protection of the River Mayne and Baldoyle Estuary an integrated sustainable system is recommended as a combination of source controls, site controls and regional controls to ensure a high water quality of the runoff from the developed lands.

Source Control

- Pervious Pavements – In private parking areas and private hardstanding areas.
- Bioretention Areas – Provide in private landscaped areas with hardstanding pavements and downpipes draining to these areas. A perforated overflow pipe will be required to discharge to the main public sewer.
- Filtration Strips - Provide in rear gardens and private areas with hardstanding pavements and downpipes draining to these areas. A perforated overflow pipe will be required to discharge to the main public sewer.
- Water Butts – Should be provided for houses.
- Rainwater Harvesting Systems – Only appropriate for large apartment blocks and commercial units. Storage may not be available during rainfall event and as such should not be included for treatment storage / attenuation calculations.

The following is an outline strategy of SuDS devises for source control:

Source Control	Roofs / Yards	Driveways / Parking Bays
Pervious Pavements	10%	25%
Bioretention / Landscaped Areas	20%	35%
Filtration Strips	10%	10%
Water Butts	30%	
Rainwater Harvesting	Only appropriate for large apartment blocks and commercial units	
Direct to SW Network / Site Control	30%	30%

Site Controls

- Pervious Pavements - Should be used for public parking bays and hardstanding areas only if FCC Roads will take them in charge.
- Bioretention Areas / Tree Pits – Bioretention area should be utilised within pocket parks and open spaces. Tree pits should be provided with parking areas and along road side verges. Gullies or open kerbs should drain road runoff to these areas with a perforated overflow pipe discharging back into the main public sewer.
- Filtration Trenches – Filtration trenches should be provided within pocket parks and open spaces. Road gullies can also drain to filtration trenches provided under roadside verges.
- Swales – Should be provided where the road reservation has sufficient width to incorporate swales
- Petrol Interceptor – Runoff from roads and parking areas should pass through a petrol interceptor.
- Infiltration devices are most likely not suitable on site due to the lack of adequate infiltration. Infiltration tests must be carried out to insure the ground is suitable where infiltration devices are proposed.

The following is an outline strategy of SuDS devises for site control:

Site Control	Feeder Roads	Access Roads	Parking Along Roads	Foot & Cycle Paths
Pervious Pavements	Only to be used in public areas where acceptable to Fingal County Council Taking in charge requirements			
Bioretention / Landscaped Areas	30%	30%	30%	80%
Filtration Strips	10%	10%	10%	
Swales	30%	30%	30%	
Petrol Interceptor	80%	80%	80%	
Infiltration Devices	Only to be used if adequate infiltration and water table level			

<u>Regional Controls</u>

- Wet Ponds – Should be provided as a final treatment before discharging to the Mayne River. Wet ponds should provide treatment storage and attenuation.
- Stormwater Wetlands – Should be provided as a final treatment before discharging to the Mayne River. Wet ponds should provide treatment storage and attenuation.

The following is an outline strategy of SuDS devises for regional control:

Regional Control	Surface Water Network from Existing Development	Surface Water Network from New Development
Wetlands	Need to intercept surface water from the existing development where levels allow and where feasible.	100%

As the existing surface water network has been constructed at a low level to by pass the North Fringe Sewer it will not be possible to divert all the surface water runoff from the existing development to the regional wetlands due to the low level of the existing outfall sewer. Where feasible and subject to detail design surface water pipes that currently drain to the existing outfall sewer should be diverted to the new surface water sewer system which will drain to the regional wetlands.

Divergence of surface water from the existing roads and from the existing surface water network to SuDS devices should also be considered for surface water drainage from the existing development. Possible options are to intercept road runoff, gullies and sewers and pass them through SuDS devices for treatment before reconnecting them to the main sewer system or to the regional control.

Where feasible and subject to detail design all new developments should drain to the regional wetlands via a new surface water network. SuDS techniques should also be fully implemented by utilising source and site controls.

APPENDIX A - SUSTAINABLE URBAN DRAINAGE SYSTEM

A-1 Background to SuDS

Sustainable urban drainage is a concept that incorporates long term environmental and social factors into drainage design. It takes account of both the quantity and quality of runoff as well as the amenity value of surface water in the urban environment.

Appropriately designed, constructed and maintained SUDS are more sustainable than conventional drainage methods because they can mitigate many of the adverse effects on the environment of stormwater runoff. They achieve this through:

- reducing runoff rates, thus reducing the risk of downstream flooding
- reducing the additional runoff volumes and runoff frequencies that tend to be increased as a result of urbanization, and which can exacerbate flood risk and damage receiving water quality
- encouraging natural groundwater recharge (where appropriate) to minimize the impacts on aquifers and river base flows in the receiving catchment
- reducing pollutant concentrations in stormwater, thus protecting the quality of the receiving water body
- acting as a buffer for accidental spills by preventing a direct discharge of high concentrations of contaminants to the receiving water body
- reducing the volume of surface water runoff discharging to combined sewer systems, thus reducing discharges of polluted water to watercourses via CSO spills
- contributing to the enhanced amenity and aesthetic value of developed areas
- providing habitats for wildlife in urban areas and opportunities for biodiversity enhancement.

They do this by:

- Dealing with runoff close to where the rain falls
- Managing potential pollution at its source now and in the future
- Protecting water resources from point pollution (such as accidental spills) and diffuse sources.

A-2 SuDS Management Train

A SuDS strategy should adopt a Surface Water Management Train approach in the design of the proposed surface water drainage regime by utilising suitable SuDS mechanisms in providing Source, Site and Regional Control.

Each section and phase of the development within the LAP lands must demonstrate to the satisfaction of the Local Authority that water quality improvement measures are adequately provided using the approved methods.

The following are examples of SuDS devices for source, site and regional control:

Source Control – control of runoff at or near to its source

- Rainwater Harvesting
- Permeable Paving
- Filter Drains
- Green Roofs
- Bioretention Tree Pits
- Infiltration Trenches

Site Control – management of water in a local area or site

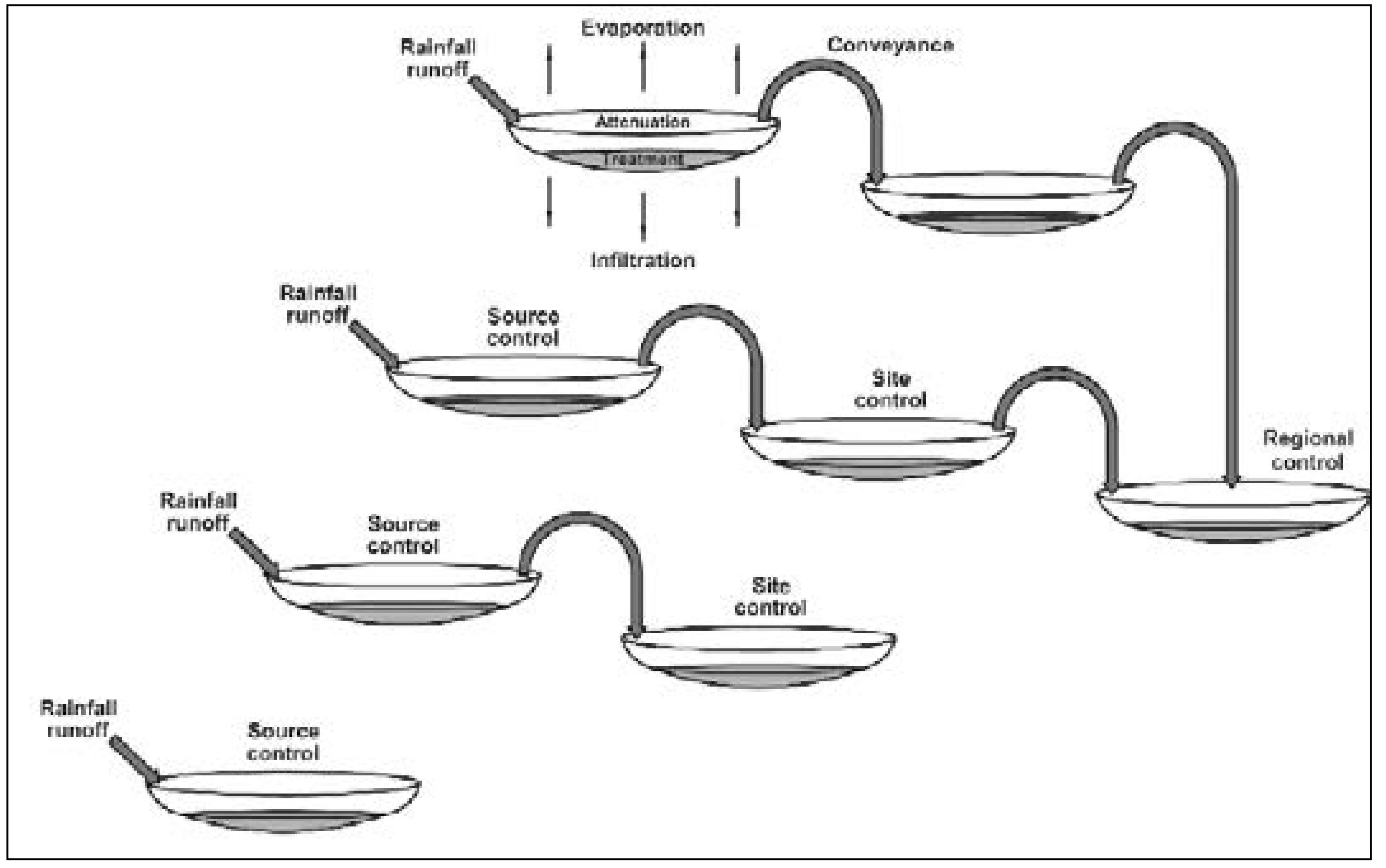
- Permeable Paving
- Filter Drains
- Swales
- Bioretention Tree Pits
- Infiltration Trenches
- Petrol Interceptor

Regional Control – management of runoff from a site or several sites

- Petrol Interceptor
- Retention Pond
- Detention Ponds
- Wetland

As a priority, stormwater should be managed in small, cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas. The SuDS Trains in Figure A.1 below conveys a hierarchy with the higher trains preferred to those further down. This indicates that prevention and control of water at source should always be considered before site or regional controls.

Figure A.1 The SUDS management train



The more SuDS controls the surface water from the development passes through the less risk of pollution to the Mayne River and ultimately to the Baldoyle Estuary. The conveyance of water between SuDS control should be via natural conveyance systems (e.g. swales, filter trenches and bioretention areas) where possible, although pipework and sub-surface proprietary products may be required due to limited space.

The variety of the above options should be considered for the various phases of development on the lands with consideration given to local land use, land take, amenity and maintenance.

A-3 Surface Water Quality Control

There are several processes by which SuDS remove pollutants which include the following:

Precipitation
This process is the most common mechanism for removing soluble metals. Precipitation involves chemical reactions between pollutants and the soil or aggregate that transform dissolved constituents to form a suspension of particles of insoluble precipitates. Metals are precipitated as hydroxides, sulphides, and carbonates depending on which precipitants are present and the pH level. Precipitation can remove most metals (arsenic, cadmium, chromium III, copper, iron, lead, mercury, nickel, zinc) and many anionic species (phosphates, sulphates, fluorides).

Sedimentation
Sedimentation is one of the primary removal mechanisms in SUDS. Most pollution in runoff is attached to sediment particles and therefore removal of sediment results in a significant reduction in pollutant loads. Sedimentation is achieved by reducing flow velocities to a level at which the sediment particles fall out of suspension. Care has to be taken in design to minimise the risk of re-suspension when extreme rainfall events occur.

Filtration and biofiltration
Pollutants that are conveyed in association with sediment may be filtered from percolating waters. This may occur through trapping within the soil or aggregate matrix, on plants or on geotextile layers within the construction.

Adsorption
Adsorption occurs when pollutants attach or bind to the surface of soil or aggregate particles. Eventually the materials onto which pollutants adsorb will become saturated and thus this method of treatment will stop.

Biodegradation
Biodegredation is the biological treatment of pollutants in surface water by using the oxygen within the free-draining materials and the nutrients supplied with the inflows, to degrade organic pollutants such as oils and grease.

Uptake by plants
In ponds and wetlands, uptake by plants is an important removal mechanism for nutrients (phosphorous and nitrogen). Metals can also be removed in this manner (although intermittent maintenance is required to remove the plants otherwise the metals will be returned to the water when the plants die).

Nitrification
Ammonia can be oxidised by bacteria in the ground to form nitrate, which is a highly soluble form of nitrogen. Nitrate is readily used as a nutrient by plants.

The removal mechanism appropriate for each pollutant is presented in Table A.2.

Table A.2 Removal mechanisms for each pollutant category

Pollutant	Removal mechanisms in SUDS
Nutrients Phosphorous, nitrogen	Sedimentation, biodegradation, precipitation, de-nitrification.
Sediments Total suspended solids	Sedimentation, filtration.
Hydrocarbons TPH, PAH, VOC, MTBE	Biodegradation, photolysis, filtration and adsorption.
Metals Lead, copper, cadmium, mercury, zinc, chromium, aluminium	Sedimentation, adsorption, filtration, precipitation, plant uptake.
Pesticides	Biodegradation, adsorption, volatilisation.
Chlorides	Prevention.
Cyanides	Volatilisation, photolysis.
Litter	Trapping, removal during routine maintenance.
Organic matter, BOD	Filtration, sedimentation, biodegradation.

The various SuDS techniques can be used to form part of the management train. Table A.3, extracted from Ciria C697, The SUDS Manual, list various SuDS techniques and categorises them into pre-treatment, conveyance, source, site and regional controls. They are also ranked on their hydraulic and water quality performance potential.

Technique	Description	Management train suitability						Water quantity				Water quality								Environmental benefits		
		Prevention	Conveyance	Pre-treatment	Source control	Site control	Regional control	Conveyance	Detention	Infiltration	Water harvesting	Sedimentation	Filtration	Adsorption	Biodegradation	Volatilisation	Precipitation	Uptake by plants	Nitrification	Aesthetics	Amenity	Ecology
Water butts, site layout & management	Good housekeeping and good design practices.	●	◎		●			◎	◎	●	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
Pervious pavements	Allow inflow of rainwater into underlying construction/soil.	●			●	◎			●	●	◎	●	●	●	●	●				◎	◎	◎
Filter drain	Linear drains/trenches filled with a permeable material, often with a perforated pipe in the base of the trench.		●		●	◎		●	●				●	●	●	●						
Filter strips	Vegetated strips of gently sloping ground designed to drain water evenly from impermeable areas and filter out silt and other particulates.			●	●			◎	◎	◎		●	●	●	●					◎	◎	◎
Swales	Shallow vegetated channels that conduct and/or retain water (and can permit infiltration when un-lined). The vegetation filters particulates.		●		●	●		●	●	◎		●	●	●	●			◎		◎	◎	◎
Ponds	Depressions used for storing and treating water. They have a permanent pool and bankside emergent and aquatic vegetation.					●	●		●	◎	●	●	●	●	●	●	●	●	●	●	●	●
Wetlands	As ponds, but the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters the flow. Shallower than ponds.		◎			●	●	◎	●	◎	●	●	●	●	●	●	●	●	●	●	●	●
Detention basin	Dry depressions designed to store water for a specified retention time.					●	●		●			●	◎	◎	●			◎		◎	◎	◎
Soakaways	Sub-surface structures that store and dispose of water via infiltration.				●					●			●	●	●							
Infiltration trenches	As filter drains, but allowing infiltration through trench base and sides.		◎		●	●		◎	●	●			●	●	●	●						
Infiltration basins	Depressions that store and dispose of water via infiltration.					●	●		●	●			●	●	●	●				◎	◎	◎
Green roofs	Vegetated roofs that reduce runoff volume and rate.	●		●	●				●				●	●	●	●	●	●	●	●	◎	●
Bioretention areas	Vegetated areas for collecting and treating water before discharge downstream, or to the ground via infiltration.				●	●			●	●		●	●	●	●	●	●	●	●	●	●	●
Sand filters	Treatment devices using sand beds as filter media.			●		●	◎		●	◎			●	●	●	●	●					
Silt removal devices	Manhole and/or proprietary devices to remove silt.			●								●										
Pipes, subsurface storage	Conduits and their accessories as conveyance measures and/or storage. Water quality can be targeted using sedimentation and filter media.		●			●		●	●			◎	◎									

Key to symbols ● High/primary process ◎ Some opportunities, subject to design

Table 1.7 *Capability of different SUDS techniques*

1 - 16 CIRIA C697

Table A.3 Capability of different SuDS techniques

SuDS treatment train should be used to manage pollution risks. The recommended number of SuDS devices required for runoff from a development generally depends on where the runoff comes. The higher the risk of the runoff carrying pollutants the more treatment is required. Table A.4 below is a useful guideline for managing a SuDS treatment train for a residential or mixed use development.

Table A.4 Recommended Number of Treatment Train Components

Receiving water sensitivity → / Runoff catchment characteristic ↓	Low	Medium	High
Roofs only	1	1	1
Residential roads, parking areas, commercial zones	2	2	2
Refuse collection/ industrial areas/ loading bays/lorry parks/highways	3	3	3

A-4 SuDS Controls

The following is a brief outline of the various SuDS techniques which can be used at source, site and regional:

Source Control

1. *Minimise directly connected impervious areas.*
Provision of rainwater harvesting, rainwater butts, soakaways with overflows, disconnecting roof drains and directing flow to vegetated areas, directing flows from hardstanding areas to stabilized vegetated areas.

2. *Permeable pavement:*
A permeable hardstanding designed to promote infiltration of surface runoff into a permeable sub-base.

3. *Infiltration trench:*
A trench, usually filled with permeable granular material, designed to promote infiltration of surface water to the ground.

4. *Green roofs:*
A roof with vegetation growing on its surface, which contributes to local biodiversity. The vegetated surface provides a degree of retention, attenuation and treatment of rainwater and promotes evapo-transpiration.

5. *Rainwater Harvesting:*
A system that collects rainwater locally rather than allowing it to pass to the drainage system. This rainwater once harvested can then be treated and be reused for domestic uses other than human consumption such as flushing of toilets, washing machines, garden irrigation.

6. *Bioretention Area / Tree Pit:*
A planted area or tree pit that filters surface water through engineered filter material before runoff discharging treated surface water through a perforated overflow pipe back into the main drainage system. This can be used in private areas for run off from roofs and paved areas and also from public roads through integrated kerb inlet slots.

<u>Site Control</u>

7. *Swale:*
A grass channel for stormwater collection with shallow side slopes and gradients to allow ease of maintenance and which is normally dry except during rainfall.

8. *Filter Strip:*
A gentle uniformly sloping vegetated area designed to drain surface runoff as sheet flow from impermeable surfaces and remove sediment.

9. *Extended detention basin:*
A vegetated depression, normally dry, constructed to store surface water temporarily during periods of rainfall to attenuate flows and provide some treatment and possibly infiltration.

10. *Infiltration basin:*
A basin, which is normally dry, that is designed to store and infiltrate surface runoff into the ground.

11. *Existing Ditches:*
Can be utilised where possible to convey runoff from the development to a proposed attenuation area. The ditch will provide treatment, infiltration and storage and mimic the natural catchment behaviour. The existing ditch system should be retained where possible.

12. *Bioretention:*
A drainage practice that utilizes landscaping and soils to treat urban stormwater runoff, filtering it through a designed planting soil media and collecting the flow through perforated under-drainage pipework.

<u>Regional Control</u>

13. *Retention pond:*
A SuDS pond consisting of a significant sized permanent pool of water (up to 4 times the treatment volume for the site) designed to treat surface runoff by detaining the water to provide settling of sediments, and chemical and biological processing as well as provide attenuation. Often used to provide high amenity value

14. *Stormwater wetland:*
A continuously wet area in which the water is shallow enough to enable the growth of bottom-rooted plants. It has a requirement for a continuous base flow to maintain healthy vegetation. Treatment of stormwater can be very effective, but if used for attenuation, consideration needs to be given to the effect of fluctuating water levels on plant life.

Design, details, features and maintenance issues associated with each of these SuDS features are contained in Appendix B of this report.

A-5 Quantity and Quality Performance Requirements

As part of the detail design of the drainage systems within the Baldoyle - Stapolin LAP

Table A.5 below gives a matrix of the benefits of various SuDS techniques for quality, quantity, community and performance.

Table A.5: Quality, quantity, community and performance matrix - CIRIA C697.

SUDS Group	Technique	Water quality treatment potential					Hydraulic Control				Maintenance	Community acceptability	Cost	Habitat creation potential
		Total suspended solids removal	Heavy metals removal	Nutrient (phosphorous, nitrogen) removal	Bacteria removal (*)	Capacity to treat fine suspended sediments and dissolved pollutants	Runoff volume reduction	0.5 (1/2yr)	Suitability for flow rate control (probability) 0.1 – 0.3 (10/30 yr)	0.01 (100 yr)				
Retention	Retention pond	H	M	M	M	H	L	H	H	H	M	H*	M	H
	Subsurface storage	L	L	L	L	L	L	H	H	H	L	H	M	L
Wetland	Shallow wetland	H	M	H	M	H	L	H	M	L	H	H*	H	H
	Extended detention wetland	H	M	H	M	H	L	H	M	L	H	H*	H	H
	Pond/wetland	H	M	H	M	H	L	H	M	L	H	H*	H	H
	Pocket wetland	H	M	H	M	H	L	H	M	L	H	M*	H	H
	Submerged gravel wetland	H	M	H	M	H	L	H	M	L	M	L	H	M
	Wetland channel	H	M	H	M	H	L	H	M	L	H	H*	H	H
Infiltration	Infiltration trench	H	H	H	M	H	H	H	H	L	L	M	L	L
	Infiltration basin	H	H	H	M	H	H	H	H	H	M	H*	L	M
	Soakaway	H	H	H	M	H	H	H	H	L	L	M	M	L
Filtration	Surface sand filter	H	H	H	M	H	L	H	M	L	M	L	H	M
	Sub surface sand filter	H	H	H	M	H	L	H	M	L	M	H	H	L
	Perimeter sand filter	H	H	H	M	H	L	H	M	L	M	L	H	L
	Bioretention/filter strips	H	H	H	M	H	L	H	M	L	H	H	M	H
	Filter trench	H	H	H	M	H	L	H	H	L	M	M	M	L
Detention	Detention basin	M	M	L	L	L	L	H	H	H	L	H*	L	M
Open channels	Conveyance swale	H	M	M	M	H	M	H	H	H	L	M*	L	M
	Enhanced dry swale	H	H	H	M	H	M	H	H	H	L	M*	M	M
	Enhanced wet swale	H	H	M	H	H	L	H	H	H	M	M*	M	H
Source Control	Green roof	n/a	n/a	n/a	n/a	H	H	H	H	L	H	H	H	H
	Rain water harvesting	M	L	L	L	n/a	M	M	H	L	H	M*	H	L
	Permeable pavement	H	H	H	H	H	H	H	H	L	M	M	M	L

**limited data available*
H-high potential
n/a: not applicable
M-medium potential
L-low potential

A-6 Checklist for the SuDS Selection Process

Step 1: Data collation, agreement of preliminary site design criteria.

Step 2: Review development Masterplan and implement pollution prevention and optimum site layout and design, wherever possible.

Step 3: Identify feasibility of within-curtilage source control and sustainable water management options.

Step 4: Divide site into sub-catchments.

Step 5: Determine hydraulic and water quality design requirements (taking account of any benefits already accruing from Steps 2 & 3).

Step 6: Identify feasibility of potential sub-catchment/site source control options (eg infiltration trenches, infiltration swales, infiltration basins), using selection matrices.

Step 7: Identify feasibility of potential sub-catchment/site detention/treatment options (eg detention basins, ponds, wetlands, filter trenches), using selection matrices.

Step 8: Identify feasibility of potential site/regional control options (eg ponds, wetlands,basins etc), using selection matrices.

Step 9: If there is more than one component in the treatment train, are additional conveyance components required to link techniques?

Step 10: Identify feasibility of potential conveyance components (eg swales, infiltration /filter trenches, pipes, overland flood flow routes, wetland channels etc), using selection matrices.

Step 11: Does the identified SUDS management train meet all hydraulic, water quality, amenity and ecological criteria set for the site? (If not return to Step 6).

APPENDIX B - SuDS SELECTION
RATING TABLES FOR VARIOUS SuDS TECHNIQUES

Technique	Land Use Characteristics	Site Characteristics	Catchment Characteristics	Quality and Quantity Performance	Amenity and Environment	Economics and Maintenance	Total
Pervious pavements	24	15	16	12	12	8	**87**
Bioretention	26	21	18	15	16	9	**105**
Filter drains	28	21	15	13	12	8	**97**
Grassed filter strips	27	14	15	10	15	9	**90**
Swales	27	14	14	10	13	10	**88**
Infiltration devices	18	13	16	12	10	7	**76**
Infiltration basin	16	10	15	12	11	7	**71**
Extended detention basin	26	13	12	8	13	10	**82**
Wet ponds	26	18	15	13	20	9	**101**
Stormwater wetlands	27	19	17	17	22	9	**109**
On-/off line storage	17	17	13	4	9	12	**72**

Table 5.1: Decision Criteria for Selecting SUDS Techniques

Land Use Characteristics									
Technique	Urban Development	Car Parks	Roads	Housing	Local Pocket Parks	Existing Development	High Amenity Zoned Lands	Existing Storm Water System	Total Score
Pervious pavements	5	5	3	4	3	2	1	1	**24**
Bioretention	3	4	4	3	5	3	4	3	**29**
Filter drains	4	4	4	4	5	2	2	3	**28**
Grassed filter strips	2	3	5	4	5	3	3	2	**27**
Swales	3	2	5	2	4	3	4	4	**27**
Infiltration devices	2	3	2	4	3	1	2	1	**18**
Infiltration basin	2	3	2	2	3	1	2	1	**16**
Detention basin	3	3	4	4	5	2	3	2	**26**
Wet ponds	2	3	4	4	4	1	4	4	**26**
Stormwater wetlands	2	3	5	4	2	1	5	5	**27**
On-/off line storage	2	3	3	2	3	2	1	1	**17**

Site Characteristics						
Technique	**Space Required**	**Coastal and Tidal Outfall**	**Sensitive Salt Wetlands**	**Low Infiltration rate**	**Water table > 1m**	**Total**
Pervious pavements	5	3	3	3	3	**15**
Bioretention	3	4	4	3	5	**21**
Filter drains	5	3	3	5	5	**21**
Grassed filter strips	2	3	3	3	3	**14**
Swales	2	3	3	3	3	**14**
Infiltration devices	5	3	3	1	1	**13**
Infiltration basin	4	3	1	1	1	**10**
Extended detention basin	3	3	1	3	3	**13**
Wet ponds	2	4	4	4	4	**18**
Stormwater wetlands	1	5	5	4	4	**19**
On-/off line storage	5	3	3	3	3	**17**

Catchment Characteristics								
Technique	**Drainage sub-catchment area**	**<2 ha**	**2-8 ha**	**> 8 ha**	**Site slope**	**0-10%**	**Drain to Sensitive Area**	**Total**
Pervious pavements	Can be used for drainage of any size area provided it is split into sub-catchments	5	3	1	Ideally, level site. If sloping terracing or check dams within pavement required and care to prevent surcharging at low points	4	3	**16**
Bioretention	0.1-0.8 ha max sub- catchment size	5	4	3	Ideally no more than 6-10%, but with careful design can be used on steeply sloping sites	3	3	**18**
Filter drains	4 ha max 0.8 ha max for perimeter filter	5	2	1	Ideally no more than 6-10%	4	3	**15**
Grassed filter strips	2 ha max	5	1	1	Ideally no more than 6-10%	5	3	**15**
Swales	2 ha max	5	1	1	Ideally no more than 4-10%	5	2	**14**
Infiltration devices	2-4 ha max	5	3	1	Ideally no more than 6-10%	4	3	**16**
Infiltration basin	4 ha max	5	2	1	Ideally no more than 15%	4	3	**15**
Extended detention basin	8-10 ha min	1	2	5	Ideally no more than 15%	3	1	**12**
Wet ponds	8-10 ha min	1	2	5	Ideally no more than 15%	3	4	**15**
Stormwater wetlands	8-10 ha min (except for pocket wetlands, 2 ha min)	1	2	5	Ideally no more than 8-15%	4	5	**17**
On-/off line storage	Drainage areas of any size if good-sized flow control devices provided	3	3	3	Place storage parallel to site contours. Care to prevent surcharging in system	3	1	**13**

Quantity and Quality Performance Requirements					
	Treatment Suitability	Hydrological			Total
Technique	Pollutant Removal	Water quality control	Groundwater recharge	Flow Rate Control	
Pervious pavements	4	3	1	4	**12**
Bioretention	4	4	3	4	**15**
Filter drains	4	4	1	4	**13**
Grassed filter strips	3	3	2	2	**10**
Swales	3	3	2	2	**10**
Infiltration devices	2	2	5	3	**12**
Infiltration basin	2	2	5	3	**12**
Extended detention basin	2	2	2	2	**8**
Wet ponds	3	3	3	4	**13**
Stormwater wetlands	5	5	3	4	**17**
On-/off line storage	1	1	1	1	**4**

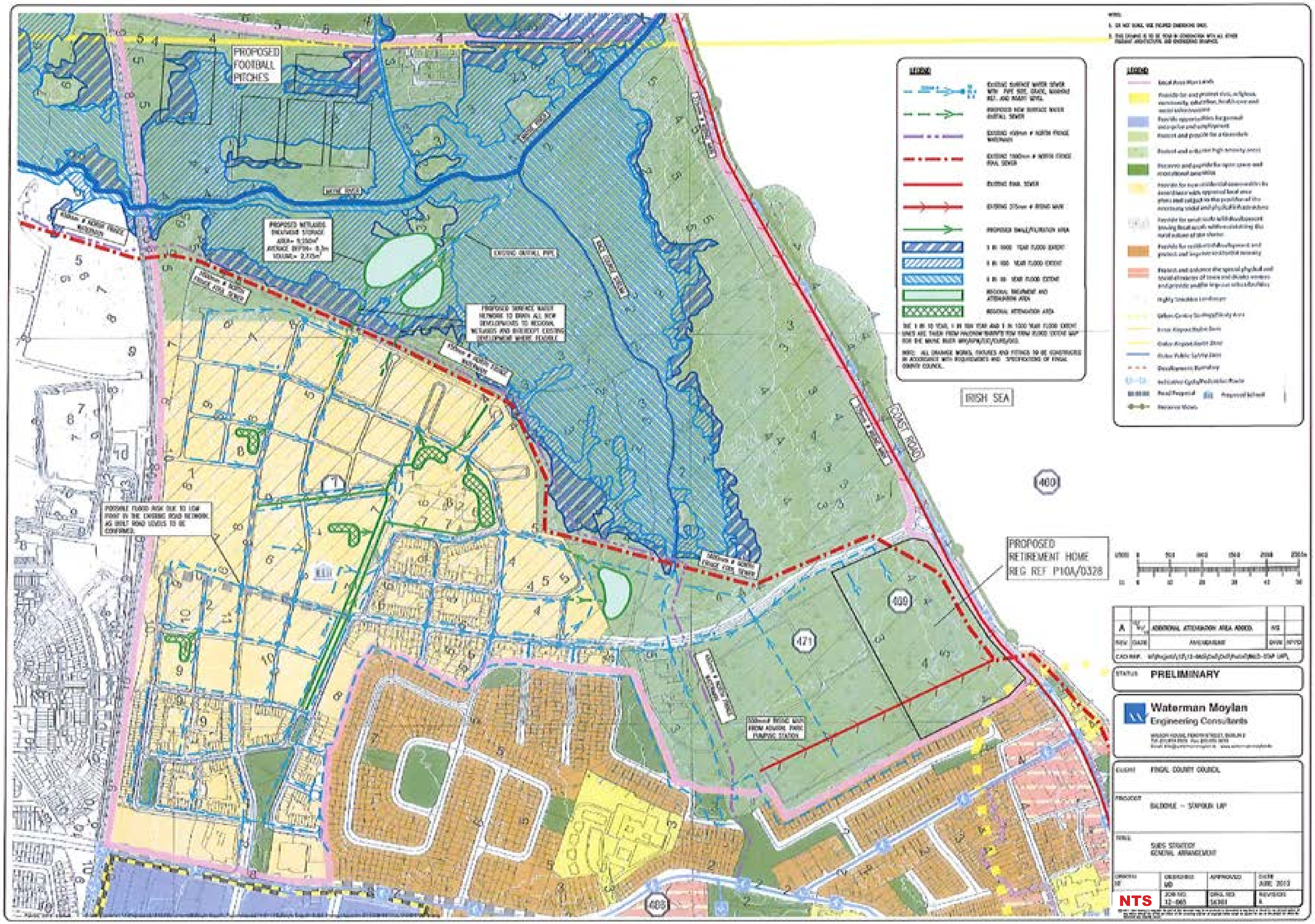
Amenity & Environment											
Technique	Safety		Pond Premium		Aesthetics		Wildlife Habitat		Community Acceptance		Total
Pervious pavements	Very good	5	No	1	Low	2	None	1	Moderate	3	**12**
Bioretention	Very good	4	No	1	High	4	High	4	High	3	**16**
Filter drains	Very good	5	No	1	Low	2	Very low	1	Moderate	3	**12**
Grassed filter strips	Very good	4	No	1	Low to moderate	3	Moderate	3	High	4	**15**
Swales	Good	3	No	1	Moderate	3	L	2	High	4	**13**
Infiltration devices	Very good	4	No	1	Very low	1	Very low	1	Moderate	3	**10**
Infiltration basin	Moderate - design to prevent fast inundation	3	No	1	Low	2	L	2	Moderate	3	**11**
Extended detention basin	Moderate-risk assessment required	3	No	1	Moderate	3	Moderate	3	Moderate	3	**13**
Wet ponds	Moderate-risk assessment required	3	Yes	5	High	4	High	4	High	4	**20**
Stormwater wetlands	Varies-risk assessment required	3	Yes	5	Very high	5	Very high	5	High	4	**22**
On-/off line storage	Very good	3	No	1	None	1	None	1	Moderate	3	**9**

Economics and Maintenance							
Technique	**Life span**		**Initial Cost**		**Maintenance Burden**		**Total**
Pervious pavements	Very High	2	Moderate	3	Moderate	3	**8**
Bioretention	Moderate	3	Moderate to High	3	Moderate to High	3	**9**
Filter drains	Moderate	2	Moderate to High	3	Moderate to High	3	**8**
Grassed filter strips	High	2	Low (cost of land can be high)	5	Low	2	**9**
Swales	Very High	3	Moderate	5	Moderate	2	**10**
Infiltration devices	Moderate to High	2	Moderate	3	Moderate	2	**7**
Infiltration basin	Moderate to High	2	Moderate	3	Moderate	2	**7**
Extended detention basin	High	4	Low (cost of land can be high)	2	Low	4	**10**
Wet ponds	Very High	4	Low (cost of land can be high)	1	Low	4	**9**
Stormwater wetlands	High	4	Moderate (cost of land can be high)	1	Low	4	**9**
On-/off line storage	Moderate to High	4	Moderate to High	4	Low	4	**12**

APPENDIX C

SuDS Strategy

General Arrangement



APPENDIX D SuDS Strategy SuDS Features

Table of Contents

1. **Introduction**

1.1. **Purpose of this Report**

This report sets out a description of the SuDS features considered as possible options for incorporating into the detail design of the Baldoyle-Stapolin LAP lands

Also included is an assessment of the water quality improvement that may be achieved by the correct implementation of the specific feature described in terms of the percentage removal of pollutants of concern.

2. **Suds Features**

Tree Pits and Bio-Retention Areas

Tree pits and bio-retention areas receive surface water runoff from hard standing areas including roads and car parks. The surface water drains through engineered filter material lying on top of a perforated pipe surrounded in voided stone. This perforated underdrain system discharges the treated surface water back into to the main surface water sewer system.

Tree pits and bio-retention areas can be easily incorporated into the landscaping scheme for existing and proposed developments. They can be utilized as a retrofit SuDS feature for existing developments. Existing surface water systems can be diverted through these tree pits and/or bioretention areas before discharging the treated surface water back into the existing network.

	Percentage removal of pollutants of concern					
Techniques	Total Susp. Solid	Hydro-Carbons	Total Phos-phorous	Total Nitrogen	Faecal Coli-forms[5]	Heavy Metals
Bio-retention areas	50-85	93-99	60-80	42-49	-	64-95

Figure A.1 Example of a Bioretention Area

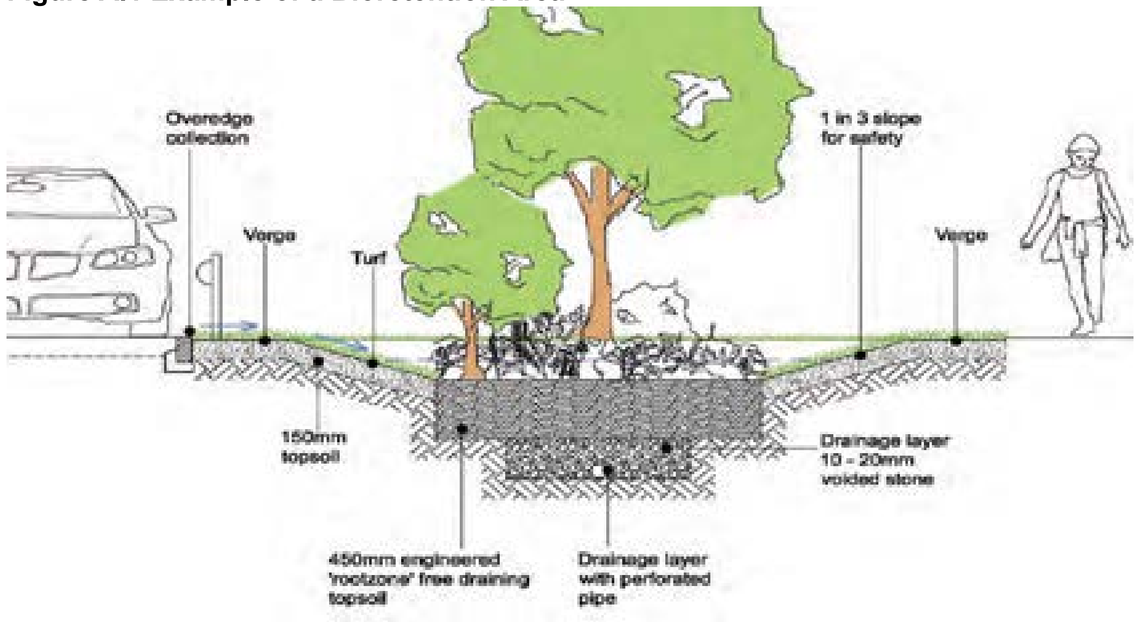


Figure A.2 Example of Tree Pits

Detention Basin

Dry (extended) detention basins/ponds are designed to detain the stormwater runoff from a design storm event and to allow sediment particles and associated pollutants to settle out. Unlike wet ponds, dry extended detention ponds do not have a permanent pool of water.

Detention basins are normally vegetated depressions that are mainly dry, except during and immediately after storm events. Detention basins can be constructed as on-line or off-line structures, and can be used as parks, playgrounds or sports fields.

The basins can be sized to accommodate the 1/30 and 1/100 storm events in accordance with criterion 2.1 and 2.2 of the GDSDS volume 2 "New Development". A series of high level overflows can be provided of storm events in excess of the design storm.

Best practice for the geometric design of basins suggests that the bottom of the basin should be relatively flat with gradients not in excess of 1/100 towards the outlet. This is to maximize contact with vegetation and to prevent standing water in the detention area. The length to width ratio is to be between 2:1 and 5:1. Side slopes should not exceed 1:4 wherever mowing is required in order to reduce risks associated with maintenance activities.

The ecological value of the basins can be significantly improved through the provision of a micropool or wetland at the base/outlet, and for basin serving large developments and discharging directly to watercourse a sediment forebay or other upstream component will improve water quality. Extended detention ponds can be used in almost all soils and geology, with minor design adjustments for regions of karst (i.e., limestone) topography or in rapidly percolating soils such as sand. In these areas, extended detention ponds should be designed with an impermeable liner to prevent groundwater contamination or sinkhole formation.

Dry extended detention basins provide moderate pollutant removal. While they can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants due to the absence of a permanent pool. A few studies are available on the effectiveness of dry extended detention ponds. Typical removal rates, as reported by Winer, R. 2000. National Pollutant Removal Database for Stormwater Treatment Practices: 2^{nd} Edition. Center for Watershed Protection, are:

	Percentage removal of pollutants of concern					
Techniques	Total Susp. Solid	Hydro-Carbons	Total Phos-phorous	Total Nitrogen	Faecal Coli-forms[5]	Heavy Metals
Detention Basins	29-93	-	7-32	15-47	-	29-54

Figure A.3 Example of a Detention basin

Figure A.4 Detention basin

Retention basin

Retention basins are basins or ponds that have a permanent pool of water. During a rainfall event the runoff entering the pond is detained and treated through the settlement of suspended sediments and biological uptake until it is displaced by runoff from the next storm. The pond should be designed for ease of maintenance, and should contain several zones:

1. The sediment forebay: Interception and treatment storage should ideally be accommodated up catchment. Where there are residual sediment risks, or where a sediment forebay is the only suitable management option at the site, then the pond can be split to allow coarse sediments to settle in the forebay before the runoff enters the permanent pool.

2. The permanent pool that will remain throughout the year. The permanent pool acts as the main treatment zone and helps to protect fine deposited sediments from re-suspension. The top water level for this volume should set to the invert level of the outlet structure. The use of an impermeable lining (geotextile liner or puddle clay) will help maintain the permanent water level.

3. The temporary storage volume provides flood storage and attenuation for up to the 1/100 year storm event or as required.

4. The shallow zone (aquatic bench) along the edge of the permanent pool to support wetland planting. This acts as a biological filter and provides ecology, amenity and safety benefits.

The inlet and outlet structure should be ideally placed to maximise the flow through the basin, other features such as baffles, islands, and pond shaping will also help increase the flow path hence improving the sedimentation and treatment process.

The basins can be sized to accommodate the 1/30 and 1/100 storm events in accordance with criterion 2.1 and 2.2 of the GDSDS volume 2 "New Development". A series of high level overflows can be provided of storm events in excess of the design storm.

Retention basins provide good to moderate pollutant removal the removal of major pollutants to watercourse by this method is given in the table below:

	Percentage removal of pollutants of concern						
Techniques	Total Susp. Solid	Oils & Grease	Total Phos-phorous	Total Nitrogen	Bacteria	Heavy Metals	Nitrates
Retention Basin	29-93%	-	7-33%	15-47%	78%	29-54%	24%

Figure A.5 Retention Basin

Figure A.6 Retention Pond

Stormwater Wetland

Storm Water wetlands are specifically constructed to treat pollutants in runoff and comprise a basin with shallow water and aquatic vegetation that provides infiltration. They are one of the most effective SUDS techniques in terms of pollutant removal and offer valuable wildlife habitat as well as important aesthetic benefits to the area. Wetlands are constructed marsh systems providing varying degrees of deep and shallow water. They are not normally designed to provide significant attenuation but if required to act as a water detention device the temporary storage may be provided above the level of the permanent water level.

Wetlands consist of the following elements:

- Shallow vegetated areas of varying depths
- Permanent pool, or micropool
- Small depth range overlying the permanent pool, in which runoff volumes are stored
- Sediment forebay
- Overflow or emergency spillway

Wetlands are the most effective type of SUDS in terms of pollutant removal. As storm run-off flows through the wetland, pollutant removal is achieved through settling and biological uptake within the facility. Stormwater wetlands can provide significant reductions in sediment, nutrient, heavy metals, toxic materials, floatable materials, oxygen demanding substances, oil and grease as well as a partial reduction in bacteria and viruses.

The average removal of pollutants by stormwater wetlands is shown in Table 4.6

	Percentage removal of pollutants of concern[1,2,3]					
Techniques	Total Susp. Solid	Hydro-Carbons	Total Phos-phorous	Total Nitrogen	Faecal Coli-forms[5]	Heavy Metals
Storm Water Wetlands	80-90	50-80	30-40	30-60	-	50-60

1) The performance of SUDS is subject to a number of variables and the values should not be considered or used as absolute values.
2) Summary based on design values provided in Atlanta Regional Commission (200l), Barren (1998). New Jersey Department of Environmental Protection (ZOOO), Highways Agency et a1 (1998b) and reviewed against mean values quoted by United States Environmental Protection Agency (I999a to I999n) and median removal efficiency quoted by Centre for Watershed Protection (Winer. 2000).
3) Stormwater pollution concentrations are dependent on various factors and the performance of the SUDS techniques will vary. For any one storm event the observed performance may not reach the specified level (it may also be exceeded). This can be allowed for in design.
5) Removal rate for faecal coli-form is based on no resident wildfowl population in ponds and wetlands.
- Insufficient data to quote removal rate.

Table: Estimates of pollutant removal capability of Stormwater Wetlands for ` assessment of SUDS management trains (CIRIA C609)

Figure A.7a Stormwater Wetland

Figure A.7b Stormwater Wetland

Figure A.8 Stormwater Wetland

Permeable Surfacing

Although pervious pavements are traditionally constructed using granular material for the sub-structure into which the water percolates, there are a range of high voids-ratio plastic media products also available. Voids ratios range from 30 to 95%. The water quality outflow from these pavements is generally high. It is thought that the treatment is mainly achieved by the geo-textile membrane (preferably unwoven) placed immediately below the blockwork. Therefore although geotextile might usefully be placed at the bottom of the structure for other reasons, it is unlikely to contribute to treatment of the surface water at this location. Several permeable pavements have been monitored in the UK and elsewhere in the world. The volumetric reduction is largely a function of whether the pavement is lined or not, and seasonal effects. Short storms in summer often have only a nominal outflow, while long wet winter events do not achieve a significant volume reduction compared with standard drainage.

The performance of unlined pavements is a function of both the receiving soil type and construction technique, as it has been found that permeable surfaces can have their porosity significantly reduced by the construction process. It is reported that unlined pavements, even in clays, still achieve considerable reductions of runoff for ordinary events.

For systems designed to only drain by infiltration, it is important to provide a relief pipe to cope with excess runoff in case of reduced infiltration rates and / or very extended wet periods, where surcharge would be a problem. Reduction of runoff over a season of rainfall may be very great, but hydraulic design of these units should be based on their performance under extreme conditions.

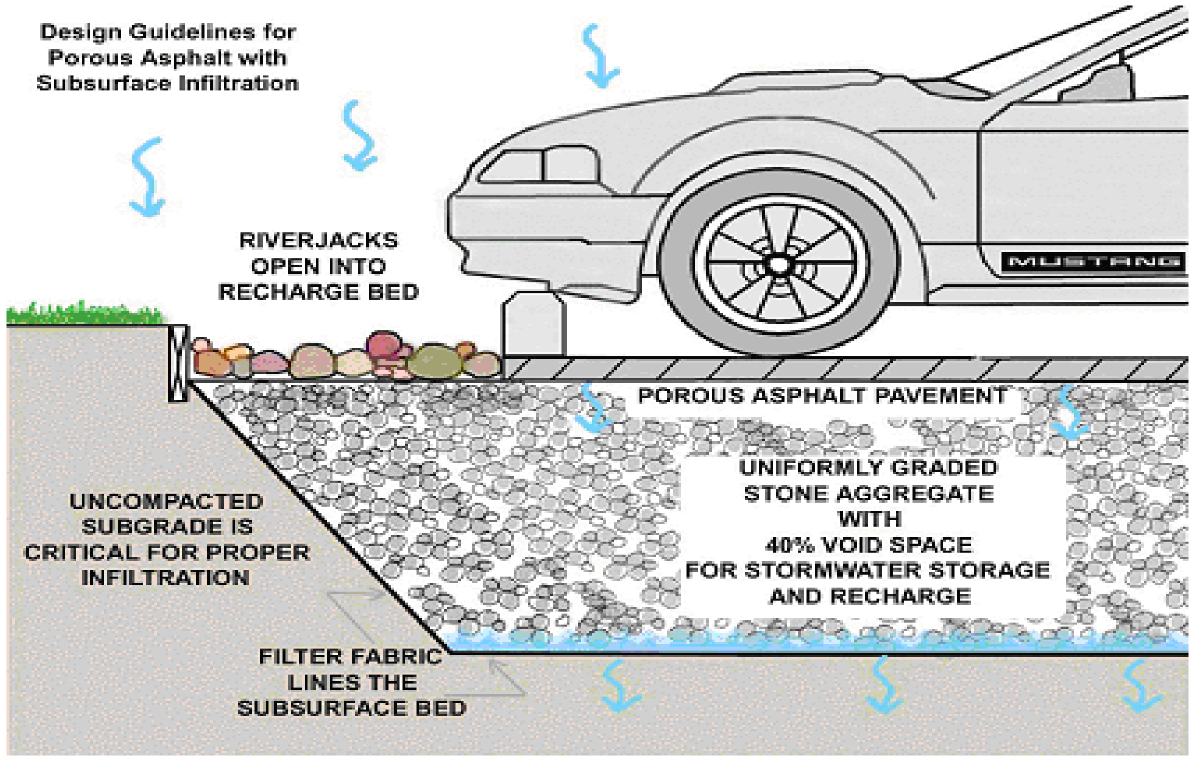
Lined pavements are built where there is a concern to protect the groundwater from pollutants. For lined systems, runoff reductions are still significant although less than unlined systems. During long wet winter periods, runoff volumes might only be reduced by 30 percent in lined permeable pavements, though average annual figures have been found to be up to 55 percent. Observed runoff rates from these mechanisms, even in the wettest periods, are low, usually below 2l/s/ha, for much of the storm runoff volume. The maximum flow rates recorded are in the order of 25l/s/ha, but these may have been constrained by the outlet pipe system. The figures suggest that these units are very effective in limiting the impact of runoff on receiving streams and urban drainage systems.

	Percentage removal of pollutants of concern					
Techniques	Total Susp. Solid	Hydro-Carbons	Total Phos-phorous	Total Nitrogen	Faecal Coli-forms[5]	Heavy Metals
Pervious Pavements	60-95%	70-90%	50-80%	65-80%	-	60-95%

1) The performance of SUDS is subject to a number of variables and the values should not be considered or used as absolute values.
2) Summary based on design values provided in Atlanta Regional Commission (200l), Barren (1998). New Jersey Department of Environmental Protection (ZOOO), Highways Agency et a1 (1998b) and reviewed against mean values quoted by United States Environmental Protection Agency (I999a to I999n) and median removal efficiency quoted by Centre for Watershed Protection (Winer. 2000).
3) Stormwater pollution concentrations are dependent on various factors and the performance of the SUDS techniques will vary. For any one storm event the observed performance may not reach the specified level (it may also be exceeded). This can be allowed for in design.
5) Removal rate for faecal coli-form is based on no resident wildfowl population in ponds and wetlands.
- Insufficient data to quote removal rate.

Figures 4.2a and 4.2b below show examples of how porous asphalt and permeable paving can be used throughout the individual developments to delay/reduce storm water runoff.

Figure A.9 Permeable Paving



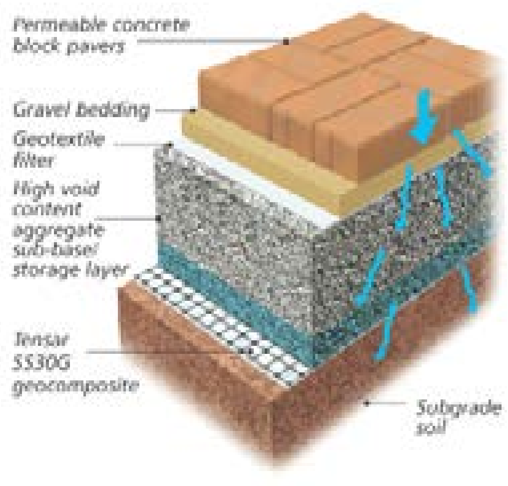
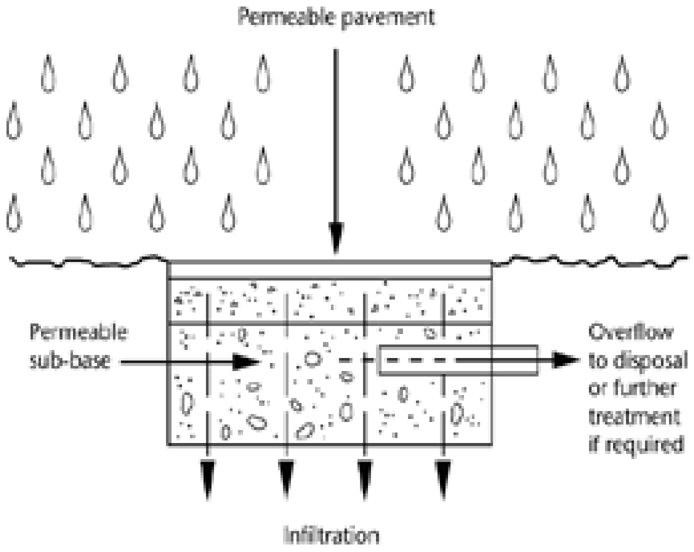


Figure A.10 Permeable Paving Dentails



Infiltration Basin

These are designed depressions for the storage of stromwater runoff for infiltration into the subgrade. This facilitates the recharge of groundwater resources and replenishment of surface water base flows. Infiltration Basins also have the additional benefit of significantly removing pollutants and suspended solids through the process of filtration through the underlying unsaturated soils.

Infiltration basins are ideally used for small storm events and should be used to treat surface water runoff, in an offline function, from smaller catchments. Pretreatment prior to infiltration is required to ensure long-term performance of the basin.

Infiltration basins require a large accessible are which is relatively flat and highly pervious. The side slopes are to be no steeper than a grade of 1:4 to facilitate maintenance, and grass cutting. The basin floor should level, and design should account for seasonally high water tables, and provide a minimum of 1.0m of unsaturated soils, beneath the base of the device, for infiltration purposes.

Figure A.11 Infiltration Basin

Infiltration Trench

Infiltration trenches are shallow excavations filled with gravel, rubble, stones or other void forming media creating a temporary subsurface storage for storm water runoff.

Infiltration trenches can be used to capture point flow, from down pipe gully connection etc, or sheet flow from a paved surface. The surface water runoff is treated through infiltration through the soil. This reduces the runoff volumes, recharges groundwater and retards flows to the watercourse.

Trenches are best located adjacent to impermeable surface such as car parks or access roads, and can be incorporated into landscaping and public open spaces, and through good design minimize land take requirements. Infiltration trenches can be located underneath open spaces enabling a dual use of lands.

Infiltration trenches are best used where on sites without significant slopes. The longitudinal slopes should generally not exceed 2%, as treatment of surface water flows is ideally suited to the lower flow velocities in the trench. The water table seasonal highs should be at least 1.0m below the invert of the trench to provide for an adequate infiltration rate and treatment in the unsaturated soils.

There are three elements to the design of filter trenches that require consideration:

1. Design of filter material to percolate water.
2. Design of filter material to store water
3. Design of pipe system to convey water

Fill materials are normally graded stone/rock 40-60mm in diameter, as it is important that the voids ratio is sufficiently high to allow for adequate percolation.

Geotextiles should be used to prevent soil piping but should have a greater permeability that the subsoil's it drains to.

Figure A.12 Infiltration Trench

Swales

Swales are linear vegetated drainage strips typically provided along roads in grass verges and in public open spaces to delay/reduce runoff in times of extreme storm events.

The objective is to use the swale as a retention basin and for runoff treatment, with flows passing to a perforated drainage pipe below the swale. This enables the swale to be designed as a balancing system with a controlled outflow based on the pipe size serving the system of swales. The great advantage of this system is that there is considerably less risk of erosion from flows passing along the swale as they will tend to be short individual lengths. The physical problems related to pipe connections, which are needed to pass under roads and driveways crossing the swale, are also avoided. Inflow / outflow design should be based on infiltration techniques and the hydraulic constraint of the receiving pipe. In addition the under-drain is likely to have a continuous low flow during wet winter periods and some account of this should be made in checking on the possible range of the system performance. Design therefore requires careful application to make the most of this drainage system.

Figure A.13 Schematic of Swale area in public open space along/between roads

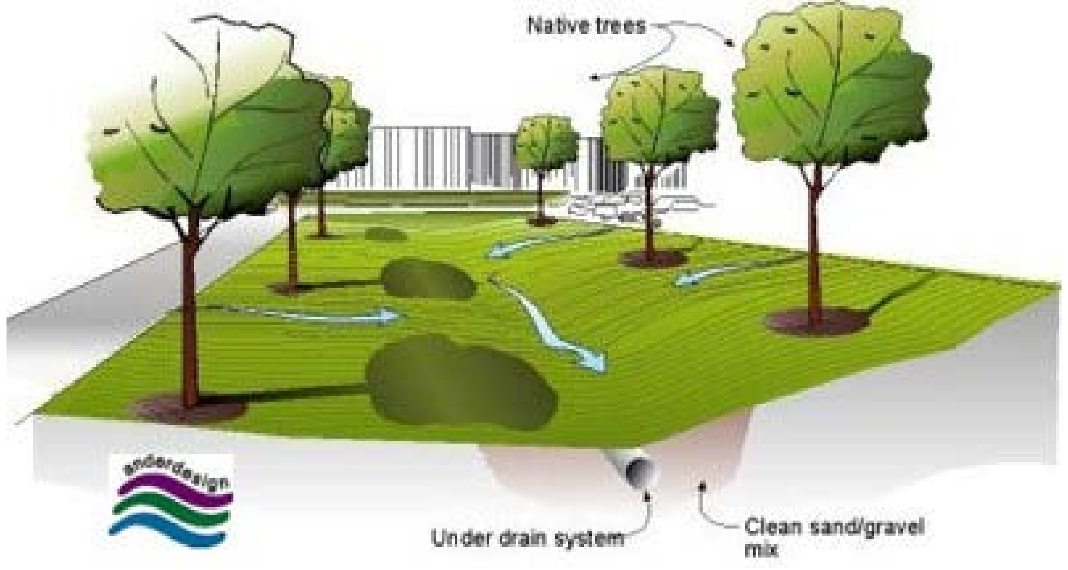


Figure A.14 Swale

Figure A.15 Swale – Flow restriction through pipe diameter

Soakaways for Hard Areas

Soakaways can be used for roof water only, as the high sediment loads from road runoff usually cause blockage problems within 20 years.

All soakaway structures should be evaluated for extreme event exceedence and provided with overflow pipework where a certain level of service cannot be assured and there is a risk of flooding as a result. Consideration of topography is important to ensure overland flows are directed away from properties. Infiltration trenches are an alternative to soakaways. They tend to be more effective in many instances as they allow much greater efficiencies to be achieved, due to the units having greater surface area per unit volume. Also as the bottom of the trench tends to be nearer the surface than the base of a soakaway, this reduces the risk of direct interaction between the infiltration unit and the groundwater table.

The use of Infiltration trenches in private properties to serve roofs is at some risk due to landscaping and gardening activities. They should be located at sufficient depth to ensure that they are unlikely to be damaged. They should not be located on common boundaries as construction of fences and hedges will damage the drainage system. The location of filter drains should theoretically be constrained in the same way as soakaways, and should be at least 5m from the property in compliance with Building Regulations. However as they are not deep, it is suggested that the minimum distance should be at least three times the depth of the trench, assuming adjacent buildings have appropriate foundations.

In the UK, where pervious pavements have been used as infiltration units, these have been located as close as 1m from the property where the soil is highly permeable. A 10 year event is commonly used for design of property infiltration systems. However this might be increased significantly if they are seen as one of the mechanisms for meeting the requirement for "long term" storage.

These mechanisms should individually serve only one or very few properties. This is needed to avoid flow taking place along a trench to a low point and focusing all the potential flooding in one garden / location.

Soakaways should be provided on each individual property taking runoff from the dwelling roof. A series of soakaways shall be linked together by means of overflow pipes should the inflow exceed the infiltration rate. With this overflow discharging into the main storm water system.

Figure A.16 Soakaway cross-section

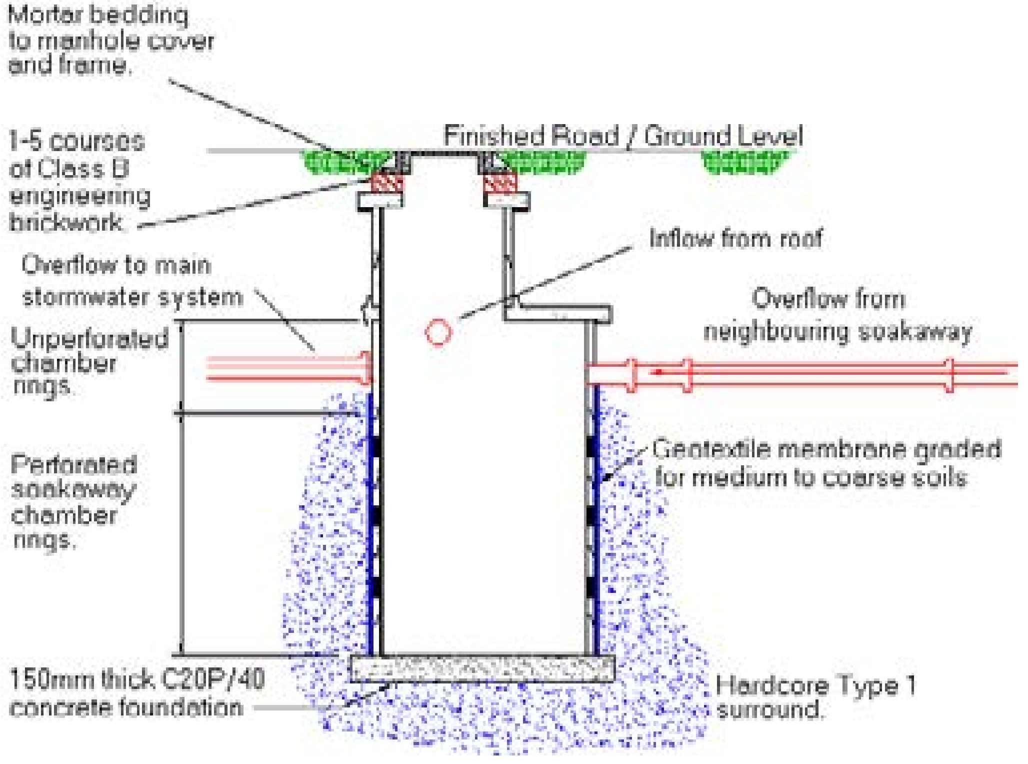
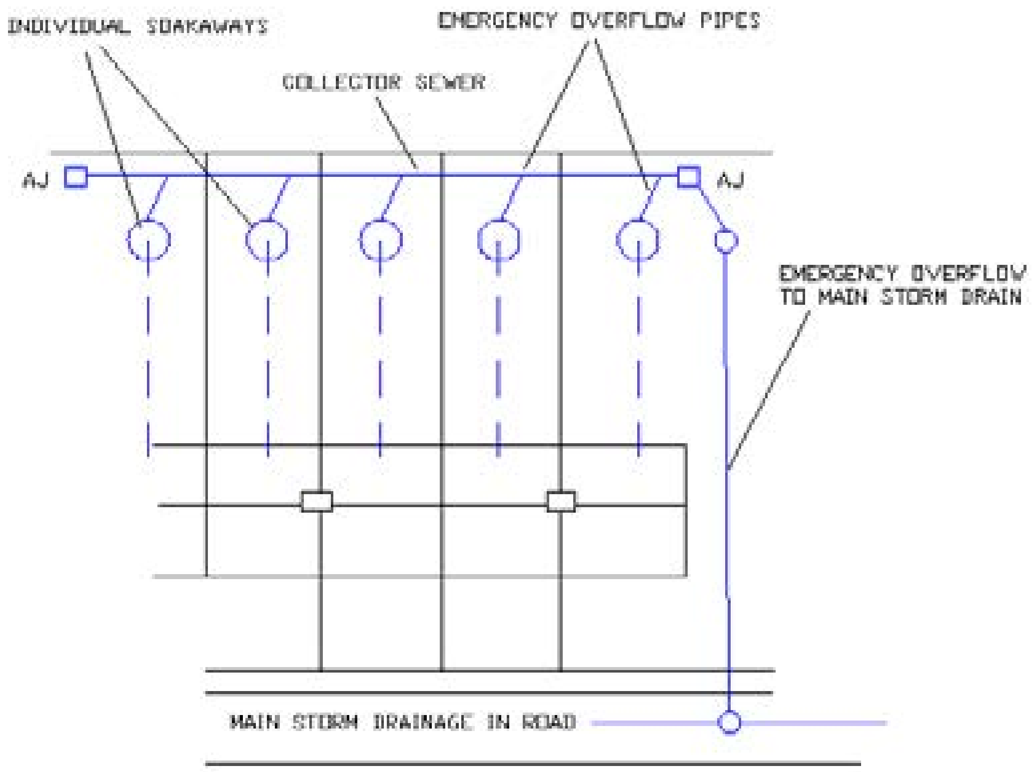


Figure A.17 Plan view - Soakaways in series.



Rainwater Harvesting

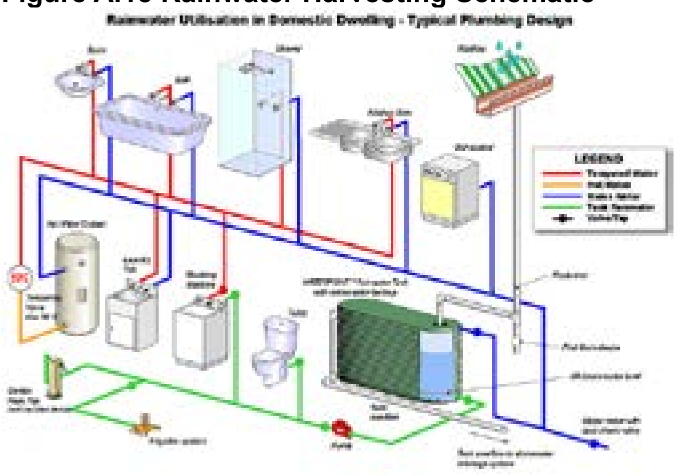
Rainwater harvesting is the collection and storage of rain from roofs for future use. The water is generally stored in rainwater tanks and piped back into residential industrial or commercial development to be used for general domestic use, irrigation, and landscaping uses. The rainwater storage tank shall have an overflow pipe to the main sewer or soakaway/infiltration system.

These systems are installed to be used in normal everyday use and for the mains to takeover/provide supply automatically in times of dry weather. It has the following advantages;

- Softer water for washing - less corrosion on machinery and less detergents used
- Ideal for garden watering as the water is soft and contains no chlorine
- Reduces burdens sewerage systems.
- Rainwater is ideal in industry and commercial buildings, especially for low grade process water
- Reduces future investment in increasingly expensive and lengthy projects for new water developments
- Reduces pressure on water resources
- Suitable for washing vehicles
- Reduction on expensive treatment of mains water using power and chemicals
- Contributes to reduced flooding problems
- Reduces demand for mains water.

Sizing of the rainwater harvesting systems should be based on average rainfall data for the area and expected demand for harvested water in order to provide an efficient sizing for the storage tank.

Figure A.18 Rainwater Harvesting Schematic



Green Roofs

Green roofs are a multi-layered system that covers the roof of a building or podium structure with vegetation over a drainage layer.

Green roof systems are used to reduce the volume and rate of runoff from development roofs, and hence reduce the amount of hardstanding resulting from a development.

There are three main classifications of greenroofs:

Extensive green roofs - These cover the entire roof area with low growing low maintenance plants. This system comprises of 25mm-125mm of hardy drought tolerant mosses, succulents, herbs and grasses.

Intensive green roofs – These are landscaped environments of high amenity which include trees grasses shrubs and planters. Intensive green roofs can be used for the storage of stormwater.

Simple intensive green roofs – These are vegetated with lawns or ground covering plants. These roof systems require regular maintenance.

Figure A.19 Extensive Greenroof system

Figure A.20 Intensive Greenroof system

Strategic Flood Risk Assessment (SFRA)

Table of Contents

1.0 INTRODUCTION

1.1 Requirement for a Flood Risk Assessment

Fingal County Council is in the process of preparing a Local Area Plan for the Baldoyle-Stapolin for the period 2012-2018 which will provide a 6 year statutory framework which will inform and guide development.

In accordance with Section 28 of the Planning and Development Act 2000 as amended, the planning authority shall have regard to any guidelines issued by the Minister of the Environment, Heritage and Local Government to planning authorities in the performance of their functions including the preparation of Development Plans.

The Minister has published statutory Planning Guidelines on "The Planning System and Flood Management – Guideline for Planning Authorities" in November 2009 and these guidelines focus on providing comprehensive consideration of flood risk in the preparing of Regional Plans, Development Plans and Local Area Plans, and in determining applications for planning permission.

Waterman Moylan have been appointed by Fingal County Council to carry out a Strategic Flood Risk Assessment in accordance with these guidelines to inform the Local Area Plan.

It is the responsibility of each applicant for planning permission to determine the flood risk pertaining to the lands upon which development is proposed and to include appropriate mitigation works as part of the proposed development for which permission is sought.

1.2 The Planning Guidelines and Flood Risk Management

The assessment of flood risk requires an understanding of the source of the floodwaters, the process and direction of flow and the people and assets affected by flooding. The Guidelines introduce the mechanism of Flood Risk Assessment (FRA) into the planning process by incorporation of flood risk identification, assessment and management.

The core objectives of the Guidelines are to:

- Avoid inappropriate development in areas at risk of flooding;
- Avoid new developments increasing flood risk elsewhere, including that which may arise from surface water run-off;
- Ensure effective management of residual risks for development permitted in floodplains;
- Avoid unnecessary restriction of national, regional or local economic growth;
- Improve the understanding of flood risk among relevant stakeholders;
- Ensure that the requirements of the EU and national law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management.

These core objectives are achieved through the process of Flood Risk Assessments. The level of detail required for a Flood Risk Assessment depends on the purpose of the FRA. In the subject case of the making of the Baldoyle-Stapolin Local Area Plan 2012-2018, a Strategic Flood Risk Assessment (SFRA) is required to inform that plan making process.

To achieve the objectives of the Guidelines, the following principles are applied:

- Avoid the risk, where possible
- Substitute less vulnerable uses where avoidance is not possible, and
- Mitigate and manage the risk, where avoidance and substitution is not possible.

1.3 Structure of the Flood Risk Assessment

The Guidelines recommend that a staged approach is adopted when undertaking a Flood Risk Assessment (FRA). The recommended stages are briefly described below:

- Stage 1 – Flood Risk Identification
  To identify whether there may be any flooding or surface water management issues that will require further investigation. This stage mainly comprises a comprehensive desk study of available information to establish whether a flood risk issue exists or whether one may exist in the future.

- Stage 2 – Initial Flood Risk Assessment
  If a flood risk issue is deemed to exist arising from Stage 1 Flood Risk Identification process, the assessment proceeds to Step 2 which confirms the sources of flooding, appraises the adequacy of existing information and determines the extent of additional surveys and the degree of modelling that will be required. Stage 2 must be sufficiently detailed to allow the application of the sequential approach (as described in Section 1.4.2 herein) within the flood risk zone.

- Stage 3 – Detailed Flood Risk Assessment
  Where Stages 1 and 2 indicate that a proposed area of possible zoning or development may be subject to a significant flood risk, a Stage 3 Detailed Flood Risk Assessment must be undertaken.

1.4 The Flood Risk Assessment Process for the Planning Authority

1.4.1. Scales of Flood Risk Assessments

Flood Risk Assessments are undertaken at different scales by different organisations for many different purposes. The scales are as follows:

- Regional Flood Risk Appraisal (RFRA): A regional Flood Risk Appraisal provides a broad overview of the source and significance of all types of flood risk across a region and highlights areas where more detailed study will be required. These appraisals are undertaken by regional authorities.
- Strategic Flood Risk Assessment (SFRA): A Strategic Flood Risk Assessment provides a broad (area-wide or country-wide) assessment of all types of flood risk to inform strategic land use planning decisions. The SFRA allows the Planning Authority to undertake the sequential approach (described below) and identify how flood risk can be reduced as part of the development plan process.
- Site Flood Risk Assessment (Site FRA): A Site FRA is undertaken to assess all types of flood risk for a new development. This requires identification of the sources of flood risk, the effects of climate change on the food risk, the impact of the proposed development, the effectiveness of flood mitigation and management measures and the residual risks that then remain.

A Strategic Flood Risk Assessment (SFRA), which provides a broad (area-wide or country-wide) assessment of all types of flood risk to inform strategic land use planning decisions is the appropriate scale of assessment for a local area plan.

1.5 Key Outputs from the Flood Risk Assessment

The key outputs are:

- To provide for an improved understanding of flood risk issues within the Development Plan and development management process, and to communicate this to a wide range of stakeholders;
- To produce an assessment of existing flood defence infrastructure and the consequences of failure of that infrastructure and to identify areas of natural floodplain to be safeguarded;
- To produce a suitably detailed flood risk assessment that supports the application of the sequential approach in key areas where there may be tension between development pressures and avoidance of flood risk;
- To inform, where necessary, the application of the Justification Test;
- To conclude whether measure to deal with flood risks to the area proposed for development can satisfactorily reduce the risks to an acceptable level while not increasing flood risk elsewhere;
- To produce guidance on mitigation measures, how surface water should be managed and appropriate criteria.

2.0 FLOOD RISK

2.1 Components of Flood Risk

Flood risk is defined as a combination of the likelihood of flooding occurring and the potential consequences arising from that flooding.

The likelihood of flooding is defined in the Guidelines as follows:

"Likelihood of flooding is normally defined as the percentage probability of a flood of a given magnitude or severity occurring or being exceeded in any given year."

The consequences of flooding depend on the following:

"Consequences of flooding depend on the hazards associated with the flooding (e.g. depth of water, speed of flow, rate of onset, duration, wave action effects, water quality), and the vulnerability of people, property and the environment potentially affected by a flood (e.g. the age profile of the population, the type of development, presence and reliability of mitigation measures etc)."

2.2. Source-Pathway-Receptor Model

The Source – Pathway – Receptor Model (SPR Model) is a widely applied model which is used to assess and inform the management of environmental risk.

Source – The origin of a hazard (for example, heavy rainfall, strong winds, surge, etc).
Pathway – Route that a hazard takes to reach Receptors. A pathway must exist for a Hazard to be realised.
Receptor – Receptor refers to the entity that may be harmed (a person, property, habitat, etc).

For example, in the event of heavy rainfall (the source) flood water may propagate across the flood plain (the pathway) and inundate housing (the receptor). The vulnerability of a receptor can be modified by increasing its resilience to flooding.

3.0 STRATEGIC FLOOD RISK ASSESSMENT

3.1 Introduction

The Strategic Flood Risk Assessment provides an appraisal and assessment of available flood risk data for the land-use proposals within the boundaries of the Baldoyle-Stapolin Local Area Plan 2012-2018. This process identifies flood risk indicators in each area and, where it is demonstrated that lands may be at risk of flooding, recommends modifications to land-use proposals or the carrying out of more detailed flood risk assessment as appropriate.

3.2 Available Flood Risk Data

Floodmaps.ie

The OPW maintain a flooding database at floodmaps.ie.

From examination of the database there are records of previous tidal or fluvial flooding in this immediate area indicated on the OPW Flood maps, but none within the RA zoned section of the site. The floodmaps.ie generated report identifies all flooding within 2.5 km of the site. These 11 flooding instances listed are unlikely to directly impact on the Objective RA zoned lands provide for new residential communities in accordance with approved local area plan. However, of the 11 flooding instances listed within 2.5 km of the site, the Baldoyle Coastal recurring (11) and Coast Road Flood Event 24 October 2011 (1) are adjacent the open space zoned lands along Coast Road within the LAP boundary. The Mayne River Bridge recurring (9) is adjacent the halting site along Mayne Road, also within the LAP boundary.

The Floodmaps.ie report for the site is attached in Appendix A.

FEMFRAMS

The Fingal East Meath Flood Risk Assessment and Management Study has been examined to determine the existing and potential future tidal and fluvial flooding proximate to the site.

The water levels predicted by the FEMFRAMS Tidal Flooding Current Scenario for an exceedance of 0.1 % (1 in 1,000 year) and the FEMFRAMS Mayne River Fluvial Flooding Current Scenario for an exceedance of 0.1 % (1 in 1,000 year) in the vicinity of the LAP lands are set out in Table 3.1

Table 3.1 FemFrams 0.1% Current Scenario

Node	Location	Flood Level OD Malin	
		Fluvial	Tidal
1Ma906	North of the site (Mayne)	4.23	4.02
1Maa675	North east of the site (Mayne)	3.46	3.11
070	East of the site (Coastal)	-	3.39
074	North east of the site (Coastal)	-	3.41

As can be seen from the Flood Extent Maps attached (in Appendix B) the extent of the flooding is outside the residential zoned lands.

However, the northern section of the RA lands is adjacent to the flood zone area. The housing / halting site along Mayne Road is also immediately adjacent the flood zone area, as is the open space area along Coast Road.

The FEMFRAMS Flood Risk Management Plan states that “Baldoyle is affected by both fluvial and tidal flooding. There is a large bank of agricultural land at risk from out of bank flooding from the Mayne River”.

TOPOGRAPHICAL SURVEY

A topographical survey was provided by Fingal County Council and this survey was used in conjunction with the FEMFRAMS flood maps to assess the potential of fluvial and tidal flooding of the development lands within the LAP.

DELFT STUDY 2000

The previous assessment of the Baldoyle coastal flooding was reviewed. The assumptions therein are not as robust as the FEMFRAMS study, and were therefore discounted.

DUBLIN COASTAL FLOODING PROTECTION PROJECT

The 2005 Dublin Coastal Flooding Protection Project Final Report (Royal Haskoning) was reviewed. Section 5.3.1 outlined the options available to protect five specific areas within Baldoyle Estuary. These where at:

Location 1: North of Baldoyle Town Centre
Location 2: South of Mayne River
Location 3: North of Mayne River
Location 4: Northwestern end of Baldoyle Estuary
Location 5: Southern End of Portmarnock

The options outlined general require the construction of flood protection barriers to a minimum of 3.75 m OD Malin in each of the areas.

The works provided will offer protection against tidal flooding to the areas identified as having previously flooded above, or at risk due to the proximity to the flood zones identified in the FEMFRAMS study.

The works proposed at Location 1, 2 & 3 will specifically benefit the LAP lands.

3.3 Available Flood Risk Assessment Based on the OPW Source-Pathway-Receptor Model

Based on the above, it is unlikely that tidal or fluvial flooding will occur on the RA zoned lands.
No rezoning or dezoning has occurred in the preparation of the Plan as a result of the Flood Risk Assessment.

Furthermore, specific areas within the LAP boundary have been identified as being at risk, and also as having previously flooded. Following the identification of these flood risk indicators we would therefore recommend that four areas be the subject of a site specific flood risk assessment as set out in Table 3.2 below:

Table 3.2 Flood Risk Indicators for Baldoyle-Stapolin LAP

Location	www.floodmaps.ie / **PFRA Maps**	**FEMFRAMS**	Dublin Coastal Protection Project Final Report	**Other**
Existing halting site along Mayne Road (1)	Historic flooding recorded at / adjacent this location	Adjacent fluvial and tidal flood zone	Adjacent Location 2 & 3 of recommended Baldoyle Area flood protection works	
Northern section of RA zoned lands (2)		Adjacent area within fluvial and tidal flood zone		
Internal section of zoned lands 3				From an examination of the site, this area may be at risk due to the lack of an overland flood route in the event of the failure of the drainage network
Open space area along Coast Road (4)	Historic flooding recorded at this location	Within fluvial and tidal flood zone	Adjacent Location 1 of recommended Baldoyle Area flood protection works	

3.4 Recommendations for modification to or additional assessment of land-use proposals

The SFRA recommends that a site-specific Flood Risk Assessment be carried out for any proposals for developments of these lands, or where any works proposed could potentially impact on these lands. These site-specific assessments should be appropriate to the nature and scale of the development being proposed. A map showing the extent of the areas within which development proposals should be the subject to site-specific Flood Risk Assessment is included in Appendix C.

In addition, we would specifically recommend that:

- Any design consider the potential impact of tidal and fluvial flooding on basements
- Any design consider the potential impact of tidal on fluvial flooding on buildings located below existing ground levels, in particular in the lower areas of the site
- Any design consider the potential impact of groundwater on basements
- Any design consider the potential impact of groundwater on buildings located below existing ground levels, in particular in the lower areas of the site
- Any design consider the potential impact of tide locking on any proposed surface water outfalls as a result of tidal flooding
- Any design consider the potential impact of a flooded outfall on any proposed surface water outfalls as a result of fluvial flooding
- Any design consider the impact of tide locking, flood outfalls or blockages in the surface water network and provide adequate overland flood routing to mitigate against such impacts
- Any proposals to fill any existing flood plain areas, including any works in the development of local sports facilities / playing pitches be carefully considered and suitably mitigated against through the provision of adequate and appropriate compensation storage

Table 3.3 over specifically identifies the potential sources of flooding in the four areas identified in Table 3.2 above, together with recommended mitigation measures to mitigate the flood risk in each of these areas.

Table 3.3 Flood Risk Mitigation for Baldoyle-Stapolin LAP

Location Ref. on Drg. No. SK110	Location Description	Reason for Inclusion	Potential Source of Flooding	Mitigation measures
1	Existing halting site along Mayne Road	Historic flooding recorded at / adjacent this location (floodmaps.ie). Adjacent area within fluvial and tidal flood zone (FEMFRAMS). Adjacent Location 2 & 3 of recommended Baldoyle Area flood protection works (DCPP).	Tidal, Fluvial	Ensure works do not impact on the recommended Baldoyle Area flood protection works (DCPP). Ensure there is no increase in runoff / flood levels as a result of any development on the LAP lands. This should include an assessment of the impact and implications of any proposed fill on the lands adjacent to Mayne Road together with an assessment of the implications of the proposed pathway under the railway arch. Appropriate mitigation measures should be included, if required, to ensure there is no increase in runoff / flood levels.
2	Northern section of RA zoned lands	Adjacent fluvial and tidal flood zone (FEMFRAMS).	Tidal, fluvial	Set building finished floor levels at an appropriate level (500 mm) above the appropriate predicted flood levels. Determine as part of the detailed design the impact of flooded outfalls / tide locking on the outfall from this area and mitigate against same. Provide adequate overland flood routing away from this area, ensuring flood routing is directed away from properties and vulnerable infrastructure. Set the building finished floor levels at an appropriate level above predicted overland flood levels.
3	Internal section of zoned lands	From an examination of the site, this area may be at risk due to the lack of an overland flood route in the event of the failure of the drainage network.	Pluvial	Provide adequate overland flood routing away from this area, ensuring flood routing is directed away from properties and vulnerable infrastructure. Set the building finished floor levels at an appropriate level above predicted overland flood levels.
4	Open space area along Coast road	Historic flooding recorded at this location (floodmaps.ie). Within fluvial and tidal flood zone (FEMFRAMS). Adjacent Location 1 of recommended Baldoyle Area flood protection works (DCPP).	Tidal, fluvial	Ensure works do not impact on the recommended Baldoyle Area flood protection works (DCPP). Ensure only land uses compatible with the nature of this area, and area subject to flooding, are permitted.

3.5 Confirmation of compliance with the Guidelines

Table A5 of The Planning System and Flood Risk Management Guidelines for Planning Authorities includes a list of elements of a SFRA for a local area plan.

These elements are outlined below in Table 3.4, together with the appropriate location within the report where they are included:

Table 3.4 Elements to be included in SFRA

Elements of initial assessment	Location
An examination of all sources of flooding that may effect a plan area	This is included in Table 3.2
An appraisal of the availability and adequacy of existing information	This is included in Section 3.2.
Produce flood zone map where not available	N/A
Determine what technical studies are appropriate	This is included in Table 3.2 and Section 3.4.
Describe what residual risk will be assessed	This is included in Table 3.2
Potential impact of flooding elsewhere	This is included in Table 3.3.
Scope of possible mitigation measures and what compensation works may be required and what land may be needed	This is included in Table 3.3.
Set out requirements for subsequent stages of FRA	This is included in Table 3.2 and Section 3.4.

Appendix A floodmaps.ie Report

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 234 405

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 1:31,065

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.

11 Results

1. Flooding at Coast Road, Baldoyle, Dublin 13 on 24th Oct 2011 — Start Date: 24/Oct/2011
County: — Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

2. Flooding at Brookstone Road, Baldoyle, Dublin 13 on 24th Oct 2011 — Start Date: 24/Oct/2011
County: Dublin — Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

3. Dublin City Tidal Feb 2002 — Start Date: 01/Feb/2002
County: Dublin — Flood Quality Code:1
Additional Information: Photos (32) Reports (10) Press Archive (27) More Mapped Information

4. Grange Stream Baldoyle Dec 1954 — Start Date: 08/Dec/1954
County: Dublin — Flood Quality Code:2
Additional Information: Reports (1) More Mapped Information

5. Dublin Road Sutton Feb 2002 — Start Date: 01/Feb/2002
County: Dublin — Flood Quality Code:3

Report Produced: 05-Sep-2012 14:01

Additional Information: Reports (1) More Mapped Information

6. The Grange Road Baldoyle Oct 2002 — Start Date: 20/Oct/2002
County: Dublin — Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

7. Mayne Balgriffin Park June 1993 — Start Date: 11/Jun/1993
County: Dublin — Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

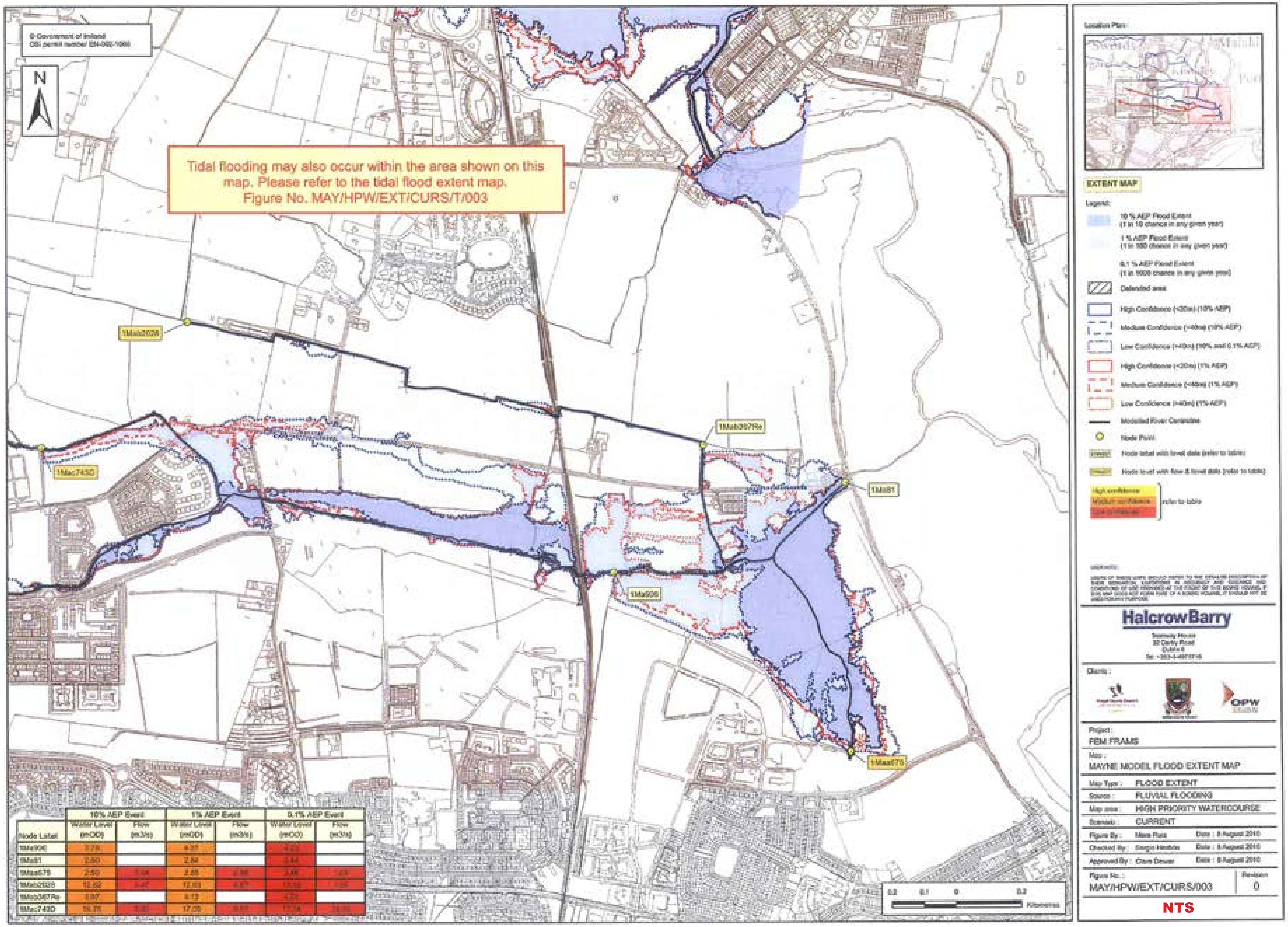
8. Grange Road Donaghmede Nov 1982 — Start Date: 07/Nov/1982
County: Dublin — Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

9. Mayne River Bridge Baldoyle Recurring — Start Date:
County: Dublin — Flood Quality Code:2
Additional Information: Reports (3) More Mapped Information

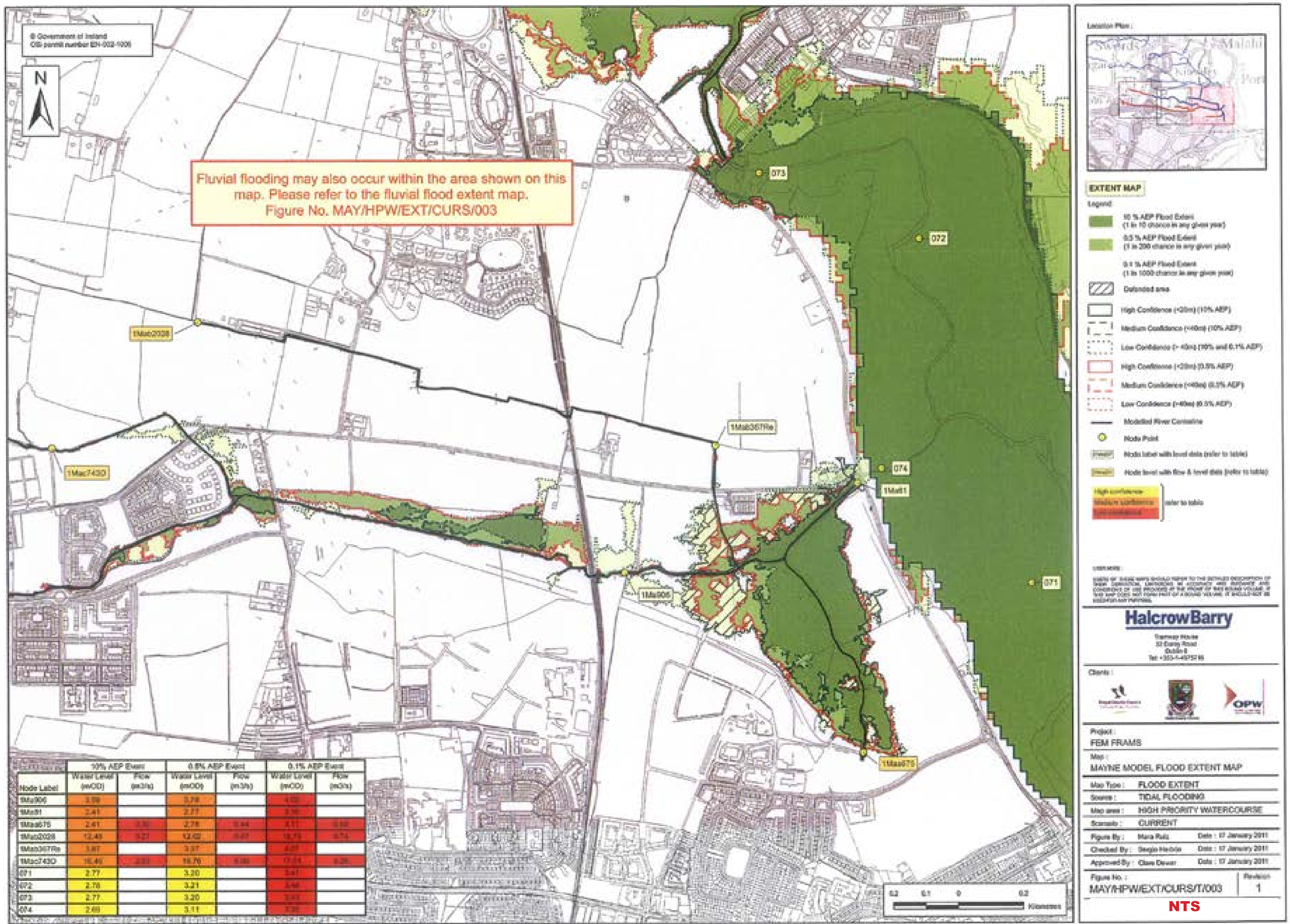
10. Sluice River Strand Road Portmarnock Recurring — Start Date:
County: Dublin — Flood Quality Code:3
Additional Information: Reports (4) More Mapped Information

11. Baldoyle Coastal Recurring — Start Date:
County: Dublin — Flood Quality Code:3
Additional Information: Reports (4) More Mapped Information

Report Produced: 05-Sep-2012 14:01

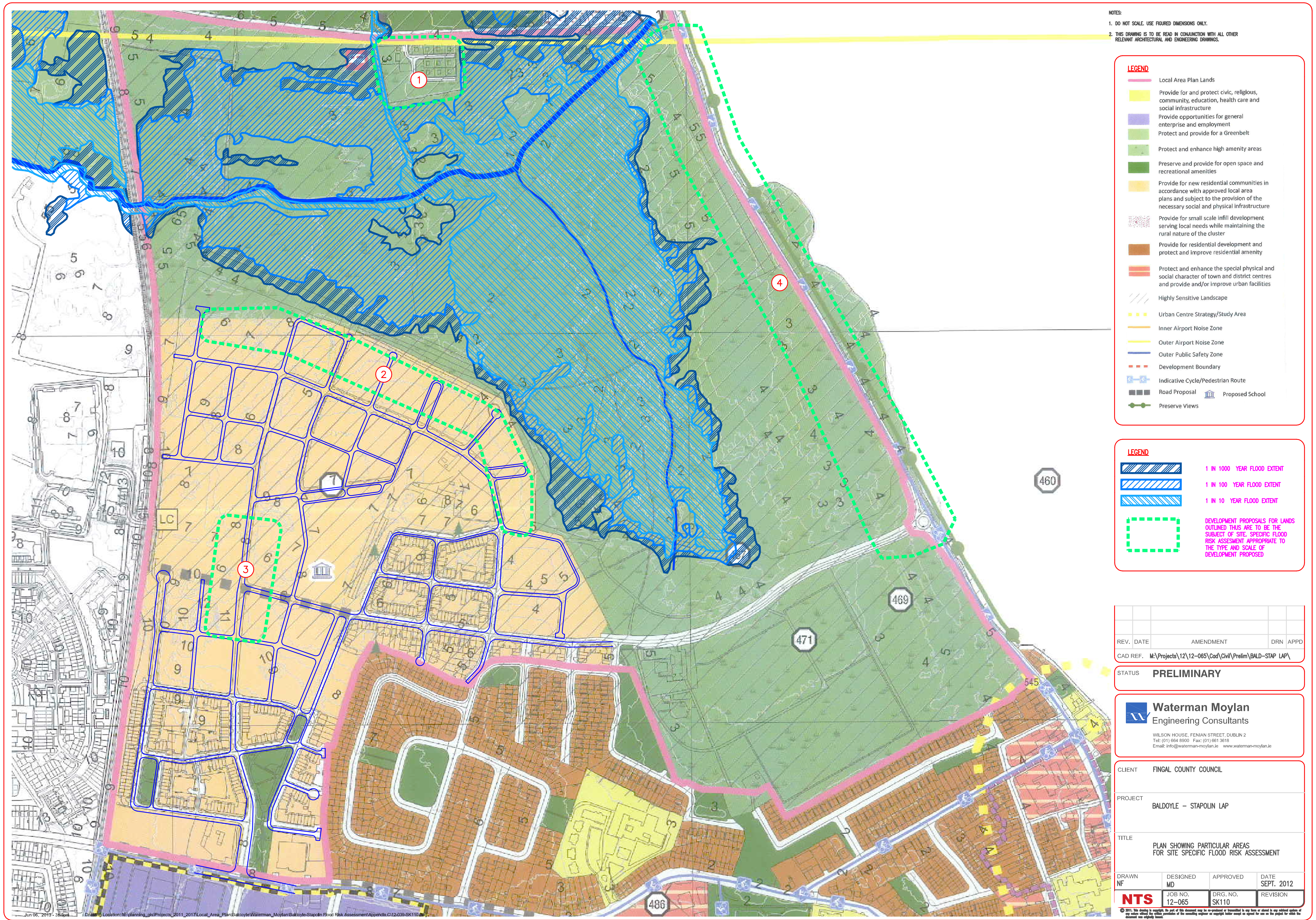


Appendix B FEMFRAMS Mayne Model Flood Extent Map – Fluvial Flooding



Node Label	10% AEP Event Water Level (mOD)	10% AEP Event Flow (m3/s)	0.5% AEP Event Water Level (mOD)	0.5% AEP Event Flow (m3/s)	0.1% AEP Event Water Level (mOD)	0.1% AEP Event Flow (m3/s)
1Ma906	3.59		3.78		[illegible]	
1Ma81	2.41		2.77		[illegible]	
1Maa675	2.41	[illegible]	2.78	[illegible]	[illegible]	[illegible]
1Mab2028	12.48	[illegible]	12.02	[illegible]	[illegible]	[illegible]
1Mab367Re	3.87		3.37		[illegible]	
1Mac743D	16.46	[illegible]	16.76	[illegible]	[illegible]	[illegible]
071	2.77		3.20		[illegible]	
072	2.78		3.21		[illegible]	
073	2.77		3.20		[illegible]	
074	2.69		3.11		[illegible]	

Appendix B FEMFRAMS Sluice Model Flood Extent Map – Tidal Flooding



Appendix C **Map showing areas where site specific flood risk assessment is recommended**