A96 CORRIDOR DEVELOPMENT SUDS ASSESSMENT

Highland Council

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HIGHLAND COUNCIL

A96 CORRIDOR DEVEOPMENT

SUDS ASSESSMENT

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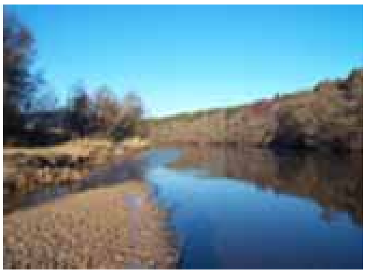

1. Introduction

1.1. Background

Faber Maunsell, in conjunction with FG Burnett, Turley Associates and Entec, were commissioned by Highland Council to prepare a masterplan for the long-term development of the A96 corridor between Inverness and Nairn. This requirement emerges from the Highland Structure Plan (approved 2001), which outlines desires for the development of around 14,000 new dwellings by 2017.

The proposed development consists of two development blocks. The first of these, Dalcross, is the larger development, covering 550 ha and having around 12,000 houses. The second development block, to be situated at the present Ardersier Fabrication Yard (henceforth referred to as AFY), will cover 150 ha and have 1750 houses.

Faber Maunsell is responsible for undertaking an assessment of the capacity of the following existing utility services and the implications associated with the new development. These include the following

- Gas
- Water
- Drainage
- Electricity
- Telecommunications

In each case discussions have taken place with the local utility supplier in order to determine the capability of the existing network and what might need to be done to accommodate the increased population.

This report is concerned with the drainage aspect of the water utility, in particular the use of Sustainable Urban Drainage Systems (SUDS), which are the preferred method of drainage in the UK. The feasibility or otherwise of several types of SUDS will be investigated, together with estimates of the likely proportions of water to be drained using different types of SUDS.

The effective use of SUDS requires a holistic approach to the whole implementation process. CIRIA C523[1] notes that to encourage use of SUDS on developments, it is important to have an awareness of the complete range of issues and the concerns of all the stakeholders involved.

Inverness Airport and the Civil Aviation Authority (CAA) have expressed concern over the use of large expanses of water as part of the drainage system. This is because such bodies of water attract birds to the area, which are hazardous to aircraft. The design of any SUDS systems must take this fully into consideration, as well as plans for future development of Inverness Airport.

Scottish Water has expressed concerns over the ability of the existing network to accommodate the increased drainage discharge. SEPA have already communicated their concerns to Scottish Water that increased drainage demand must be accommodated in an acceptable manner.

In the case of draining water from the development to natural watercourses, SEPA normally require that the water is of satisfactory quality and that there is no increase to the risk of flooding downstream or elsewhere as a result of the development. Runoff rates are normally restricted to “Greenfield” or pre-development runoff rates. This can be done by attenuating flood peaks by providing storage areas.

[1] CIRIA C523 – Sustainable Urban Drainage Systems – best practice manual for England, Scotland, Wales and Northern Ireland

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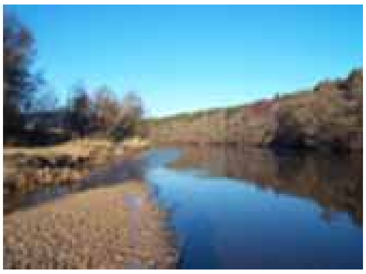


2. SUDS Assessment

2.1. Overview

Sustainable Urban Drainage Systems (SUDS) are an alternative form of drainage, which aim to emulate natural drainage systems as practicably as possible through permeable surface infiltration. SUDS attenuate the flow rate of surface waters by allowing percolation as opposed to increasing run-off generated off hard, impermeable surfaces. Planning Advice Note 61: Planning and Sustainable Urban Drainage Systems (PAN 61), states that "the overall objective is to return excess surface water to the natural water cycle with minimal adverse impact on people and the environment". Further, PAN 61 details that SUDS works on the following principles:

- Manage surface water run-off on-site as near to source as possible
- Slow down run-off
- Naturally treat runoff
- Release good quality surface water to watercourses or groundwater

Guidance for SUDS design is contained in the following regulations and good practice manuals:

- Planning Advice Note 61: Planning and Sustainable Urban Drainage Systems; Scottish Executive; July 2001
- Sustainable Urban Drainage Systems Design Manual for Scotland and Northern Ireland; CIRIA C521; March 2000
- Sustainable Urban Drainage Systems Design best practice manual for England, Scotland, Wales and Northern Ireland; CIRIA C523; March 2000
- Enhancing Sustainable Urban Drainage Systems for Wildlife; Scottish Environment Protection Agency Habitat Enhancement Initiatives
- Part M of the Technical Standards for compliance with the Building Standards (Scotland) Regulations 1990, as amended.

Once flow peaks have been attenuated to the desired level, water can be discharged at a controlled rate to nearby watercourses, provided that it is of the required quality.

2.2. Local drainage

Drainage around the airport is characterised by a number of small agricultural drainage ditches running to the Moray Firth at Ardersier. In addition there are a number of small burns (Red Burn, Rough Burn, Alton Burn) as well as the River Nairn, which terminates into the Moray Firth at Nairn.

2.3. Forms of SUDS

SUDS generally fall into one of four categories. These are:

- Basins and Ponds
- Permeable surface
- Filter strips and swales
- Infiltration devices

Each of these subgroups is described concisely below.

Basins and Ponds

Areas of open water are a part of the natural drainage pattern. The difference between basins and ponds is that basins are temporary water features and ponds are permanent water bodies. There are many different types of these forms of SUDS.

Basins and ponds are advantageous over other forms of SUDS because they are a cost-effective means of storing large amounts of water. These may cause problems to aircraft in the form of birdstrikes if they are positioned too closely to the aerodrome. Also of fundamental importance is how any water bodies are positioned relative to the direction of the runways.

There should also be provision for future expansion of the airport.

Permeable surfaces

Permeable surfaces can vary in type and appearance. They include the following:

- Gravelled areas – water can drain through the gravel to the ground beneath the surface.
- Solid paving blocks with gaps between the blocks.
- Porous paviors or continuous surfaces that have a system of voids.

The surface is only part of the drainage device. The layer below the surface (sub-base) should be very porous to allow the flow of water.

Filter strips and swales

These types of SUDS are constituted of sloping vegetated areas either in the form of a strip off ground that water can run across (filter strip) or a broad shallow channel. Filter strips are a type of source control, whereas swales are both a source control and a means of conveying runoff.

Infiltration devices

Infiltration devices allow for the infiltration of water, its temporary storage and gradual release. Soakaways and infiltration trenches allow underground storage. Infiltration basins detain water above the ground, which can then slowly infiltrate into the ground.

2.4. Overview of development drainage requirements

At around 14,000 dwellings and covering an area of approximately 700 Ha, the proposed development will be the second largest settlement in the Highland Region. In terms of scale, comparisons can be drawn with the recent Dunfermline East Expansion (DEX) that was one of the first large scale development projects in Scotland to utilise SUDS as the preferred method of drainage. This site, which was predominantly Greenfield, will be developed over the next 20 years as a mixture of industrial, commercial, residential and recreational areas.

An effective SUDS system should incorporate all of the aforementioned methods of sustainable urban drainage. For example, car parks and other large areas of flat, concrete covered land should be built with permeable covers that drain to underground tanks.

2.5. Road Drainage

The road system could be drained using offlet kerbs, French drains, filter drains and swales, which could discharge into larger storage areas.

2.6. Inverness Airport

Discussions with the Civil Aviation Authority (CAA) revealed several key points in the use of SUDS in the vicinity of an airport.

The safeguarding around a number of listed aerodromes for planning purposes changed recently. This is dealt with by Office of the Deputy Prime Minister circular ODPM 1/2002. This signaled the change from the CAA managing safeguarding centrally to a devolved system administered by each of the 40 or so officially safeguarded aerodrome licensees. Inverness is one of these Aerodromes. Therefore, any planning application up to 13 km away from the mid point of the main runway, subject to its height relative to protected surfaces, has to be submitted to the aerodrome by the local authority planners. Should the aerodrome object, but the local planning authority feel minded to approve, the CAA has to be informed and can "call in" the application for review.

The CAA also indicated that the assessment should address the following considerations:

- Where is this development in relation to the airport?
- What size/shape/depth/use of water features is envisaged?
- Is it urban, suburban or rural?
- Will this generate flight lines to other water that take flocks near or over the runway?
- What species are likely to be attracted, e.g. gull, wildfowl (duck and geese), herons?
- Feeding of wildfowl by the public can and will increase their numbers well above the "natural" carrying capacity and may generate bird traffic to and from feeding sites.

- Use a Risk Assessment methodology, bearing in mind that the worst possible outcome is catastrophic, i.e. loss of life in an aircraft accident.

CAP680 Aerodrome Bird Control, Part 4, Chapter 5 highlights several issues that must be taken into consideration in order to minimize bird activity in the vicinity of airports. These include the following: [2]

Flooding

Flooding flushes soil invertebrates to the surface and onto runways etc., making them very accessible and attracting gulls and waders and ducks at night. Drainage should be installed, or the site regarded to eliminate hollows which hold standing water.

Watercourses and drainage ditches.

Both provide cover and food, especially for ducks and herons. There are increasing indications that watercourses rather than standing water are attracting the expanding grey heron population onto aerodromes, resulting in very hazardous birdstrikes. Wherever possible watercourses on the airfield should be culverted underground throughout (rather than just within the runway strip)

***Emergency water supply tanks and oil separators**. Even small permanent open water surfaces attract ducks. These should be netter or roofed to prevent access.*

***Ponds, balancing reservoirs etc.** These larger, permanent waters attract ducks, geese, swans, Herons, Coot, Moorhen, and Cormorants. They should be eliminated wherever possible. Where the water area is sufficiently small, it should be netted over. Recent trials have shown that contrary to popular belief, wires suspended above the water surface cannot be relied on to exclude birds. Most waterfowl can take off and land vertically. Even swans and even Cormorants may only be inconvenienced to the extent that they execute several "missed approaches" and circuit over the airfield before gaining access. Therefore wires may actually increase the hazard. A less reliable means of denying access to essential features, such as balancing reservoirs, is to replace the open water with reedbeds over the entire flooded area. Where this approach is contemplated, specialist advice should be sought because reeds cannot tolerate major fluctuations in water level. Thus, it can be difficult to accommodate without seasonal rainfall, on the one hand, creating flooding beyond the reedbed or on the other, alternately submerging and drying out the reedbed seasonally. Where existing essential open water such as balancing reservoirs cannot be avoided, adopting the following habitat controls will reduce the hazard to some extent.*

The water should be as deep as possible (over 4m) to minimise bottom growing vegetation.

The shape should be as simple as possible (circular or square) with no islands or promontories, to reduce the length of shoreline and reduce nesting sites, especially for Canada Geese.

Banks should be as steep as possible (preferably vertical) with minimal vegetation. There should be a vertical lip or fence to prevent birds from waling in and out of water.

Dense vegetation, which provides nest cover, and short grass, which is grazed by wildfowl, should be avoided. The water should be surrounded by long grass or a sterile substrate.

Water should not be stocked by fish, and fishing should be prohibited to prevent the unwitting supply of food for birds.

Wet grassland

Even wet and waterlogged grass attracts feeding ducks and nesting waders, and drainage should be installed or improved, wherever possible.

CAP680 stresses that these habitat modification measures, and others, are only partially successful and are not an acceptable substitute for eliminating water or physical exclusion, unless these are shown to be impossible. It is unlikely that new habitats for birds that could potentially cause a hazard to aircraft would receive planning permission, therefore caution must be exercised in the siting of these storage areas.

Figure 2.1 below shows a proposed layout of the development, with the main block, Dalcross, being situated south of the airport, and the second block of development, AFY, situated north-east of Ardersier. These blocks all fall within the 13 km radius from Inverness Airport's main runway, therefore plans for all proposed blocks of development would have to be approved by either Inverness Airport or the CAA.

[2] Source: CAP680 Aerodrome Bird Control, Part 4, Chapter 5

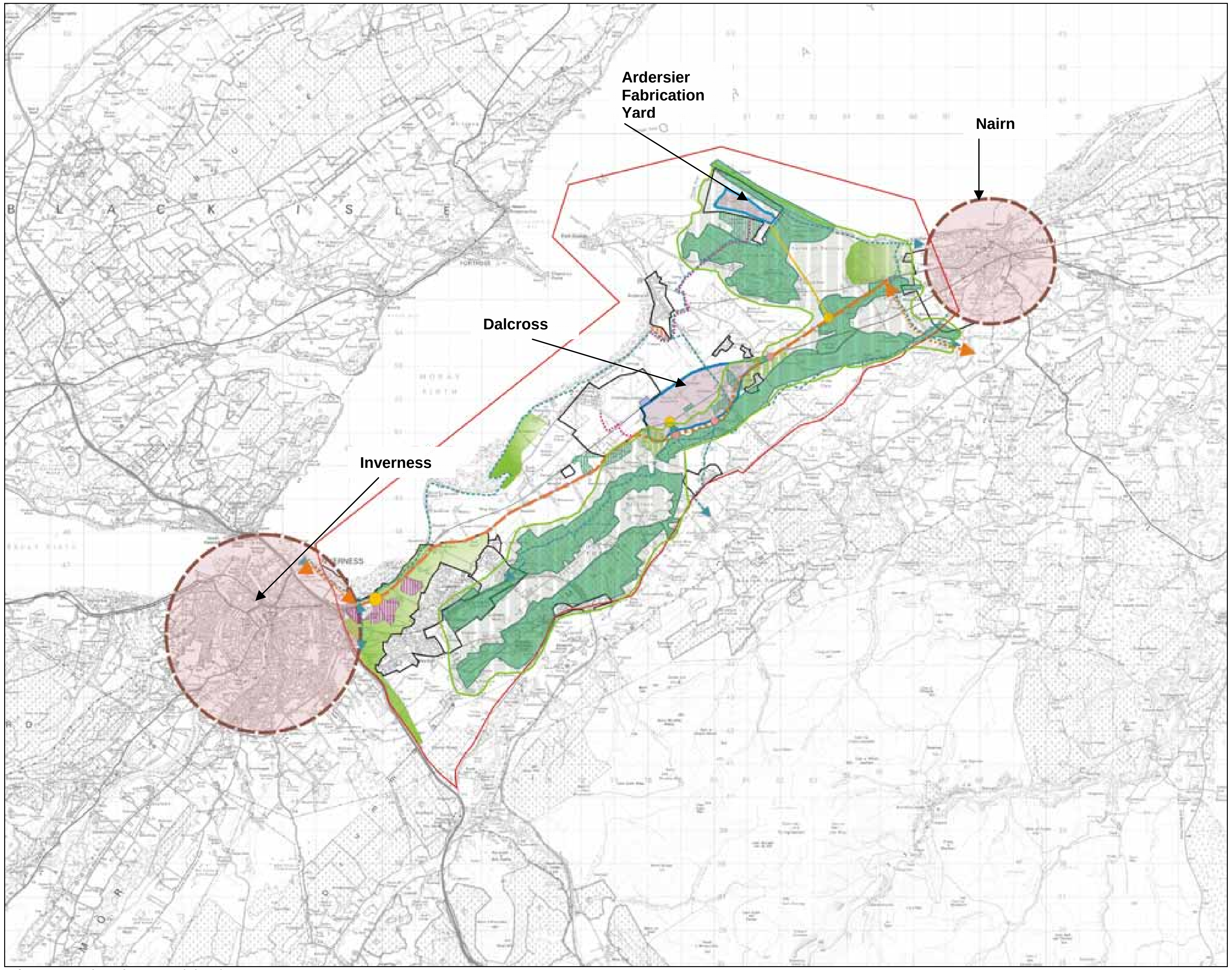


Figure 2.1: Plan of proposed development

Discussions with officials at Inverness Airport revealed that if placed correctly, expanses of water could have a beneficial effect on the existing bird situation by making existing nesting areas for birds less attractive by comparison. The existing areas may be causing problems to the airport at present.

2.7. Modelling the drainage system

The SUDS design for this development will represent one of the largest sustainable drainage solutions in the UK. Infoworks CS, designed by HMS Wallingford, has the capability to handle such a large design, and is a market leader in catchment system modelling. Watersheds are divided into sub-catchments, which connect into a SUDS network of retention basins, swales drainage channels etc. The nature of the drainage paths depends primarily on the local topography, but also the suitability of certain SUDS in specific areas, e.g. detention ponds are not suitable beside the airport.

Winter Rainfall Acceptance Potential (WRAP) maps were consulted in order to determine the permeability of the local soil, which is important to runoff rates and hence storage requirements. Table 2.1 below shows the WRAP classification system, and Table 2.2 shows the each section’s classification and potential destinations for controlled discharge of the excess runoff.

Classification	WRAP	Permeability	SOIL
1	Very high	Very low	0.15
2	High	Low	0.30
3	Moderate	Moderate	0.40
4	Low	High	0.45
5	Very low	Very high	0.50

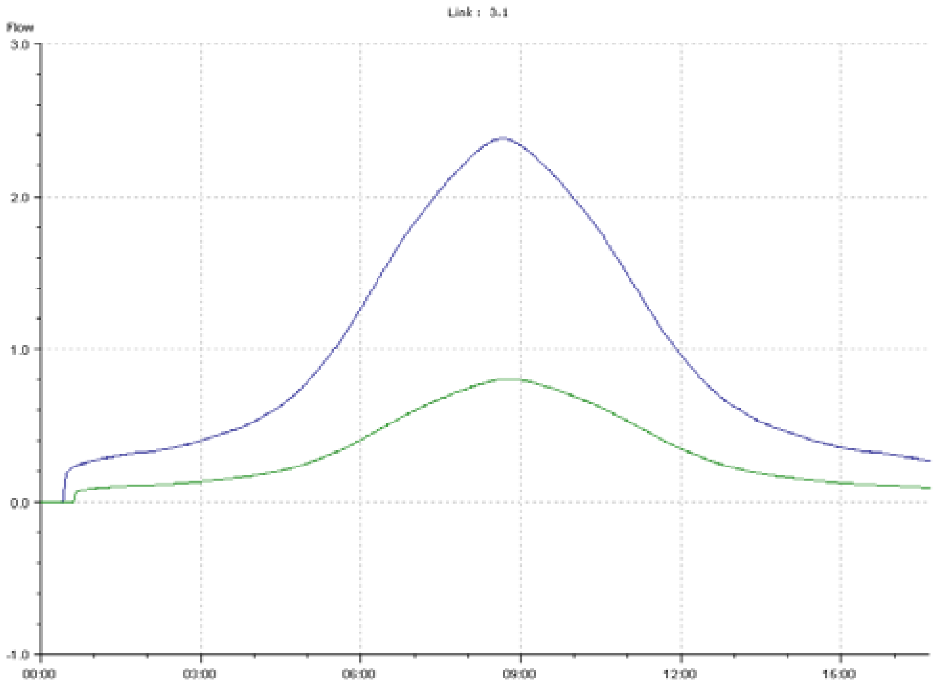
Table 2.1: WRAP Classification

Section	WRAP Classification	Potential drainage route
Dalcross	3	Agricultural drains/Moray Firth
AFY	1	Moray Firth

Table 2.2: Site WRAP classifications and drainage routes

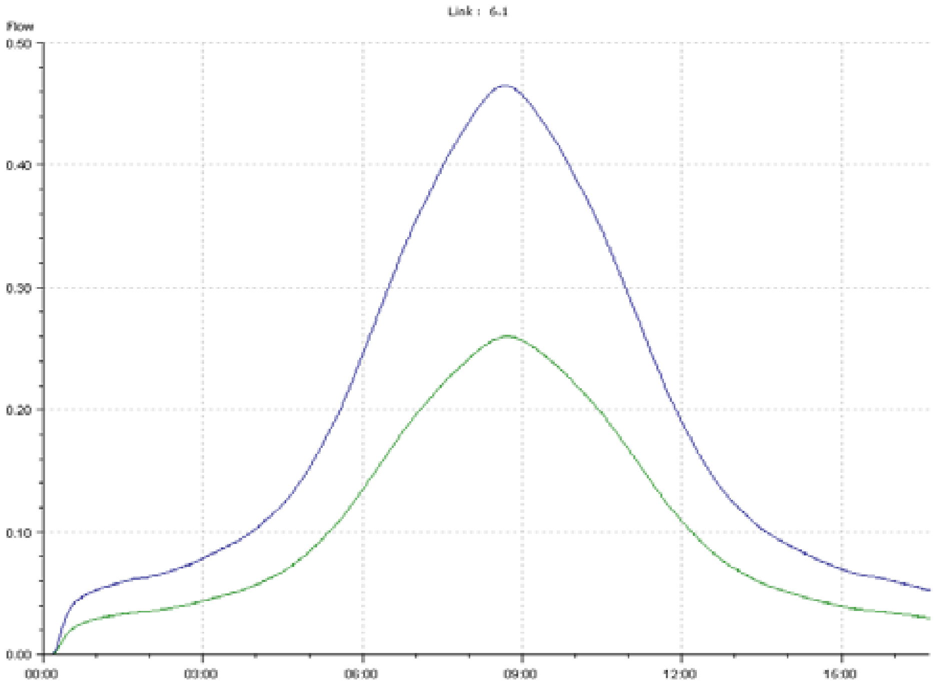
A very basic study was undertaken whereby each development block was treated as an entire subcatchment. This was done to give an early indication of attenuation requirements. Two model runs were carried out, one with a rural land use assumed for all areas and one with a likely urban land use, with roofed, paved and permeable surfaces designated at 7, 23 and 70 percent respectively.

Figures 2.2 – 2.4 below show pre and post-development hydrographs for each development block for a 200 year rainfall event.



		Flow (m3/s)		
		Min	Max	Volume (m3)
Post-development		-0.000	2.380	58314.269
Pre-development		-0.000	0.804	19715.524

Figure 2.2: Dalcross – Pre and post development 200 year event hydrographs



		Flow (m3/s)		
		Min	Max	Volume (m3)
Post-development		0.000	0.465	11424.319
Pre-development		0.000	0.260	6393.652

Figure 2.3: AFY – Pre and post development 200 year event hydrographs

The difference in area of these hydrographs represent the storage requirement for each section of development, as are summarised below.

Development	200 year event peak flow (m^3s)		Storage requirement (m^3)
	Pre-development	**Post-development**	
Dalcross	0.804	2.38	38599
AFY	0.260	0.465	5031

Table 2.3: Peak flows and storage requirement for each development section

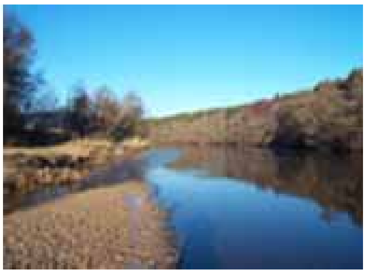
At the 200 year event, there is a requirement to attenuate to pre-development levels as shown in the table above for each site. In total, this translates to a storage requirement of approximately 44,000 m^3. The SUDS would require to attenuate flows to pre-development levels using a combination of the methods described previously.

The majority of the development is in Dalcross, which has limited drainage potential at present, consisting entirely of agricultural drainage ditches. These may have to be enlargened in order to cope with additional runoff, but it is impossible to confirm their capacity until a survey is carried out.

As the site at AFY is on the coastline of the Moray Firth, there is no question of increased risk of downstream flooding, and water can be released directly to the sea provided it is of the required standard of quality. SUDS can be used to attenuate flows until they reach the capacity of channel of culvert permitted to discharge into the sea.

Note that this investigation is intended only to give a rough idea of storage requirements, and further analysis must be much more thorough. This should involve ground models, a detailed drainage network, a comprehensive account of the area’s soil type, and detailed information concerning present and proposed land use for each section of development.

3 OTHER METHODS

3. Other Methods

3.1. Rainwater collection

The storage and use of rainwater for domestic dwellings allows a significant saving in water that needs to be supplied, but more importantly from a drainage point of view, decreases the amount of water that needs to be stored in a communal drainage system. Commercial organisations exist which supply such systems. The following shows rainwater tank size calculations, which are available from www.freerain.co.uk.

Rainwater Tank Size Calculation Form

(Commas must be written as DOTS)	Main roof	+ Extra roof 1	+ Extra roof 2
Length of house:	13 m	m	m
Width of house:	10 m	m	m
Roof cover:	Hard roof	Hard roof	Hard roof
Rain volume:	890 mm/year	If you are unsure of your local rainfall statistics, the Met Office will hold the figures, which can be viewed from http://www.met-office.gov.uk/climate/uk/averages/19712000/index.html	
Building Purpose:	Dwelling-House		
Number of persons:	4		
Garden area to be watered:	10 m^2		CALCULATE

Result of the tank calculation for rain water systems for a dwelling house:

Need for:	cbm/year	Proceed:	
Toilet flushing:	35	Roof areas, sqm:	130
Washing machine:	17	Loss corrections:	0.8
10 sqm garden:	1	**Rain water proceeds cbm/year:**	**83**
Total need:	53	Covering rate :	157 %

On an average rainfall rate of 890 mm per year the optimum of tank size will be about 3180 Ltr.

The tank calculation basis on Your rain water need, because this is smaller than Your proceed. On a tank calculation basing on the need, should be known, that the number of persons can change.
On a tank calculation basis only on the rain water proceeds, the optimum of tank size would be about: 4980 Ltr.

This calculation is only an average calculation. The rain water rate could be different yearly.
The rain water need is calculated according to DIN 1989 and can be individually different.
The basic of the need calculation needs toilet systems with 6 ltr.-flushing boxes and modern, watersaving washing machines. Are there no modern, watersaving systems used, the need could be doubbeld.

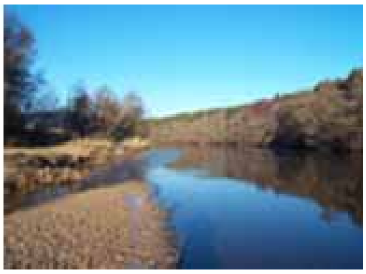
REPEAT CALCULATION

The above calculation shows that if 10,000 houses use rainwater tanks this reduces the amount of excess water that requires to be stored by 530,000m^3 per annum. Note that this is considered as a very rough estimate, based on all households using a tank size of 3180 litres, and other parameters being only estimates.

This water can be used for washing machines or flushing toilets, therefore has the additional benefit of reducing public water demand. By harvesting rainwater, the percentage of roofed surfaces would decrease which in turn would reduce the demand for attenuation by SUDS.

As with all forms of SUDS, continual maintenance is important in order to ensure they are reaching their design potential. Although most rainwater collection tank designs will have low maintenance demands, the technology and procedures will be in place for making the most out of these products over their design lifetime.

4 CONCLUSIONS AND RECOMMENDATIONS



4. Conclusions and Recommendations

There is opportunity to use SUDS as the dominant form of drainage for a large new development along the A96 between Nairn and Inverness.

The scale of the development is large, at around 14,000 dwellings and covering an area of approximately 7 km^2. The drainage design will incorporate the different SUDS methods as well as efforts to reduce the amount of storage required, such as rainfall collection.

The storage requirement has been assessed at a very basic level, and is at approximately 44,000 m^3 for both areas at the 200 year rainfall event.

Other methods of reducing the need for storage such as rainfall collection should be investigated further.

The presence of Inverness Airport means that the use of expanses of water must not cause increased bird activity around the Aerodrome. Through intelligent siting of SUDS and other methods that are detailed in CAP680, it will be possible to utilise sustainable urban drainage systems that do not present an increased threat to aircraft, but and could even be of net benefit by attracting birds away from the airport that may be causing a nuisance at present.