Site Specific FRA 'Toolkit'

Land East of Newark

General

Reference should be made to the generic recommendations on completing Flood Risk Assessments (FRA) provided in Appendix F of the Level 1 SFRA. Potential land owners of a site are bound to the fundamental principles of the drainage strategy that is in place. Any alterations to these principles would need to be justified through a robust Flood Risk and Drainage Assessment.

Mapping within Appendix C of the Level 2 SFRA provides a pictorial representation of the variation in flood risk across the site. NSDC should review the risk of flooding posed to a particular site by reference to these detailed maps. Below is a list of site specific recommendations that should be considered when completing an FRA.

Flood Risk

As shown on the mapping in Appendix C, the majority of the site falls within Flood Zone 1. The area most prone to flooding is Residential Area 1 that partly falls within Flood Zones 2 and 3 associated with Sodbridge Drain. As highlighted in table D3 of PPS25, More Vulnerable land uses are not permitted in the Functional Floodplain. More Vulnerable land uses are permitted in Flood Zone 3a subject to the Exception Test being satisfied. Parts of the site are shown to fall within an 'Extreme' flood hazard. The site does not benefit from any formal flood defences. The site is impacted on by the climate change flood extents associated with Sodbridge Drain. The Hazard to People Classification table (FD2320/TR2) should be reviewed in relation to the level of hazard within a flood zone.

General recommendations on finished floor levels and floodplain compensation have been provided in the Level 1 SFRA Site Specific FRA Toolkit.

Safe Access

All FRAs should take into consideration safe access and egress issues in the event of flooding; safe access and egress can be achieved from residential areas based on the modelled extents. When producing a site specific Flood Evacuation Plan, adherence should be made to the Nottingham and Nottinghamshire Local Resilience Forum Flood Response Plan (2009), the EA's Local Flood Warning Plan for the City of Nottingham and Nottinghamshire (2008) and all updated versions of the NSDC Emergency Plan. As previously stated, the site does not fall into an area covered by the EA's flood warnings.

The Flood Hazard within a specific area should be viewed within the context of potential access and egress routes for both pedestrians and vehicles.

Sewer Flooding

FRA's should take into consideration the sewer network along Clay Lane and the potential for sewer flooding. However, there are currently no records of sewer flooding on this site.

Surface Water Drainage

As shown on the plans in Appendix B, the vast majority of the site is shown to fall within the Severn Trent sewer network boundary. A small area of land to the east of the site falls within the Anglian sewer network.

Source Protection Zones

A small area in the north west corner of the site falls within an Inner Source Protection Zone.

Contaminated Sites

According to NSDC records there is one area located close to the western boundary of the site which is classified as contaminated.

Infiltration Feasibility

SuDs infiltration viability mapping shows that much of the site is uncertain or unsuitable for infiltration techniques. Groundwater table data should be obtained as part of a detailed site investigation.

Adoption and Maintenance

In line with the recommendations provided in the PPS25 Practice Guidance (2009), when planning SuDs, developers need to design for maintenance so that they continue to provide effective drainage for properties throughout the lifetime of the development. Prior to development, a robust SuDS maintenance strategy and mechanism to maintain SuDs in accordance with the strategy, should be agreed in writing with NSDC.

General

In line with the requirements of PPS25, a robust SuDs scheme should be adopted to promote the overall sustainable development of a site. General information relating to the most commonly found components of a SuDs system in relation to Infiltration and Attenuation techniques have been provided within this toolkit.

During the design process, liason should take place with all key relevant stakeholders such NSDC, the EA, IDBs, Anglian Water and Severn Trent Water in order to establish that the design methodology is satisfactory and to agree on a permitted rate of discharge from the site. In line with PPS25, volumes and peak flow rates of surface water leaving a developed site should be no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.

Detailed site investigations should be undertaken by a suitable qualified consultant in order to establish the suitability of implementing various infiltration SuDs techniques based on ground conditions. The SuDs hierarchy as provided in the Level 1 SFRA (FRA Toolkit) should be adhered to.

Guidance on the Exception Test

Section 1.5 of the SFRA sets out the requirements for the Exception Test.

The Exception Test should be applied following application of the Sequential Test (paragraph D10, PPS25). The Exception Test is applied to ensure that fluvial flood risk has been properly assessed in relation to the proposed land use and it's vulnerability as set out in Table D3 within PPS25. The following question should be asked when undertaking the Exception Test:

1) Does the site provide wider sustainability benefits to the community that outweigh flood risk, informed by this Level 2 SFRA? ***The NSDC Core strategy will be a key document that will need to be reviewed:***

2) Is the site on developable previously –developed land or, if it is not on previously developed land, there are no other reasonable alternative sites on developable previously developed land?

3) Does the site specific FRA demonstrate that the development will be safe, without increasing flood risk elsewhere and where possible will reduce flood risk overall (taking into consideration the effects of climate change)? ***An FRA should draw on the key findings made within this SFRA and follow the guidance set out within the 'toolkit'.PPS25 Practice Guidance (2009) (Chapter 6- Risk management by design) provides details on how a development can be made safe and not increase flood risk elsewhere.***

As highlighted in PPS25, the Exception Test provides a method of managing flood risk whilst still allowing necessary development to occur.

Site Specific FRA 'Toolkit'

Land around Fernwood

General

Reference should be made to the generic recommendations on completing Flood Risk Assessments (FRA) provided in Appendix F of the Level 1 SFRA. Potential land owners of a site are bound to the fundamental principles of the drainage strategy that is in place. Any alterations to these principles would need to be justified through a robust Flood Risk and Drainage Assessment.

Mapping within Appendix C of the Level 2 SFRA provides a pictorial representation of the variation in flood risk across the site. NSDC should review the risk of flooding posed to a particular site by reference to these detailed maps. Below is a list of site specific recommendations that should be considered when completing an FRA.

Flood Risk

As shown on the mapping in Appendix C, the majority of the site falls within Flood Zone 1. The areas most prone to flooding are Residential Areas 1 and 2 that partly fall within the flood plains of the Shire Dyke/River Witham and Lowfield Drain. Residential Area 1 is impacted on by the Functional Floodplain associated with Lowfield Drain. As highlighted in table D3 of PPS25, More Vulnerable land uses are not permitted in the Functional Floodplain. More Vulnerable land uses are permitted in Flood Zone 3a subject to the Exception Test being satisfied. The site does not benefit from any formal flood defences. The site is impacted on by the climate change flood extents from Shire Dyke/River Witham and Lowfield Drain. The Hazard to People Classification table (FD2320/TR2) should be reviewed in relation to the level of hazard within a flood zone.

General recommendations on finished floor levels and floodplain compensation have been provided in the Level 1 SFRA Site Specific FRA Toolkit.

Safe Access

All FRAs should take into consideration safe access and egress issues in the event of flooding; safe access and egress can be achieved from residential areas based on the modelled extents. When producing a site specific Flood Evacuation Plan, adherence should be made to the Nottingham and Nottinghamshire Local Resilience Forum Flood Response Plan (2009), the EA's Local Flood Warning Plan for the City of Nottingham and Nottinghamshire (2008) and all updated versions of the NSDC Emergency Plan. As previously stated, the site does not fall into an area covered by the EA's flood warnings.

The Flood Hazard within a specific area should be viewed within the context of potential access and egress routes for both pedestrians and vehicles.

Sewer Flooding

There are no records of sewer flooding on the site.

Surface Water Drainage

As shown on the plans in Appendix B, the vast majority of the site is shown to fall within the Anglian Water sewer network boundary. The north west corner of the site falls within the Severn Trent Water sewer network.

Source Protection Zones

Source Protection Zones do not impact on this site.

Contaminated Sites

NSDC have not highlighted any contaminated sites within Land at Fernwood.

Infiltration Feasibility

SuDs infiltration viability mapping shows that the site is unsuitable for infiltration techniques. Groundwater table data should be obtained as part of a detailed site investigation.

Adoption and Maintenance

In line with the recommendations provided in the PPS25 Practice Guidance (2009), when planning SuDs, developers need to design for maintenance so that they continue to provide effective drainage for properties throughout the lifetime of the development. Prior to development, a robust SuDS maintenance strategy and mechanism to maintain SuDs in accordance with the strategy, should be agreed in writing with NSDC.

General

In line with the requirements of PPS25, a robust SuDs scheme should be adopted to promote the overall sustainable development of a site. General information relating to the most commonly found components of a SuDs system in relation to Infiltration and Attenuation techniques have been provided within this toolkit.

During the design process, liason should take place with all key relevant stakeholders such NSDC, the EA, IDBs, Anglian Water and Severn Trent Water in order to establish that the design methodology is satisfactory and to agree on a permitted rate of discharge from the site. In line with PPS25, volumes and peak flow rates of surface water leaving a developed site should be no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect. Careful consideration should be given not to exacerbate existing flooding issues on downstream areas along Lowfield Drain in Balderton.

Detailed site investigations should be undertaken by a suitable qualified consultant in order to establish the suitability of implementing various infiltration SuDs techniques based on ground conditions. The SuDs hierarchy as provided in the Level 1 SFRA (FRA Toolkit) should be adhered to.

Guidance on the Exception Test

Section 1.5 of the SFRA sets out the requirements for the Exception Test.

The Exception Test should be applied following application of the Sequential Test (paragraph D10, PPS25). The Exception Test is applied to ensure that fluvial flood risk has been properly assessed in relation to the proposed land use and it's vulnerability as set out in Table D3 within PPS25. The following question should be asked when undertaking the Exception Test:

1) Does the site provide wider sustainability benefits to the community that outweigh flood risk, informed by this Level 2 SFRA? ***The NSDC Core strategy will be a key document that will need to be reviewed:***

2) Is the site on developable previously –developed land or, if it is not on previously developed land, there are no other reasonable alternative sites on developable previously developed land?

3) Does the site specific FRA demonstrate that the development will be safe, without increasing flood risk elsewhere and where possible will reduce flood risk overall (taking into consideration the effects of climate change)? ***An FRA should draw on the key findings made within this SFRA and follow the guidance set out within the 'toolkit'. PPS25 Practice Guidance (2009) (Chapter 6- Risk management by design) provides details on how a development can be made safe and not increase flood risk elsewhere.***

As highlighted in PPS25, the Exception Test provides a method of managing flood risk whilst still allowing necessary development to occur.

Site Specific FRA 'Toolkit'

Land South of Newark

General

Reference should be made to the generic recommendations on completing Flood Risk Assessments (FRA) provided in Appendix F of the Level 1 SFRA. Potential land owners of a site are bound to the fundamental principles of the drainage strategy that is in place. Any alterations to these principles would need to be justified through a robust Flood Risk and Drainage Assessment.

Mapping within Appendix C of the Level 2 SFRA provides a pictorial representation of the variation in flood risk across the site. NSDC should review the risk of flooding posed to a particular site by reference to these detailed maps. Below is a list of site specific recommendations that should be considered when completing an FRA.

Flood Risk

As shown on the mapping in Appendix C, a large part of the western half of the site falls within Flood Zones 2 and 3 associated with Middle Beck, River Devon, Car Dyke, Doge Dyke and the River Trent. The areas most prone to flooding are Residential Areas 1, 2, 3 and 4 that partly fall within the Functional Floodplain of the River Devon and Middle Beck. As highlighted in table D3 of PPS25, More Vulnerable land uses are not permitted in this flood zone. More Vulnerable land uses are permitted in Flood Zone 3a subject to the Exception Test being satisfied. Parts of these development areas are shown to fall within an 'Significant' flood hazard. The Hazard to People Classification table (FD2320/TR2) should be reviewed in relation to the level of hazard within a flood zone. The majority of the eastern part of the site falls within Flood Zone 1. A small area along the northern boundary and north east corner falls into Flood Zones 2 and 3 associated with Lowfield Drain. Part of this area falls with the Functional Floodplain associated with this watercourse. The site does not benefit from any formal flood defences. The site is affected by the climate change flood extents associated with the Middle Beck, River Devon, Car Dyke, Doge Dyke and the River Trent.

General recommendations on finished floor levels and floodplain compensation have been provided in the Level 1 SFRA Site Specific FRA Toolkit.

Safe Access

All FRAs should take into consideration safe access and egress issues in the event of flooding; safe access and egress can be achieved from residential areas based on the modelled extents. When producing a site specific Flood Evacuation Plan, adherence should be made to the Nottingham and Nottinghamshire Local Resilience Forum Flood Response Plan (2009), the EA's Local Flood Warning Plan for the City of Nottingham and Nottinghamshire (2008) and all updated versions of the NSDC Emergency Plan. As previously stated, the site does not fall into an area covered by the EA's flood warnings.

The Flood Hazard within a specific area should be viewed within the context of potential access and egress routes for both pedestrians and vehicles.

Sewer Flooding

There are no records of sewer flooding on the site.

Surface Water Drainage

As shown on the plans in Appendix B, the vast majority of the site is shown to fall within the Severn Trent sewer network boundary. An area of land to the east of the site falls within the Anglian sewer network.

Source Protection Zones

A small area in the north east corner of the western half of the site falls within an Outer Protection Zone and Total Catchment.

Contaminated Sites

According to NSDC records there are five sites classified as contaminated within the central areas of the site.

Infiltration Feasibility

SuDs infiltration viability mapping shows that much of the site is unsuitable for infiltration techniques. A small amount of areas in the north are classified as unsuitable. Groundwater table data should be obtained as part of a detailed site investigation.

Adoption and Maintenance

In line with the recommendations provided in the PPS25 Practice Guidance (2009), when planning SuDs, developers need to design for maintenance so that they continue to provide effective drainage for properties throughout the lifetime of the development. Prior to development, a robust SuDS maintenance strategy and mechanism to maintain SuDs in accordance with the strategy, should be agreed in writing with NSDC.

General

In line with the requirements of PPS25, a robust SuDs scheme should be adopted to promote the overall sustainable development of a site. General information relating to the most commonly found components of a SuDs system in relation to Infiltration and Attenuation techniques have been provided within this toolkit.

During the design process, liason should take place with all key relevant stakeholders such NSDC, the EA, IDBs, Anglian Water and Severn Trent Water in order to establish that the design methodology is satisfactory and to agree on a permitted rate of discharge from the site. In line with PPS25, volumes and peak flow rates of surface water leaving a developed site should be no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect. Careful consideration should be given not to exacerbate existing flooding issues on downstream areas along Lowfield Drain in Balderton.

Detailed site investigations should be undertaken by a suitable qualified consultant in order to establish the suitability of implementing various infiltration SuDs techniques based on ground conditions. The SuDs hierarchy as provided in the Level 1 SFRA (FRA Toolkit) should be adhered to.

Guidance on the Exception Test

Section 1.5 of the SFRA sets out the requirements for the Exception Test.

The Exception Test should be applied following application of the Sequential Test (paragraph D10, PPS25). The Exception Test is undertaken to ensure that fluvial flood risk has been properly assessed in relation to the proposed land use and it's vulnerability as set out in Table D3 within PPS25. The following question should be asked when undertaking the Exception Test:

1) Does the site provide wider sustainability benefits to the community that outweigh flood risk, informed by this Level 2 SFRA? ***The NSDC Core strategy will be a key document that will need to be reviewed:***

2) Is the site on developable previously –developed land or, if it is not on previously developed land, there are no other reasonable alternative sites on developable previously developed land?

3) Does the site specific FRA demonstrate that the development will be safe, without increasing flood risk elsewhere and where possible will reduce flood risk overall (taking into consideration the effects of climate change)? ***An FRA should draw the key findings made within this SFRA and follow the guidance set out within the 'toolkit'. PPS25 Practice Guidance (2009) (Chapter 6-Risk management by design) provides details on how a development can be made safe and not increase flood risk elsewhere.***

As highlighted in PPS25, the Exception Test provides a method of managing flood risk whilst still allowing necessary development to occur.

Infiltration SUDS

1.10 This type of SUDS relies on discharges to ground, where suitable ground conditions allow. Therefore, infiltration SUDS are reliant on the local ground conditions (i.e. permeability of soils and geology, the groundwater table depth and the importance of underlying aquifers as water resources etc) for their successful operation.

1.11 Various infiltration techniques are available for directing the surface water runoff to ground. However, development pressures and a desire to maximise development potential often results in typically small land areas available for infiltration systems. This small area, allied to the rapid rates of runoff generation often require some form of supplementary attenuation as part of the infiltration system. The storage may be provided in the sub-base of a permeable surface, within the chamber of a soakaway, as a pond / water feature, or within underground storage pipes / tanks.

1.12 Infiltration measures include the use of permeable surfaces and other systems that are generally located below ground.

Permeable Surfaces

1.13 Permeable surfaces are designed to allow water to drain through to a sub-base at a rate greater than the rain that falls onto the surface. Permeable surfaces act by directly intercepting the rain where it falls and are therefore true source controls. In theory this system would prevent any surface water running off the site, however in reality it is impractical to design permeable surfaces to directly infiltrate intense rainfall events. The permeable sub-base can be used to temporarily store infiltrated run-off underground allowing it to percolate into the ground below. Alternatively, stored water within the sub-base can be discharged from the site.

1.14 Maintenance programmes will need to ensure that the surface is kept clear of silt and voids are clear. The use of grit and salt during the winter months will adversely affect the drainage potential of paved surfaces, however this should not be required often as ice is less likely to form on these types of surfaces.

1.15 Types of permeable surfaces include:

- Grass /Landscaped Areas: Grassed or landscaped areas provide a permeable surface that allows for the infiltration of rain falling onto these areas, and potentially also run-off from adjacent impermeable areas. Grassed or landscaped areas are a relatively inexpensive SUDS measure, however they are likely to be restricted to areas where vehicles are not present.
- Reinforced Grass: Techniques are available that allow grass to be incorporated into a pavement type surface. These provide varying ratios of hard-pavement to grass dependant on the site requirements. These range from concrete block arrangements to plastic meshes and can be used in those areas where the hard permanence of a typical pavement might be undesirable, such as in conservation areas, roadside verges, emergency services access, canal towpaths, farm tracks, rural settings etc. In the past these systems have been typically adopted for situations where a load bearing surface is required to fit into the surrounding environment, however these systems are often now installed for surface water management purposes. The grass: hard pavement ratio will be one of the dominant factors that determine the rate of infiltration through to the sub surface.
- Gravel: A bed of gravel with a high void space on a permeable sub-base offers a cost effective solution for trafficked areas. Rain falling directly onto the area is able to infiltrate through to the sub-base.
- Solid Paving with Void Spaces: Solid paving can be installed in such a way that voids are present that can be in-filled with a permeable material such as grass or gravel etc. If this is to be used as a SuDS measure, a permeable sub-base is required to allow infiltration into the underlying ground and/or temporary storage to attenuate discharges.
- Permeable Pavements: Permeable pavements allow the rain falling directly onto the area to infiltrate through into a sub-base and where suitable, through into the underlying strata. Permeable pavements are constructed using porous concrete blocks allowing the infiltration of rainwater. Small projects of less than $100m^2$ (depending on sub-grade permeability) can often be managed using 100% infiltration, whereas larger schemes will often require a combined system, with some form of attenuation provided as back-up for periods of exceptional flows. The use of geomembranes can trap pollutants and prevent them being carried into the receiving environment. The use of an impermeable membrane beneath the sub-base will work to contain any pollutants within the sub-base. One major advantage of tanked permeable paving systems is that any significant contamination, for example, a diesel spillage, will be restricted to the immediate area and not transported into local sewers or watercourses. The performance of permeable pavements will dramatically decrease over a period of time with the clogging of voids and this should be taken into consideration during the design process and maintenance.

Sub Surface Infiltration

1.16 Where permeable surfaces are not a practical option more defined infiltration systems are available. In order to infiltrate the generated run-off to ground, a storage system is provided that allows the infiltration of the stored water into the surrounding ground through both the sides and bottom of the storage. These systems are constructed below ground and therefore may be advantageous with regards to the developable area of the site. However consideration needs to be given to construction methods and maintenance access to any development that takes place over an underground infiltration system. Consideration is also needed of the depth to the groundwater table. The provision of large volumes of infiltration / storage underground has potential cost implications and infiltration devices should not generally be built within 5m of a building, under a road or on soil that may dissolve or be washed away, in line with Building Regulations advice.

1.17 Various methods for providing sub-surface infiltration include:

- Geocellular Systems: Modular block systems can be used to provide an underground infiltration facility. The modular structures are usually made of plastic and can be staked side by side or on top of each other to construct an infiltration/storage unit of the required size. The modular blocks are usually sited upon a highly permeable sub-base through which the surface water run-off is discharged (usually through the perforated pipes). The outlet from the pipes are restricted, which causes the run-off to rise up through the sub-base into the geocellular storage system. The storage systems are usually tanked with a geomembrane. These types of systems are quick and easy to install, flexible in their configuration, and have minimal maintenance requirements (providing the inflow of silt is limited). While many manufacturers claim that their products are suitable for installation beneath roadways or car parks, their use in these areas should be considered with caution. Geocellular systems can also be used for providing storage without infiltration in order to attenuate discharge rates. In these situations the system is tanked with a geomembrane or similar.
- FilterDrain: A filter drain is a trench that contains a perforated or porous pipe that runs along its bottom. The trench is filled with a suitable filter material, granular material or lightweight aggregate fill, all with a high void space. The fill may be exposed at the ground surface or capped with turf, topsoil etc that allow the trench to flood (i.e. not an impermeable surface that could pressurise the trench). Surface water run-off generated by the site is directed through the perforated pipe which then flows into the trench and infiltrates into the surrounding ground. Filter drains have been used extensively for highways and car parking areas, where they have generally been constructed in the verge and median strip.
- Soakaway (Chamber): Surface water run-off is directed to a chamber set in the ground with holes in the sides and base. This allows the stored water to soak into the ground. The storage capacity of soakaway chambers are limited and therefore they are more suited to serve dwellings rather than large developed areas. The chambers are prone to silting up over time and, therefore, need regular maintenance.
- Soakaway (Trench): Where the linear space is available, soakaways that use a trench rather than a chamber may be used to manage the runoff from larger areas.

- Soakaway (Granular Soakaway): similar to a filter drain, a soakaway (either chamber or trench) filled with a high percentage void, granular material can be used to store surface water runoff as it is infiltrated into the surrounding ground. The granular fill will offer structural strength to the soakaway although the storage volume will be substantially reduced.

Attenuation SUDS

1.18 Where site ground conditions are deemed unsuitable for the widespread implementation of infiltration techniques, surface water runoff will need to be attenuated using on-site attenuation storage. While this is a SUDS technique that will reduce the rate of discharge from the site, the overall volume will not be minimised using on-site storage alone. An important factor that needs to be taken into consideration when assessing the suitability of on-site storage is the volume required, and the impacts the storage will have on development proposals and risks to neighbouring properties.

1.19 Should the use of infiltration not be feasible, on-site storage will be required in order to attenuate the discharge from the site. An allowable rate of discharge from the site will need to be agreed with the Environment Agency, Severn Trent Water / Anglian Water, and the LPA. This can have significant implications to the proposed development with regards to the large volume of storage that may be required. On-site storage can be constructed above ground or below ground; the above ground systems usually being the cheaper option on a cost per m^3 of storage basis. It should be noted, however, that the below ground systems may pose less constraints on the developable area of the site.

1.20 On-site 'above ground' storage measures include basins and ponds, with 'below ground' facilities generally following the more engineered forms of underground storage.

Basins and Ponds

1.21 Basins are areas that have been re-profiled (or alternatively embanked) to allow for the temporary storage of runoff from a developed site. Basins are drained in such a way that ensures that they are free from water in dry weather. Therefore between periods of rainfall they can be used for other purposes such as open public space, recreation etc. Basins treat run-off in a variety of ways i.e. settlement of solids in still water, absorption by aquatic vegetation or biological activity etc. The construction of basins uses relatively simple techniques. Local varieties of vegetation should be used wherever possible and should be fully established before the basins are used. Access to the basin should be provided such that a maintenance programme can be implemented. This would include inspections, regular cutting of grass, annual clearance of aquatic vegetation and silt removal as required.

1.22 Various types of basins are available to use as SUDS measures. These include:

- Detention Basins: A detention basin is designed and constructed to store surface water run-off temporarily in order to attenuate flows over a minimal period of time. Detention basins provide better flow attenuation than floodplains as they store water until the flood has passed. The stored water is then released at a controlled rate after the storm, to avoid flooding downstream. If the runoff is held back for long enough, solids start to settle out of the water, which improves water quality.

- Extended Detention Basins: If the period of detention increases to approximately 24 hours, the basin is referred to as an extended detention basin. This results in the surface water runoff being stored beyond the time normally required for attenuation, which provides extra time for natural processes to remove some of the pollutants in the water.

Ponds

1.23 Ponds are similar to basins except that the outflow is configured such that a volume of water is contained during dry weather, usually for amenity, recreational, or agricultural purposes. Ponds are designed to hold the additional surface water runoff generated by the site during rainfall events. Like basins, ponds are designed to control discharge rates by storing the collected runoff and releasing it slowly once the risk of flooding has passed. Ponds can provide wildlife habitats, water features to enhance the urban landscape and, where water quality and flooding risks are acceptable, they can be used for recreation. It may be possible to integrate ponds and wetlands into public areas to create new community ponds. Ponds and wetlands trap silt which may need to be removed periodically. Ideally, the contaminants should be removed at source to prevent silt from reaching the pond or wetland in the first place. In situations where this is not possible, consideration should be given to a small detention basin placed at the inlet to the pond in order to trap and subsequently remove the silt. Depending on the setting of a pond, health and safety issues are an important consideration. The design of the pond can help to minimise any health and safety issues (i.e. shallower margins to the pond to reduce the danger of falling in). A fence may also be required for keeping children and wildlife out.

1.24 Various types of ponds are available to use as SUDS measures. These include:

- Balancing /Attenuating Ponds: A balancing or attenuation pond is designed only to store surface water run-off and attenuate discharge until the flood / storm peak has passed. Therefore, storage periods may not be long enough to significantly improve water quality capacity compared with ponds with longer retention times. They contain some water at all times with the water level fluctuating as the runoff passes through the device.
- Flood Storage Reservoirs: Flood storage reservoirs are very similar to balancing / attenuation ponds except that they are usually much larger. They are generally used to attenuate fluvial flood flows rather than surface water runoff from developed area and are therefore likely to be used as a SUDS measure. Should an existing flood storage reservoir in the vicinity of the proposed development be identified to offer spare capacity, then depending on ownership and agreement, it may be possible to use the spare capacity for storm water management of development areas.
- Lagoons: Should the surface water run-off have a high suspended solids content, a lagoon could be a suitable method for attenuating its discharge to the receiving environment. Lagoons are similar to balancing / attenuation ponds except that they are also designed for the settlement of suspended soils. Usually they are long and narrow in shape to ensure the longest retention time and therefore an efficient removal of suspended solids. However lagoons are usually free of vegetation and therefore do not provide any biological treatment.

- Retention Ponds: Retention ponds are designed to detain the surface water runoff for periods between several days and two weeks. This allows for a higher level of settlement, biological treatment and limited attenuation of flows. Retention ponds provide a greater degree of treatment than extended detention basins.
- Wetlands: A wetland is similar to a pond except that it has a high proportion of emergent vegetation in relation to open water. Wetlands use plants to make the treatment of surface water run-off more efficient and can allow the detention times required to fully treat the run-off to be reduced to a couple of weeks. Constructed wetlands are ponds with irregular perimeters and undulating bottom contours into which wetland vegetation is purposely placed to enhance pollutant removal from surface water runoff. Surface water runoff enters a constructed wetland through a forebay where the larger solids and course organic material settle out. The runoff discharged from the forebay passes through emergent vegetation which acts to filter organic materials and soluble nutrients. The use of constructed wetlands can be looked at from two perspectives. The first is that the wetland is used primarily to maximise pollutant removal from storm water runoff and also help to attenuate storm water flows. Alternatively, it may be used primarily to control storm water flows, with increased pollutant removal capabilities.

Alternative Forms of Attenuation

1.25 In many situations the development of a site may involve proposals that would inhibit the use of basins or ponds as a means of managing the surface water runoff. This may be due to land take, economic feasibility, or other issues such as health and safety etc. In these situations it may be appropriate to use a storage option that is viewed as being more 'engineered' than an open basin or pond. Most of these methods involve the provision of storage beneath the ground, which may be advantageous with regards to the developable area of the site. However, consideration needs to be given to construction methods, maintenance access, and to any development that takes place over an underground storage facility. The provision of large volumes of storage underground also has potential cost implications.

1.26 Methods for providing alternative attenuation include:

- Deep Shafts: Deep shafts can be utilised in areas with low groundwater tables, though they should only be used under exceptional circumstances.
- Geocellular systems: see previous discussion
- Oversized pipes: Oversizing the pipes that make up the on-site drainage network is a cost effective method that is often used for providing attenuation storage within the network. The main draw back is that it can be very difficult to obtain the required level of storage as the pipe diameters are often restricted by the depth of cover (vertical distance between top of pipework and ground surface) available and the need to gravity drain into an existing network. A solution to this is to lay multiple pipes side by side. However this increases the excavation areas and may also place restrictions on the development footprint. The use of oversized pipes is not an effective method of providing on-site storage if the network is at a relatively steep gradient. This is because the storage at the upstream end of the pipe is unlikely to be used.
- Rainwater Harvesting: Rainwater harvesting is the process of collecting rain that falls directly onto roofs (and in some cases hardstanding areas) such that it can be re-used for non-potable uses around the home or business (typically flushing toilets, car washing and irrigation etc). The simplest form of rainwater harvesting involves the collection of runoff from a roof via a water butt situated at the bottom of a down pipe. This water can then be used for irrigation. For systems where the collected runoff is to be used for toilet flushing, washing machines etc, it is likely that the water would be pumped from a storage tank installed on the grounds of the property. Packaged systems are available although the costs (including ongoing maintenance) may outweigh the payback in terms of reduced water supply charges. The use of rainwater harvesting fits well with the overall water cycle, as it may assist with a minor reduction in volumes of off-site runoff 'post development' together with reducing overall demand for potable water. Rainwater harvesting will not be considered in terms of reducing the volume of storage required on site due to the possibility of bypassing or overflowing in wetter months.

- **Tanks**: There are a number of tanks available for the provision of storage to attenuate surface water runoff. While most storage tanks are installed beneath the ground, above ground storage tanks may be feasible for industrial or commercial developments, where amenity issues or space are not significant restrictions. Tanks are likely to be prefabricated, but could also be constructed in-situ for below ground concrete tanks. Plastic and Glass Reinforced Plastic (GRP) tanks are also often used, with sizes of up to 25m3 being available off the shelf (although larger tanks used above ground may have additional reinforcing requirements). Consideration must be given to below ground tanks with regards to cover depths, load bearings, and also invert depths should the tank be drained by gravity. The storage requirements need to be based on a sound hydrological assessment, as undersizing the tank would be costly to remediate.
- **Green Roofs**: A roof area that is used for growing appropriate types of vegetation, which provides a degree of retention and attenuation. In addition, vegetation and substrate can absorb a range of pollutants. Green roofs are more suitable for public and institutional buildings that have good maintenance programmes and support. Green roofs are available in both prefabricated and in-situ construction however they are heavy systems and can have major structural implications for buildings and are usually impractical to retro-fit.

Combined Infiltration /Attenuation Systems

1.27 In most situations, SUDS systems include both infiltration and storage. Most of the techniques identified above can be used in combination, however dedicated infiltration and attenuation systems include swales and filter strips.

- **Swales**: A swale is a grass-lined channel designed to control both the flow rate and quality of surface water run-off that is generated by the adjacent site. Not only does the water run down the sides of the swale at a reduced speed, but it can also be slowed further as it flows along the channel before being discharged from the site. This detention of the runoff also increases the infiltration from the swale.
- **FilterStrips**: A filter strip runs along the edge of a permeable area and is sloped to allow the sheet flow across the vegetated strip. Unlike a swale however, no storage is offered other than what is held back by the vegetation. The overland flow across the filter strip is likely to run into a water course at some point rather than being formally collected and discharged at a controlled rate from the site.