Land Drainage - Phase 3

Manhood Peninsula

Chichester District Council

25 May 2006

Final Report

9M4111

A COMPANY OF
ROYAL HASKONING

HASKONING UK LTD.
COASTAL & RIVERS

Burns House
Harlands Road
Haywards Heath, West Sussex RH16 1PG
United Kingdom
+44 (0)1444 458551 Telephone
01444 440665 Fax
info@haywards-heath.royalhaskoning.com E-mail
www.royalhaskoning.com Internet

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Drafted by	Emma Williamson	
Checked by	Ian Hutchison	
Date/initials check	………………….	………………….
Approved by	Martin Whiting	
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1 INTRODUCTION

The Manhood Peninsula Land Drainage Study commenced in December 2002. The study was to be on a phased basis with the first phase being an overall data gathering and overview of land drainage on the Peninsula. The subject of subsequent phases was to be defined based on the findings of the previous phase(s). It is intended that all 3 reports are to be read in conjunction with each other.

Phase 1 was submitted in August 2003 and involved an initial assessment to gain a basic understanding of the land drainage issues. It identified any gaps in the understanding of the drainage system and, most importantly, provided a platform for further assessment.

Phase 2 involved a study into the effects of siltation in and around Pagham Harbour taking into account the effect of climate change. Also included were suggested remedial measures, the potential effect on the Lavant flood alleviation scheme and the impact on the environment.

Phase 3 is a study of the role of the ditch system in terms of transport and storage, an investigation of possible storage sites and consideration of SuDS.

2 TERMS OF APPOINTMENT

Royal Haskoning were requested to hold a meeting on 27th July 2005 with representatives from Chichester District Council, West Sussex County Council and European Spatial Planning: Adapting to Climate Events (ESPACE). In this meeting, the requirements for Phase 3 of the Manhood Peninsula Land Drainage Study were discussed, based on the issues identified within the ESPACE action plan and a brief prepared by Chichester District Council.

An initial proposal was submitted on 8th August 2005 and a final proposal was submitted on 6th September 2005. Royal Haskoning were appointed to undertake this work on 24th November 2005.

3 OBJECTIVES

The objectives of this phase of land drainage study as set out at the proposal stage were as follows:

- Identify transport, storage and combined ditches;
- Investigate and identify suitable water storage sites, their potential storage capacities, uses and environmental benefits;
- Assessing the viability and limitations of SuDS on the Peninsula;
- Supply data to input to the preparation of the education material by the ESPACE project team.

4 IDENTIFICATION OF TRANSPORT, STORAGE OR COMBINED DITCHES

4.1 Introduction

This section of the work involved the use of the available topographic survey data and mapping and knowledge of the Peninsula to identify the probable function(s) of the watercourses within particular areas as a desk study.

4.2 Methodology for Initial Classification

In the brief and proposal it was anticipated that all drainage ditches would be classified as transport, storage, combined or uncertain. During the course of investigation to determine the function of the ditches it became clear that it was not practical to adequately classify the ditches using the categories identified.

It became clear that with the amount of data from Ordnance Survey plans and the survey data available that the size of the areas classified as uncertain would be such as to limit the usefulness of the results. Ditches can serve a combined purpose of storage and transport or can have a different classification depending on the water level. Detailed survey data for the ditch would be needed to determine gradients, and volumes would be needed but this is not available.

The methodology and classification was therefore amended to determine the areas where transport in the ditch system is very important. By default this identifies the ditches in the remaining area as of limited importance to transport and therefore more suitable for storage.

In order to identify the classifications the principle purpose of flood risk management as set out above i.e. to reduce the risk of flooding to people and property was used. On this basis the systems which serve to convey water away from areas where people and property are at risk were classified as key transport routes.

Initial classification of Main Rivers, Critical Ordinary Watercourses (COWs) and Internal Drainage Board Watercourses (IDBs) highlighted them on the maps as vital transport routes. Then drainage ditches around towns, villages and other built-up areas were marked as requiring continued clearance so they could act as transport ditches. The impact of non-clearance of these ditches would result in flooding to property.

Key transport routes, identified on each of the maps (Appendix 1) as a dashed red line, are those watercourses currently not classed as Main River, COWs or IDBs, but which on review of the system were deemed to be important ditches as they move water away from areas considered to be at risk of flooding. All of the key transport routes marked on the maps are believed to be riparian owned and therefore the responsibility of the riparian landowner to maintain and keep clear.

Consultation was carried out with West Sussex County Council and the Environment Agency and as a result of this process the information they provided has been marked on the maps as a series of labels in order to aid decision making when using the maps to consider drainage issues. Areas that have been identified through this consultation include private ditches requiring cleaning, where streams overflow or ponding occurs and where drains no longer exist.

There are also further areas on the maps that are believed to require continued drainage and transport of water away from the area; these have been shown on the maps by a blue cloud effect. This denotes where there is presently insufficient information readily available to fully identify the key transport areas. These areas would benefit from further review and local input in order to ascertain how key they are to providing drainage on the Peninsula.

The Coastal Flood Zone for the 1 in 200 year flood event on the Peninsula is included on the Key Plan (Sheet 00, Appendix 1). This layer highlights where properties are currently located in geographically sensitive areas and are more likely to be affected by sea conditions resulting from climate change.

In summary the following assumptions were made when producing the maps:

- Main Rivers, IDBs and COWs are primarily transport routes.
- Further important major transport routes which are currently not classified have been marked and highlighted as key transport routes.
- Key areas for drainage are areas in which water needs to be dealt with to reduce the risk of flooding.
- Key areas for drainage do not have to link to transport routes. It is possible that water could be drained out of an area into storage ditches for example.

The initial desk study classifications are presented in the form of a booklet of maps of the Peninsula (Appendix 1).

4.3 Changes of Classifications

4.3.1 General

It is recognised that the initial classifications will need to be refined and updated as more data (quantitative or anecdotal) becomes available. The maps produced are therefore live documents which will change in the future. Indeed areas have been identified on the maps where clarification is required at present.

4.3.2 Local Knowledge

Local knowledge was noted at the outset as being invaluable in refining the initial classification and/or reducing the extent of uncertain areas and has been identified when producing the maps.

A meeting was held on 17th January 2006 in Royal Haskoning's office so that all the working data used for the initial classification would be available for reference.

At this meeting some amendments to classifications were made based on the local knowledge of Chichester District Council staff.

It was further agreed that there are many parties who could have an input to the classification. The collation of the input of many parties needs to be dealt with in an ordered fashion so that classifications do not change back and forth unnecessarily. Meetings were also held with West Sussex County Council and the Environment Agency in order to benefit from their local knowledge, which then allowed further identification of key storage areas and transport routes.

Some parties e.g. Councils or Parish Councils could have an overall view or a specific area view whereas there may be individuals whose site specific input could provide vital local information.

4.3.3 Climate Change

Issues and impacts on the Manhood Peninsula relating to climate change were discussed widely in the Royal Haskoning Phase 1 report (2003) and that section of the report has been included as Appendix 2. Since the Phase 1 report the Government has published its new Strategy "Making space for water" (2004) as a consultation exercise aimed at allowing space for water in order to manage the adverse consequences for people and the economy that can result from flooding and coastal erosion whilst aiming to achieve environmental and social benefits.

The new Strategy:
- Builds on work already carried out to take account of sustainable development and the Government's strategic priorities;
- Addresses the messages from the Foresight *Future Flooding* report, and reflects lessons learned from the flood events in the recent past;
- Addresses the challenges and pressures we are facing over the next century such as climate change, development pressures and rising levels of risk and cost;
- Highlights the need for a more integrated and holistic approach to the management of risk using a portfolio of measures.

(Defra, 2004).

The Foresight *Future Flooding* report referred to in the Strategy applies the same UKCIP02 climate change scenarios used by Royal Haskoning in the Phase 1 report. Section 2 of "Making space for water" considers climate change as one of the six key drivers of flooding, which although likely to have a high impact also has a high level of uncertainty surrounding it. Climate change is expected to impact a range of water policies over the longer term in England and therefore "Making space for water" highlights the need to build in adaptation to the predicted climate change impacts over the coming decades through policy frameworks and forward planning.

Whilst it is acknowledged that there is a great deal of uncertainty surrounding the issue of climate change, its timing and extent, it is perceived that regardless of this the conditions will become more severe over time. The Strategy notes that the primary impacts on flood risk are expected to be from changes in precipitation, extreme sea levels and coastal storms.

It is anticipated that climate change will not impact on the classification of main transport routes or areas that are important to the drainage system on the Peninsula. Although, it has been identified that climate change in the form of increased rainfall and storminess could increase the need to clear ditches more frequently either to allow increased flow capacities through the ditch system or to provide more storage to reduce the risks of flooding. Changes in sea level whether as a result of climate or other changes may restrict the time that drainage discharges and outlets to the tidal foreshore are able to operate, this may result in more water in the ditch system but less time for it to be discharged. Therefore, the above changes highlight how the available capacity of the drainage system in further events is likely to be reduced. It was not within the scope of this report to calculate and consider specific volumes related to the capacity of the system and further work in this area would help to clarify some of the uncertainty.

However, an increase in winter rainfall of up to 30%, as discussed in the Phase 1 report, would increase the volumes in the system. This would result in a combination of existing surplus flow and storage capacities being taken up and existing capacities being exceeded.

4.3.4 Future Development

In addition to the impact of climate change the main influence on the classification of the ditches will be future development within the Peninsula if uncontrolled runoff to the existing system is allowed. Such runoff could increase the risk of flooding.

The Environment Agency has stated that target figures for discharge from a new development, which should incorporate Sustainable Drainage System (SuDS)[1] techniques varies depending on the land gradient and type of system installed. However, assuming that a storage system was to be provided with a restricted discharge to an adjacent watercourse then peak discharge would be expected to be between 3 – 7 l/s/ha.

It is preferable for all new development to be required to attenuate runoff from the site to a maximum of the natural runoff. If this were to happen, although the new development would be a key area for drainage and the implementation of SuDS, since there would be no change in flow within the watercourse there would be no need for any changes to the classification of the routes downstream of the site.

[1] SuDS – Formerly known as Sustainable Urban Drainage Systems (SUDS) now defined as Sustainable Drainage Systems (SuDS) to highlight the opportunities for the use of these techniques in both urban and rural locations.

5 STORAGE SITES AND CAPACITIES

5.1 General

In the proposal it was stated that areas would be identified where water could be stored and where storage could be detrimental.

Storage areas would be beneficial where reduced flows and runoff would help to reduce risk of flooding to people and properties downstream. Conversely storage would be detrimental where it could cause water to back up and cause flooding or where there would be the potential for the storage area to overtop or breach and cause flooding.

Inspection of the plans revealed there were few areas where the topography would allow effective storage. Some areas where storage would be possible were identified but these have already been designated as IDBs or COWs and therefore by default are important transport routes where it would be inadvisable to hold back water.

No specific areas where storage would be particularly detrimental were identified but there are many places where this could occur depending on the specific site conditions. Although no specific storage areas were located, the consultation with West Sussex County Council and the Environment Agency highlighted certain areas of the Peninsula where key issues with drainage and ditches are experienced. These have been labelled in order to provide information and knowledge to guide future recommendations for storage areas.

In considering areas suitable for storage the following criteria were used:

- There should be a clearly defined benefit in terms of flood management.
- Storage should be achieved by using existing ditches/water features and natural contours.
- It is not recommended that storage above ground (i.e. contained within raised embankments) is considered, unless in exceptional circumstances, due to the risks associated with embankment failure.

The scale of potential storage ranges from small volumes to attenuate runoff from individual properties to large volumes to attenuate flows in a watercourse draining an entire village. Technical advice, guidance and legislative issues are addressed by CIRIA in their Sustainable Urban Drainage Systems - design manual for England and Wales (C522) and in Sustainable Urban Drainage Systems - best practice manual (C523).

5.2 Existing Storage Areas

There are areas of existing storage on the Peninsula which form major parts of the current drainage system including the floodplains of Pagham, Bremere and Broad Rifes and the network of ditches.

The floodplains of Pagham and Bremere Rife are located landward of the Pagham Wall and provide storage to allow for tidal locking. Their importance in the system should never be underestimated and it is vital to the current system that they are maintained.

Any consideration to change the alignment of the Pagham Wall would have to take into account any loss of storage and the effect of any loss on the hydraulic performance of the system. Without this storage area, water could back up the system and result in flooding upstream at North and South Mundham.

Similarly Broad Rife provides an essential storage to buffer the effects of flow during tidal locking. Loss of this area could affect Earnley, East Wittering, Bracklesham and Selsey.

5.3 Ditch Storage Volumes

Ditches serve two functions storage and transport. The dimensions and condition of a ditch affect both of these functions.

For example, if it was environmentally acceptable:-

- Dredging a ditch 0.7m deep with 2 in 1 side slopes, so that 100mm were removed from the bed and 50mm were removed from the sides, would increase the flow capacity by approximately 35% and the storage volume in the ditch by approximately 25%.
- A similar amount of dredging of a 1.2m deep ditch would increase the flow capacity by around 20% and the storage volume in the ditch by approximately 15%.

These figures also indicate the scale by which flow capacity and storage volume reduce when silting up occurs.

These are however theoretical calculations based on assumed conditions for an idealised ditch section. In reality the flow capacity of a ditch system is usually controlled by the size of pipes under field accesses, driveways etc. Therefore the increase in flow capacity cannot usually be achieved for a system without improving these pipes. The restriction of these pipes does however mean that the storage capacity of the ditch is often utilised. Through cleaning out of the ditches storage capacity can be increased without significantly increasing flow, provided there is a suitable restriction downstream.

Historically ditches would have been cleaned out by hand on a regular cycle by the “spare” agricultural workforce in the winter months. Increased mechanisation, seasonal rather than full time labour and the lack of willingness to carry out hard manual labour have resulted in this practice having largely been abandoned. The capacities of the system are therefore tending to reduce with time during a time of increased runoff due to climate change. In some places the outcome of these combined factors means that the system could have reached or be approaching capacity.

It is likely that clearance of the whole system could improve the situation. There are however environmental implications of such actions and so the extent of clearance should be limited to that necessary as discussed further below. Monitoring would be needed to ensure the desired hydraulic effects are achieved without significant detriment to the environment. It is considered that the best way forward would be to identify a trial site in a problem area to implement a new clearance regime. The results could then be monitored with a view to expanding the measures to other problem areas.

5.4 Environmental Aspects of Ditch Maintenance

The effective management of ditch networks is essential in maintaining their drainage capacity and limiting the transport and impact of sediment, nutrients and chemicals in land run-off. Man-made drainage channels may require regular and periodic intervention to prevent the cessation of their functional capabilities and maintain their biodiversity value. It is vital, therefore, that maintenance practises are sympathetic to natural processes and existing species and habitats in order to minimise potential environmental impacts.

Insensitive deepening or re-profiling of ditch systems to increase capacity or gradient of flow may have a significant adverse impact on the environment. The use of heavy machinery for ditch clearance may also adversely affect bankside vegetation, destabilise banks and may lead to severe erosion, sourcing of fine sediment and sediment deposition problems further down the drainage network or within the receiving watercourse. The deepening and widening of ditches should be considered a last resort, and any associated maintenance operations should be limited to minimise the impact to the adjacent biota. Dredging should only be partial, if at all, with vegetation clearance occurring from one side of a channel or in short stretches from either bank.

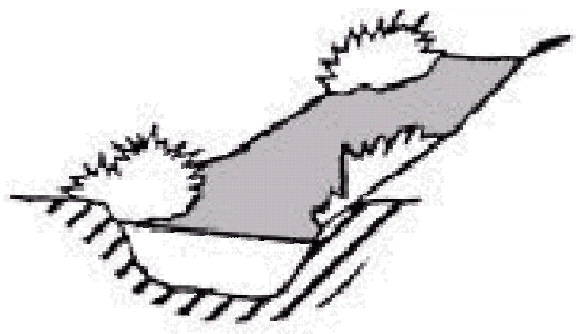

Figure 1: Partial clearance of drainage ditch

(Source: Farming and Watercourse Management Handbook, WWF, 2000)

Partial ditch clearance has several ecological advantages over full-scale clearance such as the potential of increased habitat diversity, by creating deeper areas of water which may provide additional habitat for aquatic species. The partial clearance of ditches to leave some aquatic vegetation can encourage the settling of sediments and uptake of otherwise potentially harmful nutrients by vegetation such as reeds and rushes, whilst retaining drainage functionality. Rotational clearing of limited areas or sections of drainage channels may form part of an environmentally sympathetic maintenance regime. The sourcing of fine sediment may also be limited by use of riparian buffer zones to filter sediment out of overland flows before it reaches the drain.

Bank re-profiling occurring as a result of maintenance may also provide opportunities for habitat enhancement. The angle to which banks are cut will affect the speed of revegetation: shallower banks are more easily recolonised and less prone to erosion. It may also be beneficial to leave vertical faces in some banks for kingfishers, sand martins and other bankside species. Any vegetation removed in the process of ditch clearance should temporarily be left as close to the watercourse as possible to enable any aquatic invertebrates removed to return to the watercourse. Any spoil removed should be removed from the site and not dumped on the bankside. Consideration should also be given to the potential for contamination when disposing of sediments from ditches, as contaminated sediment should always be disposed of in an environmentally sensitive manner.

5.5 Maintenance Responsibilities

Changes in policy and legislation since the publishing of the Phase 1 report means that the Environment Agency is now the authority responsible for COWs. Previously, the management of these watercourses were within the powers of Local Authorities and Internal Drainage Boards. At a National level there has also been a movement in policy away from Flood Defence towards a more holistic approach of Flood Risk Management. The management of flood risk is not only achieved by physical defences such as embankments and river walls, but also by the provision of flood warning systems, the raising of public awareness regarding flood risk and changes to annual vegetation maintenance programmes.

The Environment Agency using their permissive powers has a maintenance and cutting regime in place on the Main Rivers, COWs and IDBs on the Peninsula, which assigns the intensity of the cut type depending on the flood risk and ecological sensitivity of the ditch in question. An intensive or hard cut is carried out on ditches where there is a high level of flood risk removing 80% of vegetation, whereas a soft or sensitive cut is applied to ditches with a low level of flood risk removing 50% of vegetation.

With many of the ditches and storage areas there are key issues regarding ownership and the will to carry out the works. It is the sole responsibility of the Landowner as the riparian owner to maintain the watercourse and/or ditch system and to allow the flow to pass through the stretch without obstruction. It is perceived that there are many riparian owners who are unaware of their responsibilities or do not wish to carry them out and it is key for the relevant authorities to work together educating people in order to increase awareness. Ignorance of their rights and responsibility does not constitute a reason for not carrying out maintenance works etc.

To explain their management of watercourses and responsibilities on the Peninsula the Environment Agency has produced a leaflet entitled “A Changing Environment. Management of Watercourses by the Environment Agency in the Chichester Catchment, Sussex” (included as Appendix 4). Also as part of the need to educate people on their responsibilities the Environment Agency has produced a booklet entitled “Living on the Edge”, which sets out the rights and responsibilities of a riparian landowner (included as Appendix 3 of this report).

The Chichester Coastal Plain Sustainable Farming (CCPSF) Partnership is a project on the Peninsula which to some extent has already served to increase awareness of maintenance/legal requirements and environmental issues affecting land drainage. This project aimed to establish a demonstration area of best practice for sustainable farming and biodiversity enhancement. Ideas for habitat enhancement included margins and buffer strips, livestock management beside watercourses, reviewing nutrient pollution, riparian set-aside, wetland creation and management, ditch habitat and water levels, and watercourse and flood risk management. One of the outcomes of the CCPSF Partnership was the production of a “Farmers Pack” aimed at providing practical guidance material on best practice and restoration options available to farmers in order to enhance habitats on farmland and improve the connectivity of the floodplain.

When planning maintenance activities it will be essential to consider the management of the arisings, both vegetation and dredged material, with respect to the requirements of waste management regulations.

6 ASSESS THE VIABILITY AND LIMITATIONS OF SUDS ON THE PENINSULA

6.1 Introduction

This section addresses the viability and limitations of SuDS on the Peninsula and involves considering the strategic options and individual specific actions (including the option of retrofitting). The differing geological conditions, the topography and existing restrictions such as development were used to determine the limitations of or the particular suitability of the various types of sustainable drainage in particular areas. SuDS can be extremely effective when included in the design of a new development from the beginning. However, it tends to be difficult to implement SuDS when they are being retrofitted as this requires adding a system at a later date to an existing property or development where the necessary space may not be available. The incorporation of SuDS within a new development should be viewed as a positive advantage to the overall appearance of a project.

6.2 Sustainable Drainage Systems (SuDS)

6.2.1 Principles

The concept of Sustainable Drainage Systems (SuDS) has been developing in the UK over the last 5-7 years, following the success of such techniques in the U.S. and Europe, and emerging best practice from other countries such as Australia.

The objective of a Sustainable Drainage System (SuDS) is to mitigate flows and pollution from runoff within a development. In theory SuDS should allow drainage to replicate as close as possible a natural situation without development and remove pollutants.

There are many benefits from the use of SuDS which include the following:

- Reduction of peak flows, reducing the potential risk of flooding downstream
- Improved water quality compared to traditional surface water sewers
- Slow release of water into a watercourse increasing the base flow
- Improved amenity
- Environmental enhancement.

SuDS techniques must meet a number of criteria before being considered for general use:

- the drainage triangle – meeting quantity, quality and amenity objectives
- the management train – techniques used in series to improve quantity and quality

Prevention
↓
Source control
↓
Site control
↓
Regional control

6.2.2 Established types of system

There are four generally established methods of control related to SuDS with the exception of traditionally used in/off line storage provided in ponds, underground tanks or oversized pipes which should be only considered as a last resort in conjunction with other SuDS measures. Four categories of SuDS include:

- filter strips and swales
- filter drains and permeable surfaces
- infiltration devices
- basins, ponds and wetlands.

For all these the use of appropriate and easily understood and maintained flow control devices, especially inlets and outlets, is required in locations where supervision during design life will be difficult and maintenance often can be neglected or limited.

Filter strips

Filter strips are gently sloping grass or other vegetated surfaces that drain water evenly from impermeable surfaces. They are particularly useful for protecting infiltration devices, such as filter drains from silt.

USE: Filter strips can be used wherever possible to collect water and protect infiltration devices such as filter drains, pervious surfaces and swales.

MAINTENANCE: Monthly inspections at landscape maintenance visits; mowing as required but at least once a year.

Swales

Swales are shallow channels that are designed to convey, infiltrate, store and treat runoff. Although swales are typically broad and shallow they can be designed to be space efficient and are simple to construct and manage. New designs with permeable under-drainage have been shown to work effectively in all but the heaviest storm events. Outlets located slightly above the channel bed level will be needed at regular intervals to direct excess water to the downstream drainage system.

USE: Swales can be used in all but the densest urban situations. They are cost effective, resilient in use and simple to maintain. They can be planted and designed for amenity.

MAINTENANCE: Monthly inspections at landscape maintenance visits; mowing as required but at least twice a year.

Filter drains

Filter drains are linear devices that drain water from impermeable surfaces in a diffuse manner and to dissipate some of the water by infiltration. They are trenches filled with permeable material into which runoff is collected, stored and conveyed. Filter drains are similar to the familiar ‘French drain’ and are currently used to drain car parks, residential drives, paths and patios. They are increasingly being used to drain roads, particularly motorways and main trunk roads although risk of stone scatter has caused some concerns if used in narrow verges.

USE: Filter drains can be used in most low to medium density housing but care is required to anticipate the blocking by silt. Therefore they should be constructed late in the programme and protected during construction and thereafter. A filter strip is the ideal long-term protection. Construction should include a removable surface layer for simple reinstatement.

MAINTENANCE: Monthly inspections at landscape maintenance visits; replace clogged material as required (typically 10 years or greater depending on their location and silt load).

Permeable surfaces

Permeable surfaces allow rainwater to infiltrate through the surface into an underlying storage layer from where water is either drained to the normal system or allowed to infiltrate. They have a volume of pervious material below ground to store and infiltrate surface water and include grass, reinforced grass, gravelled areas, permeable blocks and porous surfaces (e.g. porous concrete or porous asphalt). There are solutions for many situations but the permeable block pavement is particularly appropriate for urban situations where space is limited. However, runoff to pervious surfaces from adjacent soft landscaped areas should be avoided where possible to minimise the risk of clogging of the surface by silt/sand. There is also a management requirement that must be undertaken to ensure the surface remains effective over time. Where these simple requirements can be accommodated, pervious surface can be a particularly useful technique.

USE: Permeable solutions can be used in most sites but especially useful on urban sites (e.g. car parks, roads, footpaths and other hard landscaped areas) where space is limited.

MAINTENANCE: Monthly inspections at landscape maintenance visits for clogging and water ponding, and vacuum sweeping at least twice a year (before spring and after leaf fall in autumn). It is anticipated that at some point over a period of time the surface will need to be taken up, the filter fabric and accumulated silt removed and permeable blocks relayed to reinstate its function. According to currently available technical information the replacement of permeable blocks may be needed after 20 to 40 years although there are no practical examples to prove this requirement. The reinstatement procedure is essentially:

- lift blocks and stack
- lift and dispose of geotextile, 5mm grit and accumulated silt and pollutants
- supply and lay new geotextile and 5mm grit over protected permeable sub-base
- re-lay stored blocks
- re-grit blocks and consolidate.

Infiltration devices

Infiltration devices drain water directly into the ground. They include soakaways, infiltration trenches and infiltration basins as well as swales, filter drains and ponds. Infiltration devices work by enhancing the natural capacity of the ground to store and drain water.

The effectiveness of infiltration devices depend on the 'infiltration potential' of the soil, protection from silt and avoiding compaction of the ground during construction. It is recognised that the soil conditions in, for example, Cambridgeshire where the low-lying land is generally not suitable for infiltration techniques due to the presence of clay type soils and shallow ground water table. Soakaways have been used traditionally in housing developments where ground conditions are suitable but are usually forgotten in a few years. Neglected maintenance may cause problems due to deteriorated infiltration capacity of the devices and surrounding soil. Simple and identifiable infiltration devices are required where they can be used effectively within housing developments.

There are new techniques available which combine the features of a swale and an infiltration surface, which may be appropriate for housing areas. They are called 'bio-retention' swales or basins.

USE: where sediment load is low (e.g. roofs and housing courts) and ground is permeable.

MAINTENANCE: at least six monthly inspections of silt traps and pre-treatment devices where present including removal of sediment as required. Annual check of observation well, to ensure emptying and no clogging where soakaways and infiltration trenches are used.

Basins, ponds and wetlands

There are no distinct boundaries between the various types of basins but are characterised by the length of time water is held and whether some water is retained for amenity and treatment functions:

- Detention basins – temporarily store water until the flood has passed, normally dry.
- Extended detention basins – temporarily store water and allow settlement of solids, normally dry.
- Retention basins/wet ponds – hold water back for treatment of pollution and are permanently wet ponds with rooted aquatic vegetation.
- Wetlands – are shallow ponds and marshland areas which are covered almost entirely in aquatic vegetation.

USE: Within sites where sufficient space is available and site topography is suitable for the use of basins and ponds. Public open spaces within housing offer opportunities to store runoff, collect silt and begin treatment of diffuse pollution. They can be designed as multi-functional spaces with wetland areas for wildlife, visual interest and biological treatment. It is possible in some situations to transfer part of the storage requirements to public open spaces under Local Authority ownership, particularly if the SuDS features contribute to general amenity and have financial provision for maintenance.

MAINTENANCE: different requirements depending on basin type. This is integrated with normal landscape management.

6.2.3 Alternative techniques

General

There are some other techniques which are not strictly SuDS but which perform a similar function. Some are the result of technical innovation whilst others are historic practices which are now less commonly employed. Examples include;

- green roofs
- underground storage
- water butts.

Green roofs

Green roof technology offers a number of environmental benefits including attenuation of rainwater and flow control similar to a ‘greenfield’ situation as well as additional evaporation.

USE: Green roofs can only be used as a SuDS technique where the construction and long-term management process is guaranteed. Therefore they are particularly appropriate for housing association controlled apartments and flat type accommodation where the roof is flat or gently sloping. There are now examples of this technique in the USA, Europe and increasingly in the UK.

MAINTENANCE: irrigation during establishment of vegetation to provide sufficient moisture as required in first two years. Thereafter, six monthly inspections and replacement of bare patches and removal of litter.

Water butts

According to the Environment Agency’s current guidelines, the storage available in rainwater harvesting systems may not be fully considered as available attenuation storage although they do help with controlling rapid surges of potentially polluted roof water following dry periods and also provide some attenuation. The current guidance require that the storage provided for attenuation must drain down within a short period (e.g. 48 hours) to provide storage for any subsequent storm events and this may not always be possible with water butts as their operation and water consumption will depend on the property owner or occupants.

The installation of rainwater butts to all houses is a cheap and effective way of introducing sustainable management of the water resource and helps SuDS in the following ways:

• appropriate water butt design can intercept ‘first flush’ flows from roofs. This is particularly useful in summer after long dry spells when silts and other pollutants have settled on roof surfaces.
• water collected in water butts is returned to gardens acting as a limited ‘source control’ feature.
• a water butt, acting as a silt collector, can protect storage features such as box storage.
• Therefore a SuDS friendly water butt should have a silt collection volume at the base which can be drained down allowing silt to be disposed of to garden compost or household waste. It is also important that pipe connections for roof water should not allow cross connection from household appliances.

The major advantage of water storage butts is not related to drainage rather it is that provided the water is reused the load on the water supply system is reduced. Historically water butts were used to collect water for use but in recent times the readily available supply from the tap has reduced the use of water butts.

Underground Storage

Another major SuDS innovation is the development of proprietary storage box systems (e.g. geocellular plastic structures).

USE: Although it is cheaper and environmentally better to manage attenuation in open landscape features, the underground storage of runoff is acceptable subject to suitable silt management and treatment of pollution. Deep box storage is difficult to manage because the boxes require substantial cover to prevent damage and therefore cause problems for discharge to natural drainage systems. Shallow box storage offers a better solution and can replace conventional sub-base construction. The use of appropriate proprietary products in housing needs careful consideration as they should be both cost-effective and environmentally sustainable in the long-term.

MAINTENANCE: As per the manufacturers’ advice. At a minimum six monthly inspections for silting and blockages including the removal of silt and blockages as required.

6.2.4 Installation

Installation of SuDS is most easily achieved by incorporating the measures in the design from the outset. All new developments should incorporate SuDS as a matter of course to prevent increased risk of flooding.

Retrofitting of SuDS techniques to existing developments to achieve the same objectives is extremely difficult. SuDS usually require some space which is often not available in existing developments in the right place to allow retrofitting.

There is also a cost involved with providing SuDS. If they are included in a design from the start the cost will be similar to traditional techniques. The cost of retrofitting would be considerably higher than installation as part of original construction. This cost could only be justified in areas with particular problems which need to be addressed. Whilst it would be desirable to retrofit SuDS in as many places as possible there is an issue of sustainability in that any existing system would be largely rendered redundant by an effective SuDS system. The waste in having installed the original system and now not using it would have to be considered.

The opportunities for retrofitting have been investigated but no particular sites have been identified based on a desk study.

6.2.5 Water reuse

Water collection and reuse although not strictly a SuDS technique can be particularly effective if there are significant amounts of water used such that there is always available storage for rainfall.

The major problem with water collection and reuse is the infrastructure needed for distribution from the collection point to the point of use and therefore the scale of water use has to be large enough that the saving on metered water is sufficient to cover the investment.

It is understood that some of the large warehouse buildings near North Mundham carry out recycling for irrigation and washing of produce.

It has been identified that the most appropriate other place for reuse would be from glasshouse roofs for watering of glasshouses. It is not known to what extent this is already carried out.

It is estimated that from an average sized glasshouse roof annually 3000m^3 or 3 million litres of water could be collected. There are several factors that would need to be considered by the nursery in considering retrofitting which are as follows:

- Current watering system
- Level of production
- Seasonal use of greenhouses.

If the nursery currently uses a mains irrigation system a pump would need to be fitted to pump the water from the storage tank through the system. The level of production is an important factor in order to identify if it would be economically viable to collect water, especially if a pump is required. The usual use of a greenhouse ensures that crops would need to be watered and if the greenhouses are utilised during the winter months it is expected that there would be adequate water collected to supply the crops.

The mains water supply may still need to be utilised, especially during the summer months and therefore the current system would need to be maintained.

In practical flood risk terms these measures would have only a limited effect since when the actual location of most of the glasshouses on the Peninsula is considered there are a limited number of properties downstream. However, water recycling may be economically advantageous for the nursery owners as it is likely that their water use is metered.

6.2.6 Local Examples

Chichester District Council and the Environment Agency have identified sites where SuDS or ditch management systems have been or are about to be implemented so that specific relevant local examples can be presented rather than the general theory. These include:

- Florece Road, Birdham where retention ponds were created for storage (mid 1980s).
- Flavian Fields, off Clay Lane in Fishbourne, where a ditch was enlarged to provide storage in severe events and an over ground flood route was identified using soft contouring to be utilised in the event of a system failure for surcharged water (2003).
- The Pyeland development involved enlarging an existing pond at East Beach to safely store runoff when the outfalls are tide locked.
- Embayments at Hunston, where the ditches were widened and left as “natural” storage to encourage water voles. By creating a wildlife refuge the main watercourse can be recolonised once the dredging of the main watercourse or ditch has been carried out. The watercourse was also fenced to prevent it being stripped of vegetation every time adjacent land was mowed (2002).
- Installation of check weirs and embayments at Donnington IDB ditches (2004)
- Installation of check weirs and embayments at Ferry Farm IDB ditches (2004).

6.2.7 General Advice

Past difficulties of implementing SuDS in the UK

The following is a list of past difficulties and current barriers to implementing SuDS in the UK:

- Lack of clear, unambiguous ‘joined-up’ legislation and responsibilities for SuDS implementation and also for urban drainage master planning – i.e. the regulation of flooding, water quality and surface water drainage, and the diverse range of organisations having some part in the management of urban water;
- Lack of experience/knowledge in the planning and design of into urban development, practical information and integrated team involvement;
- Historically a lack of perceived need for water cycle management from a whole-catchment perspective (although this is changing gradually);
- Inadequacy in the training of planning professionals;
- Cost implications;
- Land/space use;
- Health and safety issues; and
- Ownership and maintenance.

Changes in the planning process, with the anticipated replacement of PPG25 with PPS25, are likely to impact on the planning of new developments in terms of requirements for flood risk assessments and allowances for future climate change. This will impact on the requirements for developers to include SuDS in their design. In Section 8 of the Government strategy “Making space for water” the ownership of SuDS and responsibility for their maintenance are raised as issues of concern, with reference to further work required to establish potential legislative changes that could increase uptake.

Future developments are likely to have stronger guidance and requirements for the implementation of SuDS, which as previously discussed can be constrained by maintenance issues. The Environment Agency has noted that the adoption post development of SuDS is a key concern. Adoption by the local authority is preferred as there is more chance that the essential maintenance of the system necessary to ensure the ongoing operation as designed, will be carried out. The use of a management company is good in theory but some are likely to maintain them to a higher standard than others and so it is best to encourage the construction of a system able to cope with and absorb a certain amount of mis-management (e.g. incorporating safety factors into the design).

Local restrictions that must be considered before the development of or implementation of SuDS within a new development or as part of a retrofitting project include the following:

- Underlying Geology
- Soil type
- Topography.

On the Manhood Peninsula the Environment Agency noted that SuDS are not always easy to implement due to local conditions. Infiltration is not very good in this area, which coupled with high groundwater levels and very flat gradient means the use of SuDS is limited.

7 PREPARATION OF EDUCATIONAL MATERIAL

This will involve the supply of data for the preparation of educational material by the ESPACE project team. It is also envisaged that data may be included from the previous phases as necessary.

8 CONCLUSIONS

The classification of the ditch system into the originally identified categories although possible would leave too many areas as uncertain and so would not be usable.

A revised system of classification has been developed based on a flood risk approach.

The maps identify the important areas in terms of drainage and reduction of flood risk as determined by the desk study.

There is insufficient survey data in parts of the Peninsula to adequately identify the ditch classifications.

Ditch storage and capacity are important and are linked. Clearing of ditches is likely to increase storage by far more than capacity is increased due to restrictions such as pipes.

The viability of using SuDS on the Peninsula as a method for reducing existing problems is limited due to the difficulty of retrofitting.

SuDS would be effective and should be included in all future development whatever the scale. The inclusion of SuDS techniques should be viewed as a valuable asset to any development.

Suitable ongoing management and maintenance of SuDS are essential to their continued effectiveness and therefore future responsibilities must be fully agreed at the time of implementation.

9 RECOMMENDATIONS

The maps should be treated as working “live” documents and should be reviewed and updated as additional data becomes available.

Consideration should be given to collating and/or obtaining further survey data across the Peninsula to aid future consideration of drainage issues.

A specific “problem area” should be identified as a pilot project to assess the effectiveness of ditch clearance.

A public awareness/education programme should be implemented to disseminate the results of this study and the findings of the pilot project.

10 REFERENCES

CIRIA (2000) Sustainable Urban Drainage Systems - design manual for England and Wales (C522).

WWF (2000) Farming and Watercourse Management Handbook.

CIRIA (2001) Sustainable Urban Drainage Systems - best practice manual (C523).

Royal Haskoning (September 2003) Land Drainage Study of the Manhood Peninsula Phase 1 Report.

Wildlife Conservation Research Unit (2003) Restoring Water Voles and other Biodiversity to the Wider Countryside. A Report on the Chichester Coastal Plain Sustainable Farming Partnership.

Wildlife Conservation Research Unit. Farming and Wildlife. A Practical Guide to monitoring and enhancing biodiversity of watercourses, ditches and wetlands. A Farmers Pack.

Department for Environment, Food and Rural Affairs (Defra) (July 2004) Making Space for Water. Developing a new Government Strategy for flood and coastal erosion risk management in England: A consultation exercise.

Royal Haskoning (March 2005) Developer Brief for Plot GC16, Cambourne - Showcasing Sustainable Water Management Systems in Cambridgeshire.

Royal Haskoning (October 2005) Manhood Peninsula Land Drainage Study Phase 2 Pagham Harbour.

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Appendix 2
Climate Change Section
Royal Haskoning Phase 1 Report (2003)

8.8 Climate

8.8.1 Temperature

The Earth climate has been changing in recent times and the average global temperature is warmer than any other century in the last 1,000 years. About 0.6°C of warming has occurred over the last century, with land warming more than the oceans.

The UK Climate Impact Programme (www.ukcip.org.uk) predicts that by 2080 there may be a 2°C to 6°C increase in temperature. However it must be noted, that there are likely to be significant regional variations.

Precipitation

UKCIP predict that for the UK there will be a 15 to 60% decrease in summer precipitation and a 0% to 30% increase in winter precipitation. However, it must be noted that these scenarios are generally considered to be surrounded by uncertainty.

Increased precipitation will have differing effects in different catchments. For example, it is likely that in chalk catchments persistent autumn precipitation will affect flooding frequency and frequent intense storms would increase flooding in urbanised catchments.

8.8.2 Sea-Levels

The 1990 Intergovernmental Panel on Climate Change (IPCC) concluded that due to increasing atmospheric temperatures sea-level is rising. The amount to which the sea-level is rising changes locally. Defra then added to this information with assumed rates of large scale land movements in England and Wales in order to calculate relative sea-level rise.

In the southern region of England predicted average annual sea-level rise is 4.5mm over the next 40-50 years. This has been combined with 1.5mm, which is the assumed rate of isostatic land movement bringing the total predicted relative sea-level rise in the south to 6mm per annum (FCDPAG 3, 1993).

The relative sea-level rise for the Manhood Peninsula of 6mm per year may have significant effects for such a low-lying area. Much of the drainage system on the Peninsula was built before sea-level rise became an issue. Therefore outfalls were originally designed to discharge on the basis of sea-level at that time and it is unlikely that significant allowances were made for a rise in sea-level. Consequently, the amount of water that can be discharged is likely to be decreasing over time in turn increasing the effects of water backing-up the drainage systems.

In addition to this, the gradient from watercourses to the sea will have decreased. The decreased gradients may have lead to problems with the flow of water within the drainage system and standing water may have increased. Eventually pumping may be necessary to facilitate discharge against the higher sea levels.

Sea-level rise could have one of two effects on Pagham Harbour. The first of these is the possibility that the currents and wave action within the harbour will increase. This could reduce siltation in the harbour and may even reverse the historic process. This may be beneficial to the drainage systems that drain into Pagham Harbour as the amount of water that outflows into the harbour may increase, leading to a more efficient drainage system.

The second effect of sea-level rise in Pagham Harbour may simply lead to increased siltation of the harbour. If the energy of the water that flows in and out of the harbour does not intensify then there will be the potential for increased sediment build-up. This will lead to increased problems with the flow of water into the harbour from the drainage systems as the outflows will become silted up. This will have diverse impacts upon the drainage systems entering the harbour. To date the latter has occurred.

The design of recent schemes such as the River Lavant Diversion will have included the effects of sea level rise

8.8.3 Wind Effects

Average autumn and winter wind speeds are predicted to increase by 1-7% by 2080. Extreme events, storminess and wave impacts may become more frequent. This has obvious implications in the design of coastal defences. Land drainage could be affected by increased overtopping and the 'set up' caused by the wind will affect discharges as for increased sea level

8.8.4 Adapting to Climate Change

A strategic precautionary approach should be implicit in the design of flood defences in the future. This will ensure that appropriate short and long term policies are implemented. Examples of a precautionary approach include: oversized culvert/bridges; defence designs with provision for future raising, and avoidance of the creation of new defended areas.

Appendix 3
Living on the Edge Leaflet
Environment Agency (2004)

Note: Leaflets were published prior to the reorganisation of Flood Defence in the Environment Agency. Therefore, although the information and content is still relevant, contact details and logos may be incorrect.

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Appendix 4
A Changing Environment.
Management of Watercourses by the Environment Agency in the Chichester Catchment, Sussex

Note: Leaflets were published prior to the reorganisation of Flood Defence in the Environment Agency. Therefore, although the information and content is still relevant, contact details and logos may be incorrect.