



HR Wallingford
Working with water

EX 6362

Sefter Farm, Pagham

Assessment of surface water drainage hydraulic and water quality requirements for the proposed development to meet planning obligations



Report EX 6362

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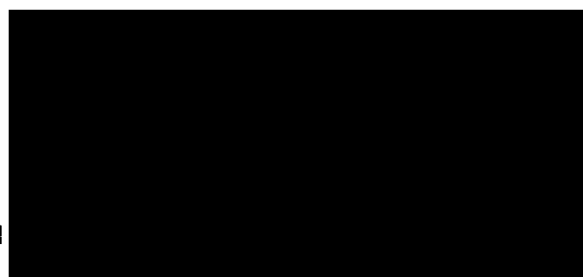
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Summary

Sefter Farm, Pagham

Assessment of surface water drainage hydraulic and water quality requirements for the proposed development to meet planning obligations

Report EX 6362
August 2010

HR Wallingford was commissioned by Douglas Briggs Partnership (the client) on behalf of Barfoots of Botley to carry out an assessment of drainage requirements for the purpose of obtaining planning permission. This has been achieved after having a meeting with Environment Agency (EA) to establish the discharge requirements associated with the attenuation of runoff from the proposed development at the Barfoot's site at Sefter Farm, Pagham, West Sussex.

The proposed development is an agricultural building to be used for processing sweetcorn and other produce. The building has a roof area of 7420m² (drawing 1) and the estimated area of hardstanding associated with the development is 9074m².

This report has detailed the storage requirements for a drainage system for the proposed agricultural building and hardstanding in order to meet Environment Agency criteria on hydraulic and water quality performance. The recommended system comprises of a permeable pavement for the hardstanding areas and a syphonic drainage system for the building roof. However compliance can be achieved in other ways if these suggestions are not considered appropriate by the client.

The permeable paving system will serve an estimated area of 9074m². This is required to attenuate runoff to the 1 and 100 year greenfield runoff rates of 4.17l/s and 15.7l/s respectively. A proposed area of 4000m² of permeable paving would achieve this requiring an orifice of 70mm is for the 1 year rate. This is linked to an orifice of 101mm for the 100 year rate by a weir at 113mm above the invert of the permeable sub-base. This assumes a sub-base porosity of 0.3 and results in a maximum storage depth at the 100 year (+20% climate change) of 415mm. The permeable paving scheme may require an oil interceptor depending on EA requirements and, if needed, this is thought to be feasible in terms of the hydraulic head available. A swale is recommended downstream of the oil interceptor to provide an additional level of treatment. Hydraulic and vermin non-return valves are recommended at the outlet from the oil interceptor into the swale.

A siphon is proposed for draining the 7420m² roof area into the farm's western reservoir (reservoir A in Figure 1.1). This will involve design of guttering and a siphon of sufficient capacity to transmit the 100 year (+20% climate change) storm event for 6-12 hour duration (see section 3.2).

An operational system is also required in reservoir A to mitigate the risk of overfilling of the reservoir, or alternatively an overflow could be provided.

In addition to these recommendations some considerations on the construction, operation and maintenance of the permeable paving system are provided.

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1. Introduction

HR Wallingford was commissioned by Douglas Briggs Partnership (the client) on behalf of Barfoots of Botley to carry out an assessment of drainage requirements for the purpose of obtaining planning permission. This has been achieved after having a meeting with Environment Agency (EA) to establish the discharge requirements associated with the attenuation of runoff from the proposed development at the Barfoot's site at Seftor Farm, Pagham, West Sussex.

The proposed development is an agricultural building to be used for processing sweetcorn and other produce. The building has a roof area of 7420m² (drawing 1) and the estimated area of hardstanding associated with the development is 9074m².

The proposed surface water drainage scheme involves two main components to drain the building roof and hardstanding areas separately. The roof runoff is proposed to drain via a siphon to the farm's western reservoir (reservoir A in Figure 1.1). A permeable paving system is proposed for the hardstanding area and may include an oil interceptor and swale downstream. The development of both systems has been informed by the principles of Sustainable Urban Drainage Systems (SUDS) and offer runoff attenuation, treatment and in the case of the roof system, rainwater harvesting.

Figure 1.1 gives an overview of the site. The bold red line area was provided by Douglas Briggs to show the area to be served by the proposed drainage system. HR Wallingford have slightly increased this area along its northern margin (thin red line) to account for some existing hardstanding areas which due to the natural fall of the land and likely re-working of the ground may feed into the proposed drainage system. In addition two areas of grassed surface around the building are identified which are assumed will retain their greenfield characteristics. The gravel car park (which already exists) is assumed to infiltrate and share no hydraulic link with the proposed development and its drainage system.

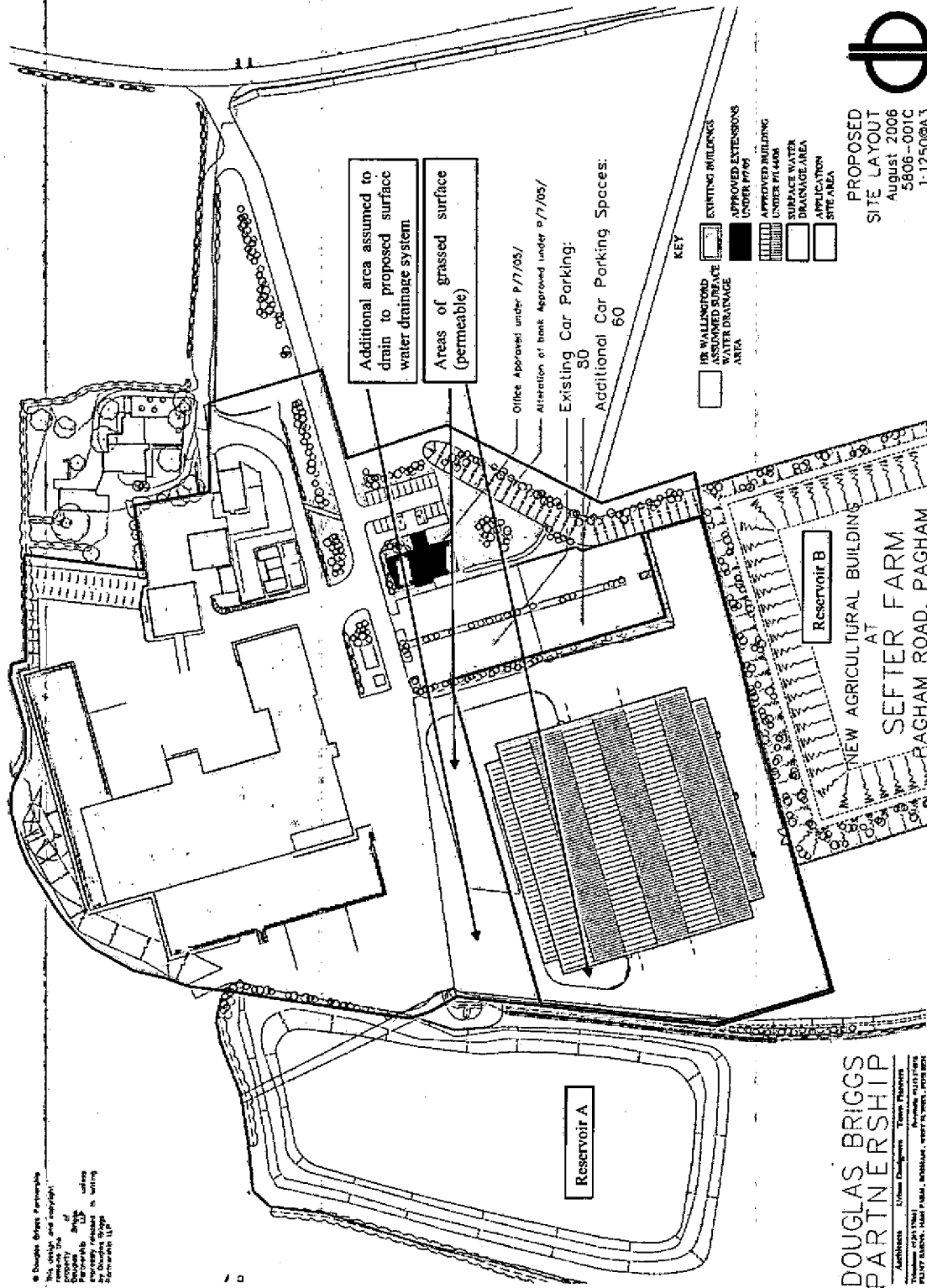


Figure 1.1 Overview of proposed development (drawing 5 annotated by HR Wallingford)

2. Data sources and consultations

This section records the data supplied by the client which has formed the basis of outline scheme development, the site visit and consultations with the Environment Agency.

2.1 DRAWING AND REPORTS RECEIVED

Table 2.1 gives the documents and drawings received by HR Wallingford from Chris Cooper of Barfoots or Paul Hughes of Douglas Briggs.

Table 2.1 The documents and drawings received by HR Wallingford

Drawing or document reference	Drawing or document file name	Date of receipt	Sender	Notes
1	5806-001C Site Layout A3.pdf	23/07/2010	Paul Hughes of Douglas Briggs	
2	5806-002B Floor Plan A3.pdf			
3	5806-003A Elevations A3.pdf			
4	5806-004B Landscape Plan A3.pdf			
5	5806-Proposed Shed PLANNING conditions 15.09.08 BOUND.dwg			
6	13207-117C Landscape A3.pdf			
7	13207-201E Site Layout Plan A1.pdf			
8	6804-213 rev A - APRON AREA PLAN.dwg	04/08/2010	Chris Cooper of Barfoots	
9	6804-211 REV C SITE DRAINAGE PLAN.dwg			
10	Sefter Farm SITE INVESTIGATION 1.0.pdf	10/08/2010		Soil survey report
11	Sefter farm - Second GI Report.pdf			Soil survey update

2.2 SITE VISIT

A site visit on 3rd August 2010 was carried out by HR Wallingford staff and involved the following;

Meeting with Chris Cooper to discuss:

- **Operation of the reservoirs on the site**
Chris Cooper believed that water for irrigation was derived from abstraction from the adjacent Rife into the reservoir to the west of the proposed development (reservoir A). This is then periodically pumped into the main irrigation reservoir to

the south of the proposed development (reservoir B). There is some uncertainty as to the operating rules regarding these reservoirs.

- **Drainage systems for the recent Anaerobic Digestion plant**

A gravel surface around the digesters allows infiltration of rainfall on roads and areas beside the structures. AD roof drainage is harvested into reservoir B while hardstanding areas drain into storm or foul depending on whether the apron area is empty or full. This drainage system will be independent of the proposed drainage system.

- **Existing drainage problems**

Chris Cooper mentioned that the site of the proposed development suffers seasonal waterlogging, particularly in the south western corner which is the lowest point within the red line area. Field drains have been installed and linked into the farm ditch which runs between reservoir B and the proposed development in a southerly direction.

A Site walkover was carried out including inspection of:

- Existing drainage systems and reservoirs
- Site topography
- Existing drainage issues.

2.3 MEETING WITH ENVIRONMENT AGENCY

Subsequently a meeting was held with the EA on 3rd August 2010 to discuss their views on the proposed development. Keeley Mowatt represented the EA at their Worthing office.

The main outcomes were as follows:

- The EA are in principle not in favour of schemes involving pumped drainage, this favours a syphonic system for draining roof runoff to reservoir A.
- Runoff rate from the development should be attenuated to match or better the 1 year return period greenfield runoff rate plus 20% climate change and 100 year return period greenfield runoff rate plus 20% climate change
- Runoff volume from the development does not necessarily have to match greenfield volumes at this location
- Greenfield runoff rates should be calculated using Institute of Hydrology report 124 (IH 124).
- The frequency of traffic movements and type of operations being carried out on the hardstanding will influence whether there is to be a requirement for an oil interceptor.

3. Outline of drainage requirements

This section presents the calculations and assumptions in developing an outline of the drainage requirements, in particular the storage requirements to meet planning consent obligations.

3.1 YARD DRAINAGE SYSTEM

The yard drainage system has been designed in line with the EA requirements stated in section 2.3 and constraints based on the site layout and levels. A permeable paving system is proposed in order to accommodate the storage requirements for attenuation of runoff rates to greenfield levels and provide partial treatment of the runoff. An oil interceptor may be required depending on traffic frequency and type of operation and a swale is suggested in order to provide an additional level of treatment before discharge to the Rife.

3.1.1 Area calculations

Table 3.1 gives the key surface types within the proposed drainage system area. The building roof is to be drained via siphon into reservoir A. The grassed area will not require a positive drainage system.

Table 3.1 Key surface areas within proposed development.

Location	Area (m ²)
Total area within red line	18484
Proposed building roof area	7420
Grassed area	1990
Total area to be served by proposed yard drainage system	9074

3.1.2 Greenfield runoff rates

Runoff from developments with positive drainage systems typically responds more rapidly than undeveloped. In order to prevent the increase in flood risk to downstream receptors the EA requires that runoff from developments to be attenuated to the existing Greenfield runoff rates.

IH 124 has been used to carry out Greenfield runoff calculations.

Qbar was calculated using the following parameters

SAAR = 720mm/year

Soil type = 3

Area = 9074m²

This gave a Qbar of 4.9l/s

Flood Studies Supplementary Report 14 (FSSR 14) growth factors were then applied to give the 1 year and 100 year greenfield rates.

1 year growth rate = 0.85, runoff rate = 4.17 l/s
100 year growth rate = 3.2, runoff rate = 15.7 l/s

3.1.3 Attenuation storage requirements

Theoretical storage

The theoretical attenuation volume was modelled using Infoworks Collection Systems (IWCS). This was carried out using a limiting discharge rate set at the greenfield runoff rate and measuring the excess spill volume for a range of different duration storms at the 1 year (+20% climate change) return period. The area serving the model was set as 9074m² and 85% runoff was assumed.

In this case the critical duration storm was a 10 hour winter profile storm which required 115.6m³ storage to prevent spill in excess of the 1 year greenfield rate.

This storage was then incorporated into a second model which was then used to evaluate storage for the 100 year (+20% climate change) event by adding a second orifice with a limiting discharge of the 100 yr (+CC) minus the 1 yr (+CC) rate (so that in total no more than the 100 year (+CC) rate is being discharged). Again a range of duration storms were run resulting in a critical duration of 8 hours for the winter profile. This resulted in a storage requirement of 352.2m³ and therefore a total theoretical storage of 467.8m³.

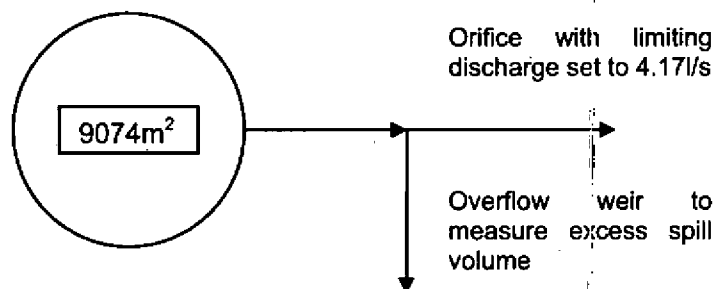


Figure 3.1 Schematic of the 1 year storage IWCS model

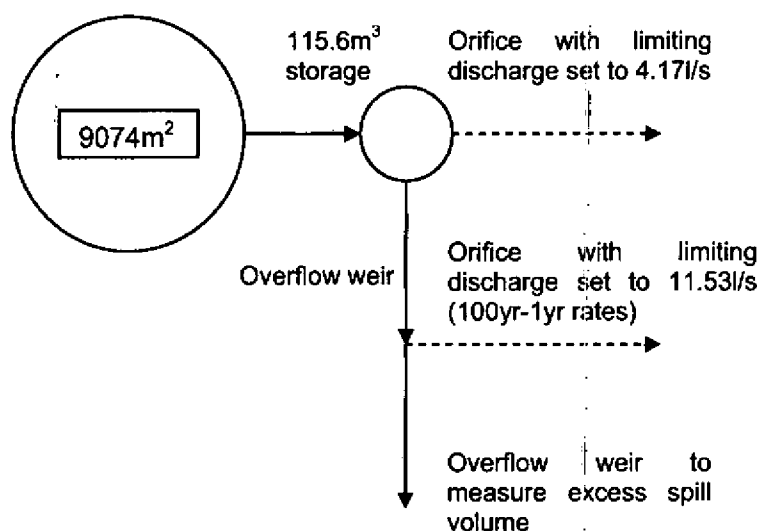


Figure 3.2 Schematic of the 100 year storage IWCS model

True storage

The theoretical storage volume assumes perfect performance of the limiting discharge to the greenfield rate for any head loss across the orifice. In reality the head discharge relationship will not be fixed and this results in the requirement for some additional storage to ensure correct performance of the system.

In order to account for this and to ensure that the levels on the site could accommodate storage in permeable pavement a model in IWCS was built to represent more accurately the permeable paving system.

Of the 9074m² area to be served, 4000m² was assumed to be permeable paving, the rest was assumed to be standard paved surface. This was done to minimise cost of the scheme and allow areas which may be considered operationally to be unsuited to permeable paving, such as turning areas, to be given a standard surface.

Figure 3.3 gives a schematic of the permeable paving system and outflow controls. This model was run with a range of duration 1 year (+20% climate change) storms and control (c) adjusted for diameter and (d) adjusted for level iteratively until spills over the weir occurred at just below the 4.17l/s 1 year greenfield rate. Once this had been completed a range of duration 100 year (+20% climate change) storms were run through the model and (e) was adjusted for diameter to ensure that peak runoff did not exceed the 15.7l/s 100 year greenfield rate.

This system resulted in the following configuration:

- Permeable paving storage requirement = 510m³ (note this is larger than the theoretical storage of 467m³)
- Permeable paving storage depth requirement assuming 0.3 porosity in sub-base = 415mm
- Orifice (c) diameter = 70mm
- Weir (d) height (above invert of permeable paving storage base) = 113mm
- Orifice (e) diameter = 101mm

This configuration would result in regular (annual) water levels in the sub-base up to 113mm and extreme water levels of 415mm (100 year return period). Indicative design drawings supplied by Formpave indicate at least 450mm of sub-base is required for HGV trafficked permeable paving which meets the hydraulic storage requirements. If a shallower storage depth turns out to be more desirable then a reconfiguration of the system using a larger permeable pavement area would reduce the depth of storage in the system.

Note that the seasonal water logging of the site is likely to preclude any opportunity for infiltration of runoff through the base of a permeable pavement. Further, an unlined sub-base is likely to become regularly saturated during the winter which may compromise structural integrity and possibly partially fill the required storage volume. For this reason a lined sub-base is recommended.

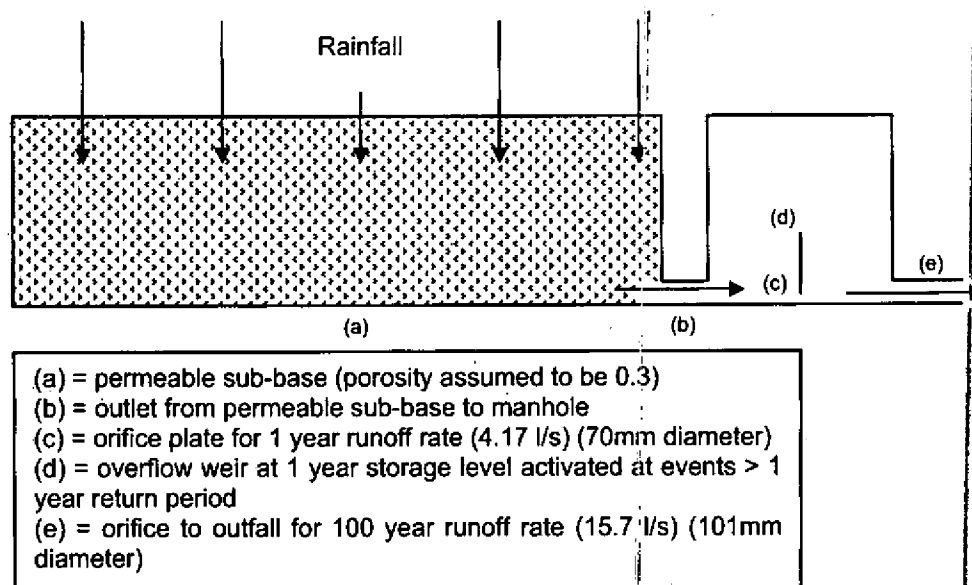


Figure 3.3 Schematic of IWCS storage model

Drawing 5 indicates that the proposed ground levels for the hardstanding range between 3 and 4.75m AOD. Given that indicative design drawings supplied by Formpave give a required total depth from surface to invert of the pavement of around 700mm. If the minimum surface is set at 3.3m AOD¹ then the invert of the sub base will be 2.6m AOD. Allowing up to 300mm head loss for an oil interceptor and a further 200mm head loss for a swale downstream of the interceptor, this would give an outfall invert level of 2.1m AOD. Given that the existing bank top at the farm ditch on the western side of the red line area is 1.8 – 2m AOD this would allow discharge at bank top level. There is therefore sufficient head to allow the use of an oil interceptor and the construction of a shallow swale downstream of the oil interceptor. This provides the opportunity for additional treatment which may be stipulated by the EA.

There is a requirement to ensure the system performance is not compromised by the effects of flooding downstream of the system outfall. During winter and/or storm events the receiving watercourse may potentially rise to bankfull levels or above. To ensure such occurrences do not result in the backing up of water into the system, a non-return valve is recommended at the outfall from the oil interceptor.

If the permeable paving is constructed properly there is little risk of orifice blockage as runoff must percolate through a permeable media and will not be able to pick up debris. There may be a risk of blockage at the orifice manhole if debris is allowed to enter and this should be avoided by keeping the manhole closed and ensuring no debris enters during inspection visits. In addition to the hydraulic non-return valve described above, a vermin non-return valve is recommended to prevent rats etc. from entering the orifice manhole and bringing in debris which may block the orifice.

¹ This would require raising proposed ground levels by a small amount in the south west corner of the red line area

3.2 ROOF RUNOFF SYSTEM

A rainwater harvesting system is proposed for the roof drainage by draining the runoff to reservoir A. This will offer the following advantages over a drainage system:

- It will attenuate runoff rates and volumes from the roof without the requirement for additional storage infrastructure on site.
- It will provide valuable additional water for irrigation on the farm (Assuming annual runoff of up to 100% of 720mm annual total, the roof area of 7420m² will deliver up to an additional 5340m³ of water for irrigation).

Detailed hydraulic and structural design of the system has not been undertaken within the scope of this study but would include:

- Design of a gutter system to accommodate the required design flows (100 year +20% climate change). The design should insure that the gutters can accommodate the critical duration storms for the permeable paving system (ie. 6-12 hour duration). Very short intense storms need not be fully accommodated by the gutter as any excess spill would not be an issue for the permeable paving system because the total volume of such events is small in comparison.
- Design of siphon between the header tank and reservoir A.
- The relative gutter levels (minimum 10.1m AOD) and reservoir A water levels (maximum 4.6m AOD)² should give sufficient head difference for a siphon to be a feasible solution.

At any one time sufficient freeboard must be maintained in reservoir A in order to ensure the 100 year + 20% climate change storm event can be accommodated. Given the assumption that reservoir A at present has no natural outfalls the roof runoff would result in an incremental increase in levels over time. For example if through the winter 400mm of rainfall occurred, with little evaporation, this would result in a reservoir level rise of 400mm. In addition the roof drainage would increase levels by 327mm in reservoir A. The total rise in level being 727mm over winter. If left unchecked this could result in overspill from the reservoir which is to be avoided given the risk of breach with respect to the presence of static caravans to the south of reservoir A. However, given the reservoir freeboard is normally of the order of 600mm, a regular reservoir monitoring schedule would mean that reservoir overtopping is highly unlikely.

Further it should be noted that the inflow rate from the roof drainage system will be lower than the accumulation of rainfall falling on the reservoir directly hence any overflow spill rate would be small.

Therefore the requirement for the receiving reservoir is a regular level monitoring program and one which responds flexibly to large individual rainfall events to ensure freeboard is maintained on the reservoir.

It would be preferable if there was an emergency overflow for the reservoir. There may be one already in existence, but this was not apparent when the site visit was carried out. A bund is desirable as a passive safety system obviates the need for any monitoring programme or the need for any pumping to take place. Given the rate of runoff and the attenuation of the reservoir plan area, this structure could be limited to a very short weir or 150mm diameter pipe, as long as there was little risk of blockage.

² Paul Hughes of Douglas Briggs via email 5/8/2010

4. Recommendations

This report has detailed the storage requirements for a drainage system for the proposed agricultural building and hardstanding in order to meet Environment Agency criteria on hydraulic and water quality performance. The recommended system comprises of a permeable pavement for the hardstanding areas and a syphonic drainage system for the building roof. However compliance can be achieved in other ways if these suggestions are not considered appropriate by the client.

The permeable paving system will serve an estimated area of 9074m². This is required to attenuate runoff to the 1 and 100 year greenfield runoff rates of 4.17l/s and 15.7l/s respectively. A proposed area of 4000m² of permeable paving would achieve this, requiring an orifice of 70mm is for the 1 year rate and an orifice of 101mm for the 100 year rate, assuming an arrangement as described in the report. This assumes a sub-base porosity of 0.3 and results in a maximum storage depth at the 100 year (+20% climate change) of 415mm.

Siphonic roof drainage is proposed for draining the 7420m² roof area into reservoir A. This will involve design of guttering and a siphon of sufficient capacity to transmit the 100 year (+20% climate change) storm event for 6-12 hour duration (see section 3.2). An operational management system is also required for reservoir A to minimise the risk of overfilling of the reservoir. Alternatively (and preferably) an overflow should be provided for the reservoir to avoid the need for having to rely on reservoir operating procedures.

In addition to these recommendations some considerations on the construction, operation and maintenance of the permeable paving system are given below.

4.1 CONSTRUCTION OF PERMEABLE PAVING

A construction schedule should be developed to ensure that the permeable pavement is not contaminated with sediment during construction.

The permeable paving liner should be fully watertight. This will prevent leaching of any polluted water out of the base should a contaminant spill occur and, equally importantly, prevent ingress of water to the system during periods of water logging during the winter months. This is important to maintain the structural integrity of the system and the required storage volume.

4.2 SITE OPERATION AROUND PERMEABLE PAVING

Some care is required in ensuring that the regular passage of traffic onto the permeable paving does not bring excessive dust and sediment onto the permeable paving, leading to long term clogging of the structure. This can be achieved by ensuring traffic passes across paved surfaces. Having said this, permeable paving is fairly resilient to normal levels of sediment deposition and can readily be rehabilitated, particularly if there is an upper geo-textile layer.

4.3 MAINTENANCE OF THE PERMEABLE PAVING

A best practice approach should be taken with the permeable paving maintenance which should be developed with the supplier. It may require annual weed killing. Discussions with both the supplier of paved systems and the EA are advised.

Maintenance of the permeable paving through jetting or vacuuming may not be appropriate given the heavy loading characteristics of HGV traffic.

5. References

Department of Communities and Local Government (DCLG) (Revised March 2010)
Planning Policy Statement 25 (PPS25): Development and flood risk

Department of Communities and Local Government (DCLG) (2009) *Planning Policy
Statement 25: Development and Flood Risk - Practice Guide*

Marshall, D. C. W. & Bayliss, A. C. (1994) Institute of Hydrology Report 124 – Flood
estimation for small catchments, Institute of Hydrology (ISBN 0 948540 61 1)

Appendix A Health, safety and welfare issues

A.1 CONSTRUCTION - CONSTRUCTION (DESIGN AND MANAGEMENT REGULATIONS)

A.1.1 Introduction

The Construction (Design and Management) Regulations 2007 (CDM 2007) require consideration to be given in the design of a project to health and safety during construction, maintenance, cleaning and demolition of any works. It is also important to highlight and record the impacts of the works on health, safety and welfare which should feed into both the Health and Safety Plan and Health and Safety File.

HR Wallingford has a role as a designer on this project under the CDM Regulations. In this role consideration must be given to health and safety issues when developing the design work and making design decisions. The Client must appoint a CDM Co-ordinator, or accept those responsibilities. It is also essential that a competent designer and principal contractor are selected to undertake this work.

We assume that the appointed CDM Coordinator will notify the Health & Safety Executive in accordance with regulation 21 of the CDM 2007 Regulations.

A.1.2 Elimination of hazards

Designers have a duty to avoid foreseeable risks 'so far as reasonably practicable' taking due consideration of other relevant design considerations. In this project we have considered risks to health, safety and welfare.

We have assumed that a competent principal contractor will be employed who is experienced in the work proposed on this project and will use established working practices for such engineering projects.

This design risk assessment only applies to the design work elements undertaken by HR Wallingford and has assumed that appropriate risk assessments have been undertaken for the other parts of the works planned.

The design process has not identified any particular hazards that can be reasonably reduced below that normally considered acceptable. Management of these residual risks is addressed below.

Operational activities on site

The Barfoots of Botley site at Sefter Farm involves movement of people on foot, tractor, HGV, forklift and potentially other plant around the site. Risks include collisions for plant and personnel. The detailed design and construction planning should carefully consider the how these risks can be reduced and managed.

Construction around reservoirs

Some elements of the drainage design will involve working around the farm's reservoirs. Risks may include but not be limited to slips and trips on reservoir banks, drowning and the undermining of structural integrity of the reservoir during construction. The detailed design should carefully consider the how these risks can be reduced and managed.

Construction of drainage system

Although permeable paving is a relatively straightforward system to install, it will include at least one manhole. This could introduce the potential for slips and trips and falls during and after construction. The detailed design should carefully consider the how risks can be reduced and managed.

A.1.3 Health and Safety Plan

We have reviewed the elements of design that has been suggested in this report and in our professional opinion we do not believe that there are any significant risks that should be drawn to the attention of a competent designer or principal contractor. However, it is essential that a competent designer and principal contractor are selected to undertake this work.

We recommend that HR Wallingford (1998), HR Wallingford (2000) and HR Wallingford (2004) be considered when assessing construction and public safety risk (see references).

A.1.4 Health and Safety file

We recommend that this report is retained on the Health and Safety File as it sets out the basic criteria and design information used scheme.

A.2 REFERENCES

HR Wallingford (1998), Construction risk in coastal engineering, Thomas Telford, 2000

HR Wallingford (2000), Construction risk in river and estuary engineering – A guidance manual, Thomas Telford, 2000

HR Wallingford (2004), Construction health and safety in coastal and maritime Engineering, Thomas Telford, 2004.