SOFT FRUIT POLYTUNNEL DEVELOPMENT, JACK'S DYKE FIELD, GROVES FARM, UPPER BOGNOR ROAD, COLWORTH, CHICHESTER, WEST SUSSEX, PO20 2DX

FLOOD RISK ASSESSMENT

ARUN DISTRICT COUNCIL
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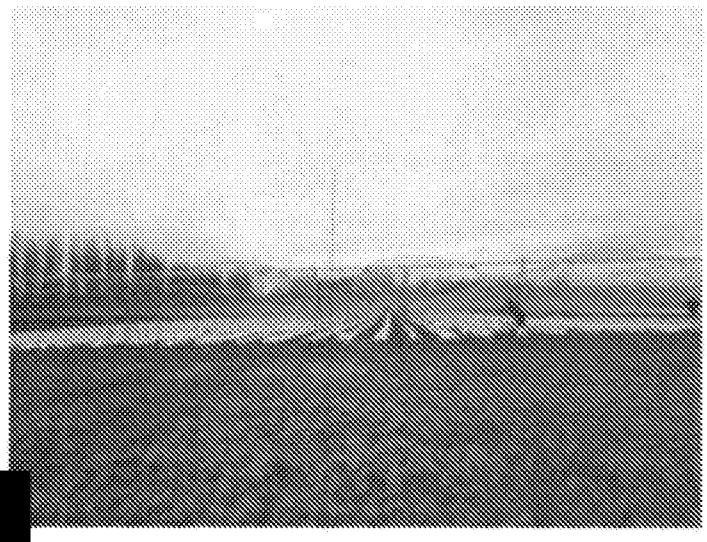
As part of the submission of a planning application

for



Merston Farm Ltd.
Groves Farm
Upper Bognor Road
Colworth
Chichester
West Sussex
PO20 2DX

by



Envireau Water
Cedars Farm Barn
Market Street
Draycott
Derbyshire
DE72 3NB

[redacted]

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JACK'S DYKE FIELD FLOOD RISK ASSESSMENT
NON TECHNICAL SUMMARY

A planning application for 12 hectares of polytunnel (Spanish Tunnel) development at Jack's Dyke field, Groves Farm, Upper Bognor Road, Colworth (Chichester District Council), will be submitted on behalf of Merston Farm Ltd., by planning consultants Douglas Briggs Partnership. This Flood Risk Assessment (FRA) has been written and submitted in accordance with FRA1 Guidance Note "Development greater than 1 hectare in Flood Zone 1".

The FRA follows guidelines laid out in Planning Policy Statement 25 (PPS25) and sets out calculations that were undertaken to assess "greenfield" runoff rates and volumes of runoff generated during storm events. The approach undertaken is that detailed in Defra/Environment Agency document "Preliminary rainfall runoff management for developments. R&D Technical Report W5-074/A/TR/1 Revision C, re-published June 2007".

A key technical issue when using this approach is that Jack's Dyke field is an agricultural drainage issue and not an urban drainage issue.

At all stages of the analysis, assumptions and selection of parameter values has been based on conservative decisions. The analysis assumes that polytunnels are covered all year, when in practice the covers are often removed in the winter. This adds to the conservative nature of the analysis.

The analysis uses a 1 in 100 year storm as a basis, and takes into account a 20% climate change surcharge in accordance with PPS25.

Long Term Storage calculations resulted in an additional storage requirement for the polytunnel area subject to the planning permission of 220m^3/ha. This FRA shows that this storage requirement can be accommodated within new drainage ditches situated outside the polytunnel area and within the leg row channels within the polytunnel area. Linings and flow restrictors placed in polytunnel leg row channels will act to reduce the rate at which runoff leaves the polytunnel area and will also provide additional storage within the channels themselves. Therefore, the leg row channels in effect become swales throughout the polytunnel areas. Runoff leaving the polytunnel area will flow into new drainage ditches that will discharge flows to the existing drainage ditches via throttle pipes. These throttle pipes will restrict the runoff flow rate from the application site to equal to or less than the "Greenfield" runoff rate.

This assessment has demonstrated that the polytunnel development at Jack's Dyke field will not have a detrimental impact on drainage and flooding on or off site providing storage is provided for within the specified storage areas.

Cedars Farm Barn, Market Street
Draycott, Derbyshire, DE72 3NB
t 01332 871870
f 01332 874866
e info@envireauwater.co.uk
w www.envireauwater.co.uk

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Based on Ordnance Survey mapping at a scale of 1:10 000 and OS DTM data at 10m grid spacing, the topography of the application site is contained by one small drainage catchment (Figures 1 and 2) that has gradients of 0.2% or less. The catchment drains to drainage ditches to the north and east of the application area. These drainage ditches converge with the Elbridge Rife approximately 250m to the northwest of the application area. Based on the connectivity of the drainage ditches to the rife; the relatively small distances involved; and the relatively flat lying ground, once water reaches one of the drainage ditches it will quickly flow to the rife. As a result of this the whole farm area has been considered as a single catchment (Figures 1 and 2).

The geology of the site has been identified from British Geological Survey Map 317/332 (Chichester/Bognor) and consists of thick deposits of aeolian silts, and gravels underlain by older Upper Cretaceous Chalk.

The Soil Survey of England and Wales classify the soils north of the site as Sub-group 571z: Deep stoneless well drained silty soils and similar soils affected by groundwater; over gravel locally. The majority of the soils at the site are classified as Sub-group 841e: Deep stoneless silty soils variably affected by groundwater.

The surface topography is isolated from the deep Chalk aquifer by the intervening aeolian silts, although the shallow superficial deposits will support their own perched groundwater system. This system will have a very shallow "water table" largely controlled by drainage to the rifes. Groundwater levels could be less than 1m deep.

Planning permission has already been granted for two existing polytunnel areas north of the proposed polytunnel area (planning applications 0/08/02777/FUL and 0/09/00433/FUL) (Figure 2).

3 QUALITATIVE ASSESSMENT OF PROPOSED POLYTUNNEL DEVELOPMENT

3.1 Hydrological Characterisation

Based upon Ordnance Survey topographic mapping and DTM data, the farm area has been considered as one single catchment area, which is shown on Figures 1 and 2.

The planning application is for 12ha of polytunnels. Figure 2 shows the area of polytunnel development, together with the direction of overland runoff and drainage directions associated with the polytunnels. The polytunnel area illustrated in Figure 2 forms the basis of the quantitative assessment of runoff from the site.

It is important to recognise that the hydrological characteristics of the polytunnel growing system is characterised by rural hydrology and not urban hydrology. While the polytunnels themselves form a high runoff cover, the drainage from the site is controlled by the processes at ground level, which is generally grassed, or vegetated soil, with or without artificial channels. This results in an overall low runoff velocity system. This is different from an urban setting, where development generally leads to high runoff surfaces, with drainage controlled by pipes, resulting in high runoff velocities.

When soft fruits are grown in the ground, the drainage from the polytunnels is achieved by a series of vegetated/grass lined, straw lined or Mypex lined channels that run along the line of the polytunnel leg stands. The line of the leg stands, are commonly referred to as "leg rows". The leg row channels will have flow restrictors in

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the form of dams placed at regular intervals along them. The overall result in the leg row channels is to increase the resistance to flow and therefore, reduce flow velocities. With flow restrictors in place, the leg row channels also provide storage. The net result is to reduce the flow velocities and runoff rate of the overall polytunnel area, when compared to simple open channels. The "in the ground" growing concept is summarised schematically on Figure 3. In essence the polytunnel growing system produces a series of drainage routes spaced 7.8m apart, which act as retention zones, seepage zones, and velocity reduction zones. Therefore, with flow restrictors in place the leg row channels become swales. However, the principal difference between rural development and an urban development is that the ratio of impermeable area to swale is generally greater and more favourable than that provided in urban developments.

This conceptualisation is important, as the drainage system following the establishment of the polytunnels is an agricultural drainage system and not an urban drainage system. It is therefore important that the analysis approach and technique reflects this. The polytunnel development represents one land use type. If polytunnels were not present then the land would still be farmed and this would need to be productive. Therefore the alternative land would be for the growing of lettuce, small grain crops or potatoes.

3.2 Proposed Polytunnel Layout

Figure 2 shows the proposed location and layout of the polytunnels at Jack's Dyke field based on site plans provided by Douglas Briggs Partnership.

The farm catchment area within which the polytunnels are located extends to approximately 80ha of which the planning application polytunnels represent 12ha. These polytunnels are located at the southern end of the Groves Farm land boundary and rainfall runoff catchment.

The polytunnels will only be covered/sheeted for some of the year between February and November and will not be covered in winter and when strong winds are forecast. Therefore, the polytunnels will not be sheeted for the winter months when fields are generally at field capacity and precipitation surpasses potential evapotranspiration and infiltration to ground. In these conditions, the fields will operate hydrologically as if there were no "development".

3.3 Proposed Polytunnel Orientation and Drainage

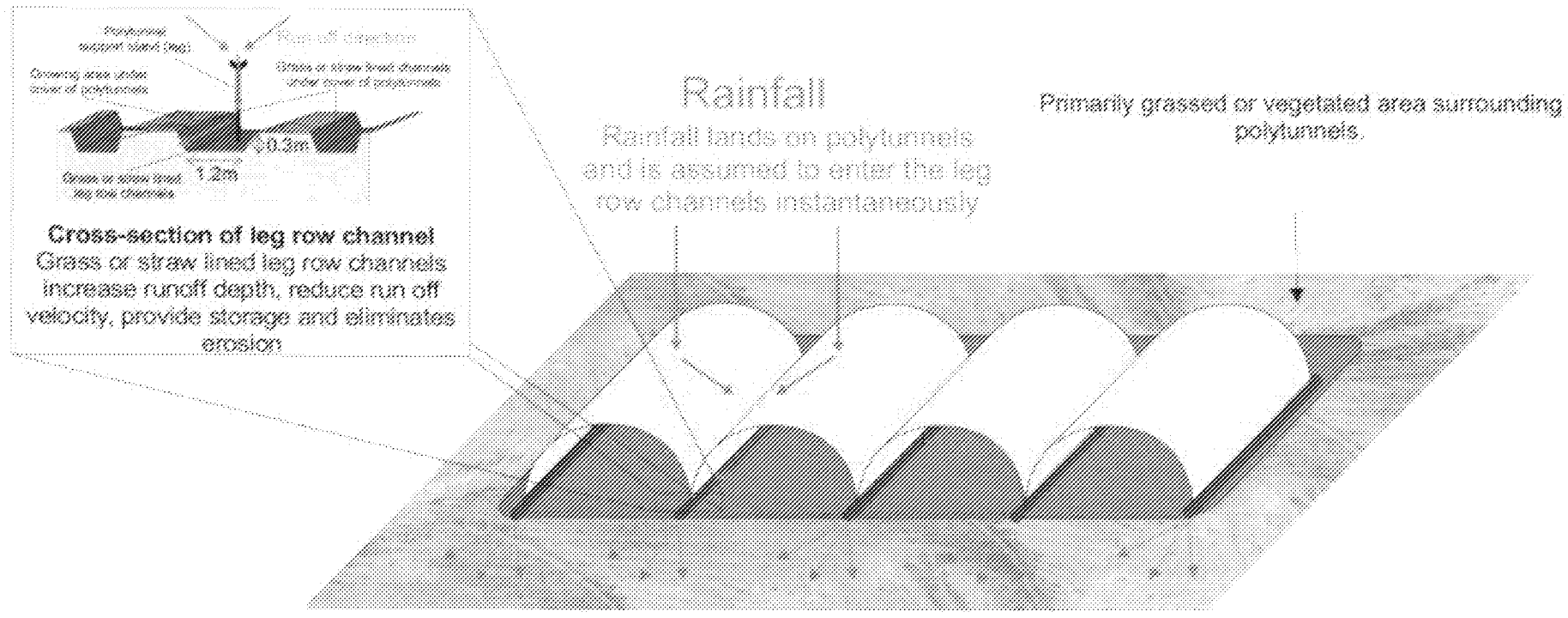
The polytunnel orientations at Jack's Dyke field are illustrated in Figures 2 and 4. Drainage from the covered polytunnels is in two stages. Initially, rainfall hits the polytunnels and 100% is assumed to instantaneously run off to the ground surface before accumulating in each of the leg rows swales.

During rainfall events the leg row swale storage comprising storage within the grass and/or straw and/or flow restrictors, will be filled, and then flow will be initiated parallel to the tunnel orientation.

Runoff within the polytunnel area will flow northeast to the end of the leg row swales via flow restrictors and will be dispersed by a 2m grassed buffer strip. From the grassed buffer strip the runoff is conveyed as overland flow through a buffer strip of wildflower meadow/pasture and into new drainage ditches that will provide additional storage. The flow will leave the new drainage ditches via a throttle pipe at equal to or less than the Greenfield runoff rate and will flow over an energy dissipater. The flow will enter into the existing drainage ditches before entering into the Elbridge Rife some 250m to the northeast of the application area.

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Runoff accumulating in leg row channels is attenuated by flow restrictors and dispersed by wide grassed buffer strips at the open end of the polytunnel and then flows as overland and channel flow into two storage areas. The flow will leave both storage areas via a throttle pipe at 2l/s/ha, and will flow over an energy dissipater. The flow will enter the existing drainage ditches that drain to the Elbridge Rife.

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Date: 10/08/2010

Figure 3

Jack's Dyke, Groves Farm - FRA

Schematic Diagram of Polytunnel Runoff and Drainage for Soft Fruit Crops

3.4 Sediment Mobilisation

Gradients at the site are very low which results in low overland flow velocities. The use of grass and/or straw and/or Mypex and flow restrictors in the polytunnel leg row swales, together with wide grassed buffer strips and existing hedge lines around the polytunnels, in Jack's Dyke field, will have a significant positive effect on further reducing the potential for soil erosion and sediment mobilisation.

Overland flow velocities >1cm/s have the potential to start mobilising soil particles and therefore initiate erosion, and velocities >10cm/s will almost certainly transport soil particles and initiate erosion, if the water is flowing over bare soil (Reading, 1986). By utilising the grass and/or straw and/or Mypex and flow restrictors, leg row channel velocities are reduced. By dispersing the flow over the heavily vegetated areas overland flow velocities are reduced. As a result, soil stability is greatly increased. Soil stability is increased further by the binding effects of the roots.

4 SEQUENTIAL TEST AND EXCEPTION TEST

The Sequential Test from PPS25 guides new development to areas at the lowest probability of flooding (Zone 1), the zones being listed in Table D.1.

When trying to identify potential areas for the polytunnel development, the proposed site was identified to be available and within Flood Zone 1 therefore meeting the criteria of the Sequential Test.

Table D.3 of PPS25 indicates that the Exception Test is not relevant to this development.

The polytunnels located at the application area will remain operational and safe during times of flood, will result in no net loss of storage from the floodplain, will not impede flood water flows and will not increase the flood risk elsewhere.

5 QUANTITATIVE DATA ANALYSIS

5.1 Approach

The approach detailed in Defra/Environment Agency document "Preliminary rainfall runoff management for developments. R&D Technical Report W5-074/A/TR/1 Revision C, re-published June 2007", has been undertaken for this investigation comprising the following elements:

- Determination of the greenfield runoff (GFR) for the 1, 30 and 100 year period events
- Calculation of the long term storage volumes for the 1 in 100 year (+20%) event

Although the approach has been developed for urban developments it must be emphasised that the polytunnel drainage at Jack's Dyke field is an agricultural drainage issue and not an urban drainage issue.

The analysis method used in this study is the same as that used elsewhere by EW as a standard approach to assess polytunnel drainage, which has been reviewed and accepted by the Environment Agency.

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The results from the analyses have then been used to develop and justify a simple rule for the sizing of storage per block of polytunnels. The methodology also incorporates a percentage increase to the 1 in 100 year storm event to accommodate climate change.

5.2 Greenfield Runoff

The GFR has been determined and is summarised in Table 1. This provides a peak Greenfield runoff rate of 3.20l/s/ha.

Table 1 GFR for IoH124 methodology.

Greenfield Runoff (GFR)		peak rate (l/s/ha)
Initial design (IoH124)	Q1yr	0.85
	Q30yr	2.38
	Q100yr	3.20

5.3 Long Term Storage Volumes

The long term storage volumes have been calculated as runoff per ha of polytunnels. This is simply to allow easy conversion to volumes, for each polytunnel block. The polytunnels represent an impermeable cover, except for the leg rows, which represent 13% of the polytunnel area, giving a PIMP value of 87 (%).

The analysis essentially calculates the storage that is required to account for additional runoff caused by the polytunnels in comparison to the volume generated in a "greenfield" scenario. This volume must be allowed to infiltrate or be kept in storage with the ability to be discharged at a rate of less than 2 l/s/ha. Inherent to the calculation is the rainfall depth and the winter rainfall acceptance potential (W.R.A.P.) soil classification taken from the Defra/Environment Agency document.

The resultant long term storage volumes are given in Table 2 below. A spreadsheet output for the volumes is provided in Appendix A.

Table 2 Long Term Storage volumes

Long term storage volume	
(Long Term Volume 100yr 6hr + 20%)	2641 m^3
(Long Term Volume 100yr 6hr +20%)	220 m^3/ha

The results demonstrate that runoff can occur from the polytunnels in excess of the GFR and that in line with EA policy that this runoff should be catered for.

5.4 Existing Water Storage

There are existing water storage areas in the form of reservoirs, located at Groves Farm. These are illustrated on Figures 1 and 2. Although these storage areas have the potential to accommodate some of the runoff from the polytunnel area, they have not been specifically designed for runoff storage and attenuation, moreover it is used as a store for irrigation water.

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6 NEW WATER STORAGE

6.1 Proposed Runoff Storage

It is recognised that additional storage and attenuation of runoff for high magnitude events is required. The long term storage requirement for the polytunnel area has been calculated as 2641m^3.

Two new drainage ditches will be constructed to provide runoff attenuation and part of the required storage. However, the majority of storage will be accommodated within the leg row swales.

New Ditch Storage

The new ditches at Jack's Dyke field are presented in Figures 2 and 4. A series of flow restrictor/dams will be placed in the new ditches to hold flows back and provide the optimum storage available. The dams would be constructed of a material similar to wooden sleepers and set at a height of 10cm below ground level. This will provide the optimum storage available to be contained within the ditches; enhance infiltration to ground; reduce surface water runoff rates; and permit water to flow along and from the ditches once the stored water level surpasses the height of the dam.

Due to low gradients at the farm, the dams should be placed at approximately 100m spacing along the ditches as shown in Figure 4. A dam will be placed at the ditch outfall to the existing drainage ditches at the farm. Outflow will be restricted by a throttle pipe and sluice gate mechanism to control flows discharging into the receiving watercourse to equal to or less than the "Greenfield" runoff rate. Again, this will allow for the optimum storage available within the ditches but will also provide a mechanism to prevent backwashing from the existing drainage ditches during high water levels.

The new ditches will be trapezoid in shape and approximately 1m wide at ground elevation, 0.5m wide at their base; with an average depth of 0.5m. The total length of the new ditches is approximately 700m. These will provide approximately 210m^3 of storage. This equates to approximately 17.5m^3/ha of storage for the 12ha polytunnel development. Therefore, additional storage in the form of leg row swale storage will need to provide 202.5m^3 of storage per hectare.

Leg row storage

The majority of storage required at the polytunnel development will be provided within the leg row swales. The storage in the leg row swales will be developed by placing sand bags or the like across the leg row at regular intervals to compartmentalise the channel. This forms a small dam behind which runoff is intercepted and water is stored in the leg row swales and allowed to infiltrate to ground. This is illustrated schematically in Figure 5. This allows the full width of the swale to become available for infiltration, and will significantly reduce peak flows from the swale area.

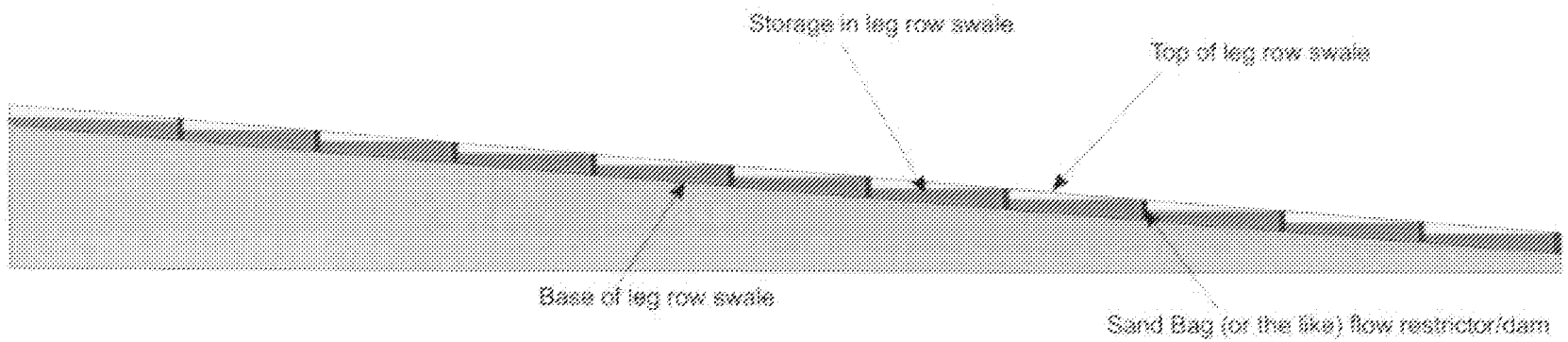
Therefore, rainfall will enter into the leg row swales where it will accumulate behind the sand bags. Once the storage capacity behind the sand bags is exceeded, flow will then enter into the next dammed compartment. At the open, lower end of the polytunnels there will be a dam. Once the capacity behind this dam is breached, all flows will leave the polytunnels as overland flow to the new drainage ditches.

An additional advantage to this method is that the soil moisture content directly adjacent to the leg row swales will be proportionally elevated during rainfall events. This will mean that during and directly after these events, less irrigation water will be required. This essentially provides a form of rainwater harvesting and recycling.

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Longitudinal Profile of Leg Row Swale



Not to scale

Cross Section of Leg Row Swale



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Figure 5	Polytunnel leg row swale schematic profiles

Leg Row Swale Storage Calculation and Design

The volume of storage in the leg row is dependent on 1) the dimensions of the leg row channel; 2) the height and spacing of the dams in the leg row swales; and 3) the gradient of the leg row swale.

At Jack's Dyke field, the topography is relatively flat and ideal for storing runoff within the leg row swales. The maximum and minimum gradients of the leg row swales are 0.2° and 0.01° respectively, as calculated from OS data. The estimated average gradient across the site is approximately 0.1°.

Storage calculations have been undertaken using this range and incorporating sand bags placed at discrete lengths. The methodology to calculate the additional storage area provided is as follows:

1. The total number of leg row swales per polytunnel block are counted and measured to give a leg row swale length (in metres) per polytunnel block.

2. The leg row swale length per polytunnel block is then divided by the polytunnel block areas (in hectares) to give a leg row swale length per hectare of polytunnel.

3. The leg row length per hectare along with the average leg row gradient; basic trigonometry; the leg row dimensions and the dam height and spacing are used to calculate the additional storage that can be provided by damming the leg row swales.

As previously stated, the storage requirements of leg row swales are 202.5m³/ha. For the topographic gradients at the farm; a leg row width of 1.2m; and a leg row swale length of 1275m/ha, the dam spacing and height requirement to fulfil the storage requirement are given in table 3 below.

Table 3 Leg row swale dam spacing and height to fulfil storage requirement.

Topographic Gradient (°)	Leg row Swale Dam Spacing (m)	Leg Row Swale Dam Height (m)	Storage Provided (m³/ha)
0.01 – 0.1	73	0.2	296 to 208
0.1 – 0.2	36	0.2	258 to 210

Therefore, assuming a worse case scenario whereby the maximum topographic gradient is used, a dam spacing and height of 36m and 0.2m respectively, would provide 210m³/ha of storage.

6.2 Discussion

The methods used in this assessment have been developed for urban runoff settings. It is therefore important to place the results within the context of polytunnel development which by its very nature is rural. While the polytunnels themselves generate essentially 100% runoff, as soon as the water hits the ground, then soil surface processes such as infiltration and evapotranspiration will start to attenuate the runoff. The leg row channels become swales by incorporating methods to restrict and store flows. At the end of the polytunnels, discharge into and over headlands (grassed buffer strips) will further attenuate flow rate and volumes by resistance in the grass sward. Further attenuation and storage is then provided in new drainage ditches that will restrict flows leaving the application area to rates equal to or less than the Greenfield runoff rate via throttle pipes.

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The leg row "swales" generally provide a greater ratio for impermeable surface to swale for the polytunnel development than that of an urban development. Additionally, storage can be provided in the polytunnel leg row "swales" to allow standing water. This is often unacceptable in urban settings because of the human health and safety factor.

For the practical guidance of the tractor driver who "rows up" and the workers which place and maintain the bags, notes regarding compulsion, the purpose of the bagging, the need to form effective dams, maintenance requirements, and the origin of the underlying calculations are provided in Appendix B.

7 OTHER POTENTIAL SOURCES OF FLOODING

7.1 Flooding from streams and rivers

The nearest tributary to the site lies in the EA Flood Zone 1 and therefore in the event of flooding, surface water flooding will be that associated with the EA Flood Zone 1. It is unlikely that river levels will be raised sufficient to induce flooding of the polytunnel areas.

7.2 Flooding from the sea

Not applicable.

7.3 Flooding from groundwater

Groundwater levels at the site are thought to be high, however, any groundwater flooding will be associated with the flooding of surface water courses. The nearest tributary to the site lies in the EA Flood Zone 1 and therefore it is unlikely that groundwater will be raised sufficiently to induce flooding of the polytunnel areas.

7.4 Sewers and road drainage

The site is a rural, agricultural development and as such there are no sewer systems or road drainage associated with the polytunnels areas.

An A road exists (the A259) to east of the application area. It is assumed that part of the road drainage for the A259 will be directed to drainage ditches and the Elbridge Rife that flows adjacent to the site. It is also assumed that the drainage network for this road has been appropriately sized and designed for storm events and will not impact on the EA Flood Zone 1. Therefore, it is considered that due to the nature of both the proposed polytunnel development and the road drainage network that neither will affect nor be affected by the other.

7.5 Reservoirs and canals

There are reservoirs close to the boundary at Jack's Dyke field which are used as a store for irrigation water. It is unlikely that reservoir levels will be raised sufficiently to induce flooding of the polytunnel areas. It is also assumed that the reservoirs have been appropriately sized and designed for storm events and will not impact on the EA Flood Zone 1.

There are no canals up gradient of site boundary.

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8 ENVIRONMENT AGENCY CONSENTS

The new drainage will feed into the existing drainage ditches at the site and therefore the development will require a "consent for works affecting watercourses" from the Environment Agency.

There is no requirement for a land drainage, impoundment or flood defence consent.

9 DRY ACCESS ROUTES

Based on the location of the site in Flood Zone 1, a site dry access route during the 1 in 100 year +20% event will always be available.

10 DRY ISLANDS

Not Applicable

11 CONCLUSIONS

This assessment has demonstrated that the polytunnel development at Jack's Dyke field will not have a detrimental impact on drainage and flooding providing storage is provided for in the proposed storage areas.

It is important that the drainage system is actively managed, to reduce flow velocities in the leg row "swales" and to distribute drainage over grassed areas.

Based on Defra/Environment Agency document "Preliminary rainfall runoff management for developments, R&D Technical Report W5-074/A/TR/1 Revision C. Long Term Storage calculations; the required additional storage requirement for polytunnel area is 220m^3/ha. This storage requirement will be provided by:

1. the new ditches with wooden sleeper dams placed at 100m intervals and set at 0.1m below ground level within the ditch
2. leg row swales by using sand bags or the like spaced 36m apart at a height of 0.2m to dam the channels.

These storage areas will restrict flows to equal to or less than the Greenfield runoff rate and provide an element of rainwater harvesting and recycling.

Under guidelines laid out in PPS25, the polytunnel development has been classified (in Table D.2 of PPS25) as "less vulnerable" and the development is considered appropriate (in Table D.3 in PPS25) for Flood Zone 1. With the current and recommended water management systems at the site, these polytunnels will remain operational and safe during times of flood; will result in no net loss of floodplain storage; will not impede water flows and will not increase the flood risk elsewhere.

Lee Clarke MSc MSc FGS
Water Management Specialist

James Dodds MSc CGeol FGS
Director

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Appendix A

Long Term Storage Volumes

[Using DEFRA/Environment Agency. 2007. Preliminary rainfall runoff management for developments. R&D Technical Report W5-074/A/TR/1 Revision C]

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Note: This spreadsheet should be used in conjunction with the Joint Defra/Environment Agency Flood and Coastal Erosion Risk Management R&D Programme Preliminary rainfall runoff management for developments, R&D Technical Report W5-074/A/TR/1 Revision C, as published June 2007.

Initial sizing of Long Term Storage

Long term storage is to be provided to cater for the additional runoff caused by the development compared to the volume that would be contributed from the site in the greenfield state. This volume must be catered for as either infiltration storage or as storage with the ability to be discharged at a rate less than 2l/s/ha. This is particularly applicable to catchments that are susceptible to flooding downstream of the proposed development, but should generally be complied with unless there are particular reasons for not providing this storage.

Discussion on the practical provision of Long term storage is provided in Chapter 5 of the Defra / EA guidance report.

1.	Development Area	(A)	12	ha	Excluding publicly open space which is not affected by the development
2.	Estimate of PIMP	(PIMP)	87	%	
3.	Impermeable area (A*PIMP/100)	(AI)	10.44	ha	All hard surfaces in the development
4.	Long term storage factor (LTF)		4.6		Storage volume per unit area per unit of rainfall (see figure 20)
5.	Rainfall depth (RD)		56	mm	Rainfall depth for 100 year 6 hr event (Appendix 1, Figure 5.1). Also see note 1. Or preferably take from FEH CD-Rom
6.	Long term storage volume				
	(RD*LTF*AI)	$(LTVol_{Actual})$	2688.1	m^3	
		$(LTVol_{Required})$	229	m^3/ha	

Note 1. Explanatory notes for using this spreadsheet are located in R&D Technical Report W5-074/A/TR/1 Revision C, as published June 2007.

Appendix B

Practical Guidance Notes for Polytunnel Developer

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Practical Guidance Notes for Polytunnel Developer

These notes are for practical guidance to the developer and the tractor driver who "rows up" and the workers which place and maintain the sand bags for damming the leg row channels.

1. Compulsion

It is a requirement that adequate and appropriate flow restrictors for rainfall runoff is achieved for the polytunnel development in the form of dams in the leg row swales. This will slow runoff down and provide storage within the leg row swale. This is to satisfy requirements laid out by the Environment Agency.

In order to meet the requirement that runoff from the polytunnels is less than or equal the "Greenfield" runoff rate, the leg row swales that run the full length of the polytunnel parallel to the orientation of the polytunnel will need to be dammed at appropriate intervals by sand bags.

2. The purpose of the sand bagging

The purpose of the sand bagging or the like is to retain rainfall runoff water and to provide barriers to flow along the leg row swales. This should compartmentalise the leg row swale into storage sections. This slows down runoff and allows more water to seep into the soil.

3. The need to form effective barriers

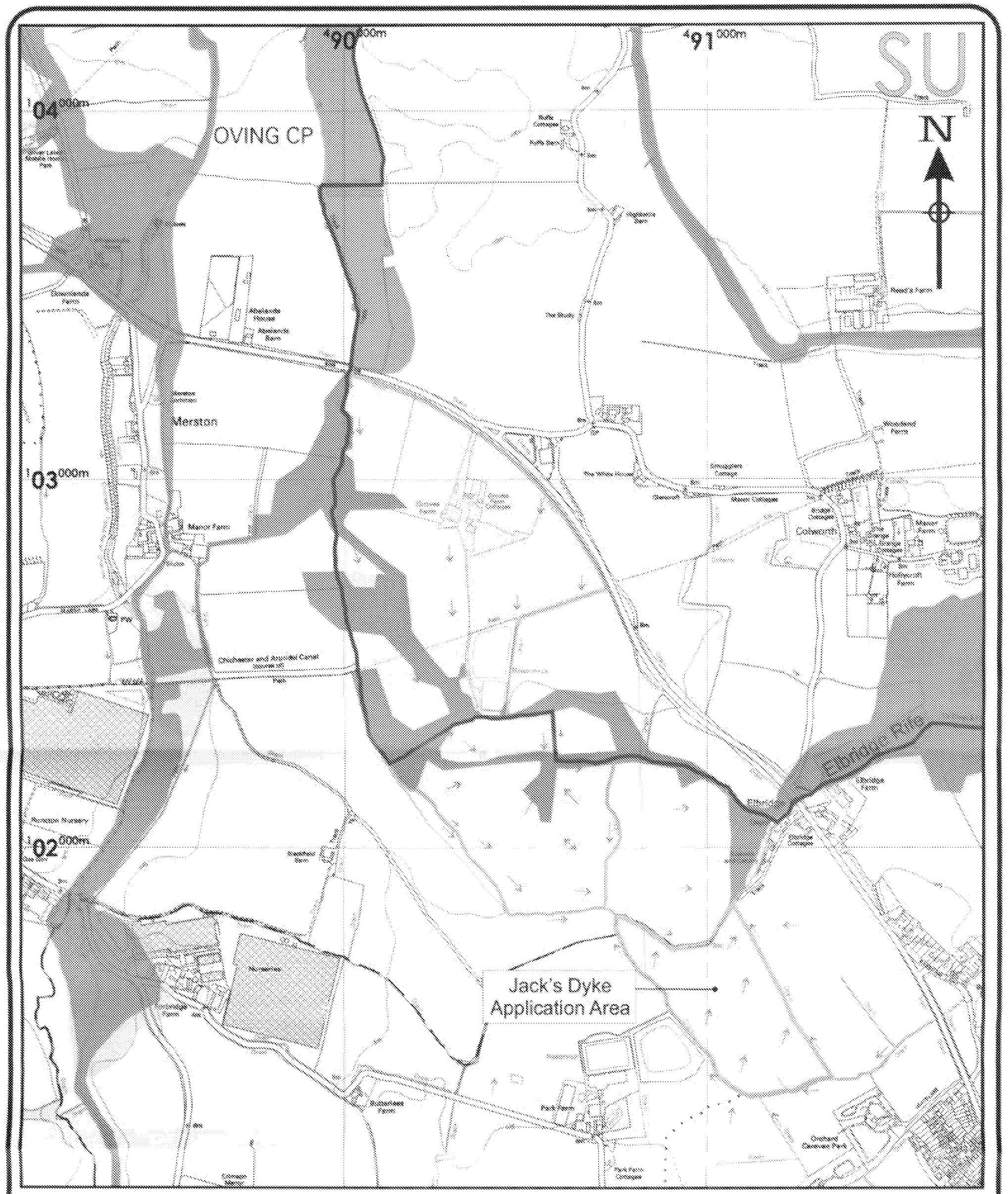
The sand bags or the like need to form effective barriers to retain water behind them. If they do not they will **not** fulfil their purpose.

4. The origin of the storage calculations.

The volume of storage in the leg row is dependent on 1) the dimensions of the leg row swale; 2) the height and spacing of the dams in the leg row swale, and 3) the gradient of the leg row swale. To meet the active water management requirement the dam height and spacing in each polytunnel block is given in this report.

It is a requirement of the storage calculations that a dam must be placed at the lowest point of the leg row swale at the downstream and open end of the polytunnel i.e. where runoff would naturally leave the polytunnel leg row swale.

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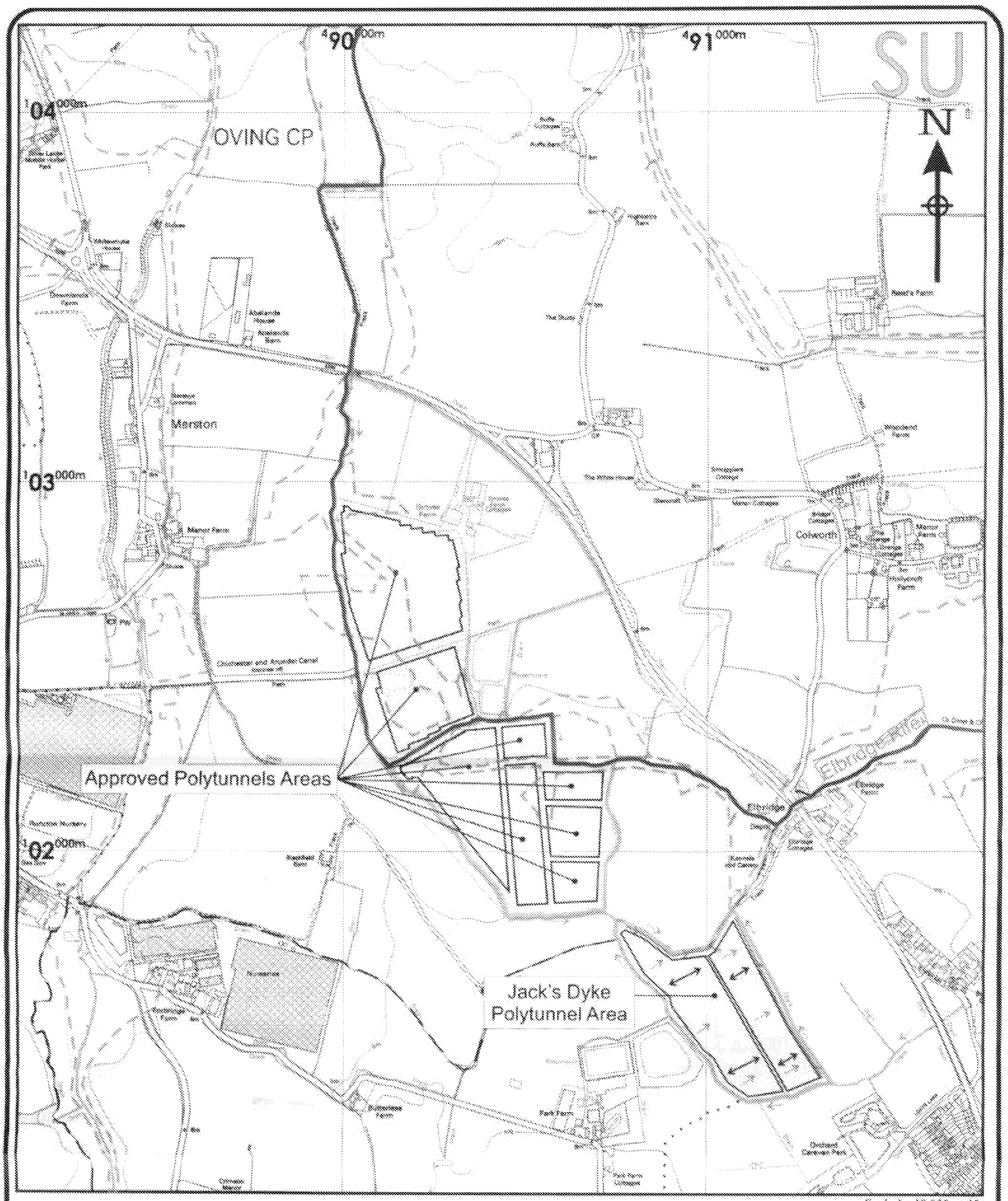


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Scale 1 : 10 000 at A3

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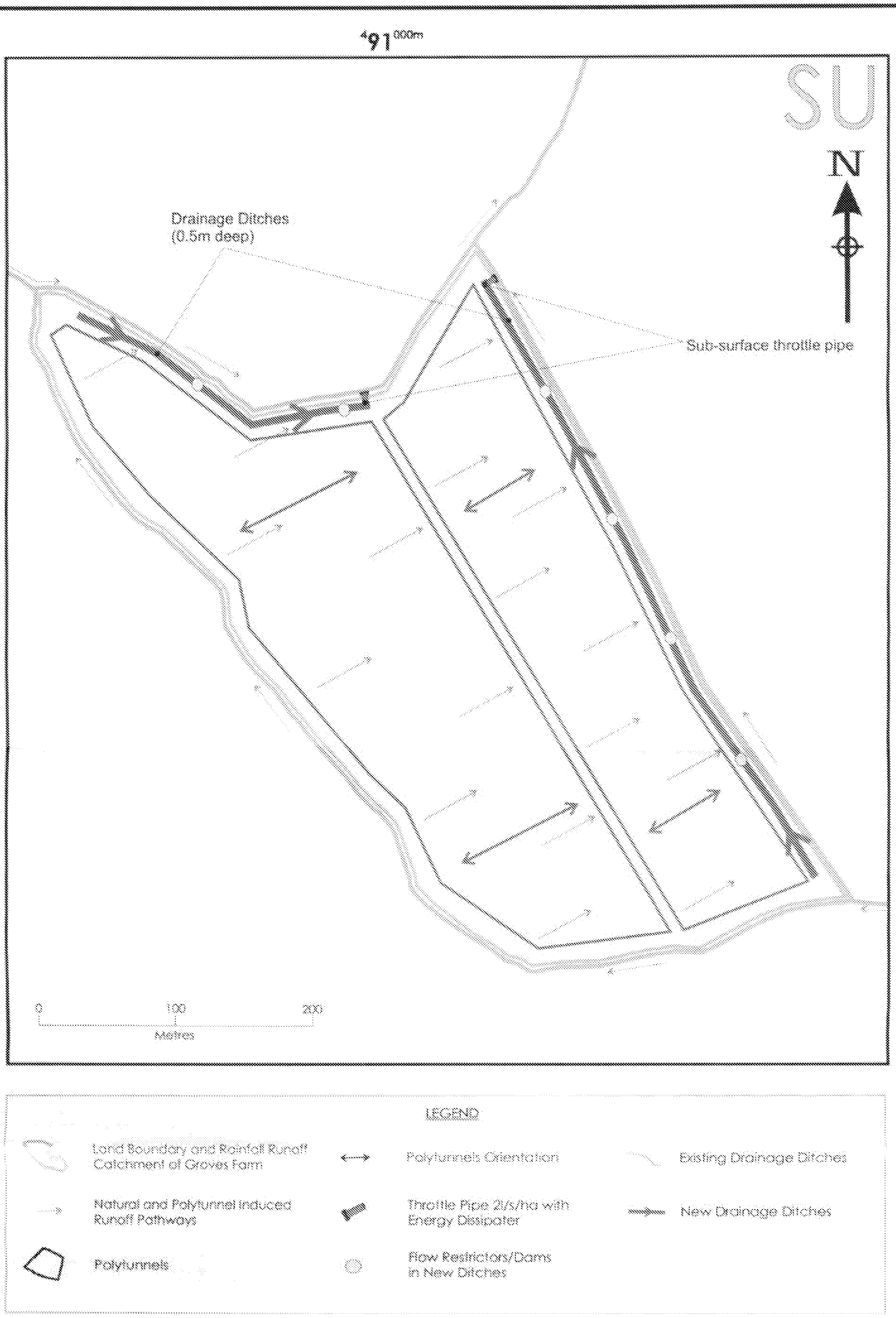
Ref: P:/Groves Farm(39134)/ Jack's Dyke FRA/Fig 1.odr Date: 10/08/2010	**Jack's Dyke, Groves Farm - FRA**
Figure 1	Land Coverage, EA Floodrisk Boundary and Natural Catchment Divides



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Ref: P:/Groves Farm(5934)/ Jack's Dyke/Fig 2.cdr Date: 10/07/2010	**Jack's Dyke, Groves Farm - FRA**
Figure 2	Polytunnel Placement, Orientation and Farm Drainage Pathways



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Date: 10/08/2010

Jack's Dyke, Groves Farm - FRA

Figure 4

Detailed Views of Polytunnel Placement, Orientation, New Ditches and Farm Drainage Pathways