

**JEPCO
NORFOLK HOUSE FARM
PROPOSED POLYHOUSE DEVELOPMENT AT GEDNEY MARSH
FLOOD RISK ASSESSMENT**



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RESERVOIR SAFETY SERVICES LTD

PROPOSED POLYHOUSES DEVELOPMENT AT NORFOLK HOUSE FARM

FLOOD RISK ASSESSMENT

CONTENTS

	Page No.
1. INTRODUCTION	1
2. EXISTING SITE AND PROPOSED DEVELOPMENT	1
3. DEVELOPMENT DETAILS	2
4. FLUVIAL FLOOD RISK	4
5. POTENTIAL IMPACT OF OUTFLOW FROM THE SITE	7
6. DAMBREAK ASSESSMENT	7
7. CONCLUSIONS	7

APPENDIX SHORT FORM QUESTIONNAIRE

PROPOSED POLYHOUSE DEVELOPMENT

FLOOD RISK ASSESSMENT

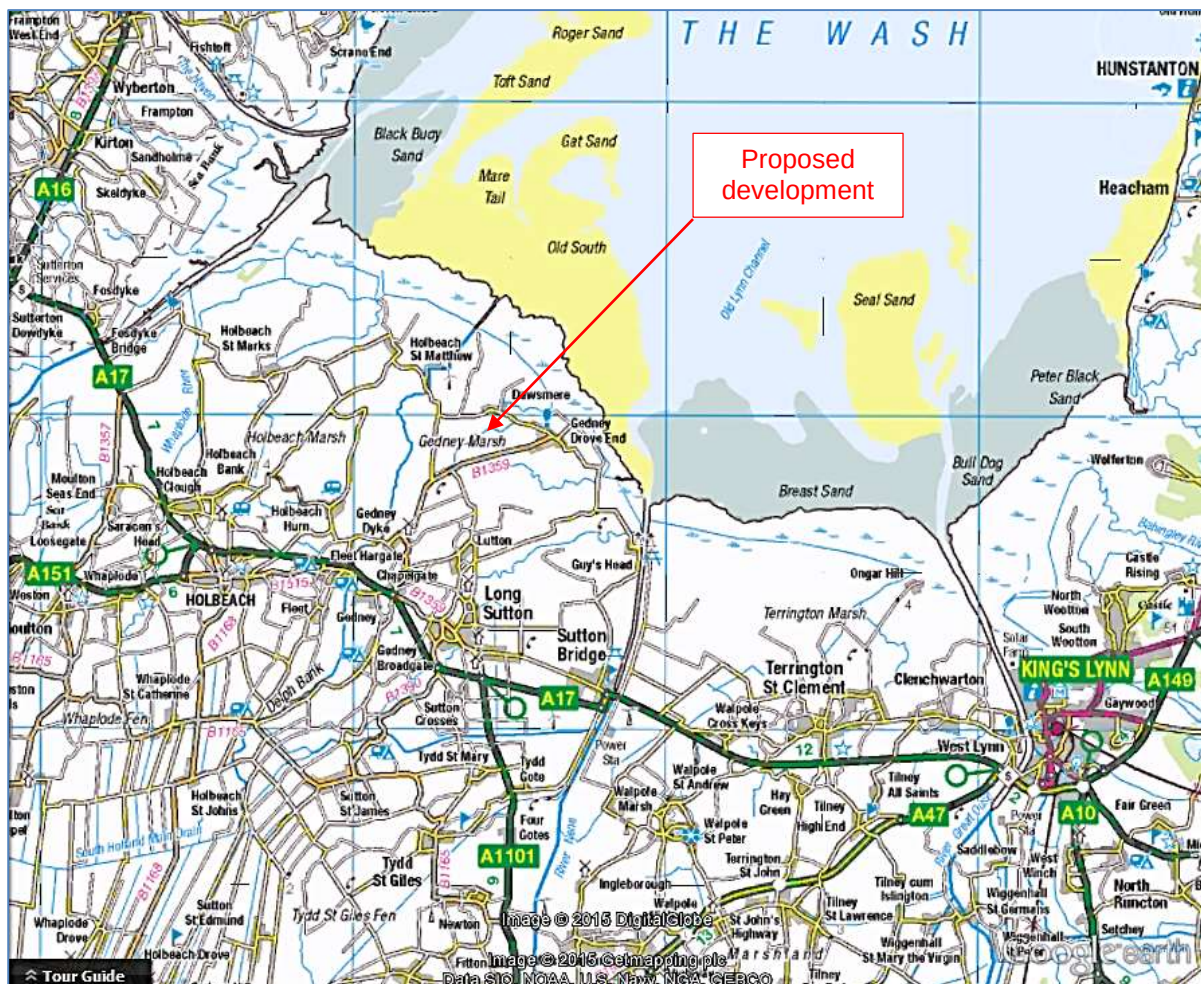
1. INTRODUCTION

This document has been prepared in general accordance with the recommendations contained in the National Planning Policy Framework (NPPF) and in accordance with Environment Agency policy which requires that planning submissions be accompanied by flood risk assessments. Its purpose is to support the short form.

2. EXISTING SITE AND PROPOSED DEVELOPMENT

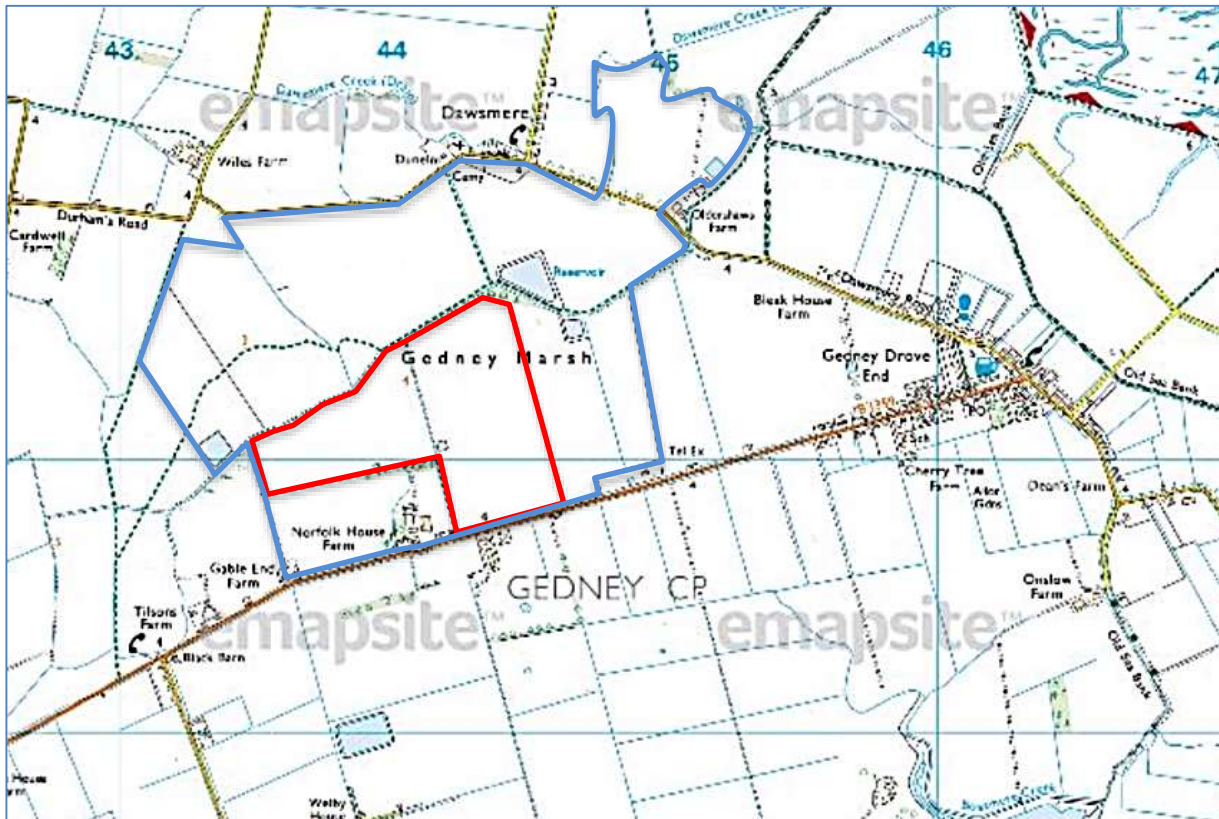
The purpose of the proposed development is to erect polyhouses on existing arable farmland in order to increase agricultural production. It is proposed that the capture of direct rainfall from the polyhouses rooves will significantly reduce the farm's external water demand, 80% of which is currently met by mains supply.

The proposed development is located about 20 km to the northwest of Kings Lynn. The site is located at grid reference TG 433 297, as shown below. The site covers an area of 37 hectares. There is an Internal Drainage Board (IDB) dyke running along one side of the site but all works will remain a minimum distance of 12 m away from this structure.



It is proposed that the roof water from the polyhouses will be held in a new 38,000 m³ capacity buffer reservoir prior to onward transmission to nearby farm irrigation reservoirs (which have a total system storage capacity of 203,000 m³) where the captured water will be stored for future use.

The boundaries of the farm and the proposed polyhouses development are shown on the plan below by blue and red lines respectively.



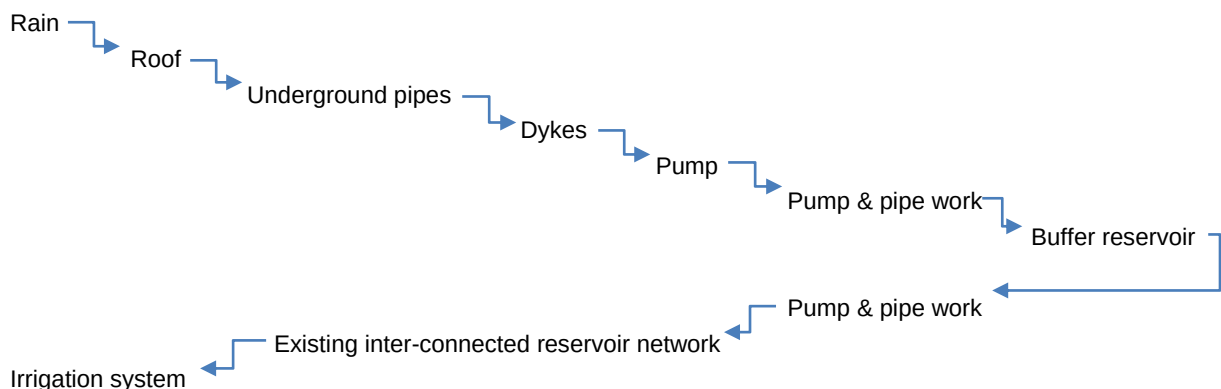
3. DEVELOPMENT DETAILS

3.1 System

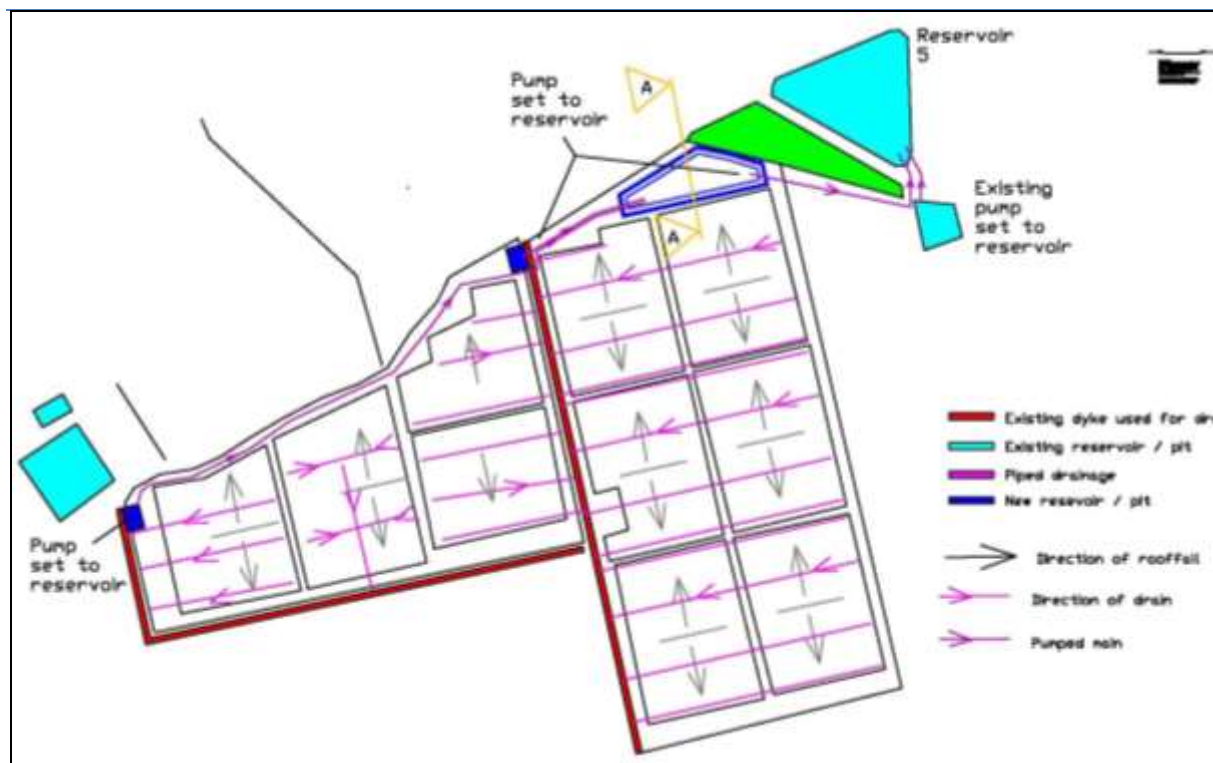
The system is designed with rainfall buffering to a reservoir, the contents of which will be transferred to the existing network of five reservoirs and will displace bought in mains water.

Greenhouse gutters will deliver the roof water to below ground drainage system (Class 51 PVC) which will then take it two existing farm dykes. Sumps will be created for pumps which will pump the water away to the new buffer reservoir. The buffer reservoir will have a capacity of 37,000 m³, which should be sufficient to accept a rainfall event in excess of 100 mm. A small area of greenhouses will drain directly to the buffer reservoir due to their proximity to the structure.

The piped drainage system will be gasketed such that if levels in the dykes rise above the invert level of the outlet then there will still be a nominal 5 m hydraulic gradient to ensure that flow is maintained. A schematic of process flow of the system is shown below.



The general arrangement is show below:



Further details of the system are as follows:

Underground drainage – This will comprise suitably laid network of headers and sub headers, ranging from 750 mm to 160 mm diameter, class 51 PVC, laid on a suitable pipe bedding.

Dykes - The existing dykes collect field drainage from the fields where the polyhouses will be located and hence this flow will cease due to interception by the polyhouses rooves. The dykes currently drain into the IDB drain and this will be modified such that they will normally be isolated from the IDB drain. A sump pit will be excavated at the end of each dyke for installation of the pump system to the reservoir.

Pumps - There will be two duty pumps to transfer flow to the buffer reservoir, although a further two standby units will be available as back up. At this stage it is anticipated that the primary pumps will be electric and the back-up ones diesel, thus offering protection against individual pump failure and energy source failure. Pumps will be controlled automatically according to level.

Buffer reservoir - The reservoir will have a perimeter embankment and will be lined either with clay or a geomembrane, as generally shown on the attached sketches. Its net capacity allowing for freeboard will be 38,000 m³. The proposed reservoir will be a large raised reservoir, as defined by the *Reservoirs Act 1975*, as it will store more than 25,000m³ above the lowest level of the surrounding natural ground.

Existing reservoir network - There are five existing reservoirs, four of which have a storage capacity of 45,000 m³ and the other has a capacity of 22,500 m³. They are all linked via a pumped transfer network so that any reservoir can pump to any other. These are currently used to supply water for spray irrigation of crops in nearby fields.

A schematic showing details of the proposed drainage system is shown overleaf.

3.3 Water utilisation

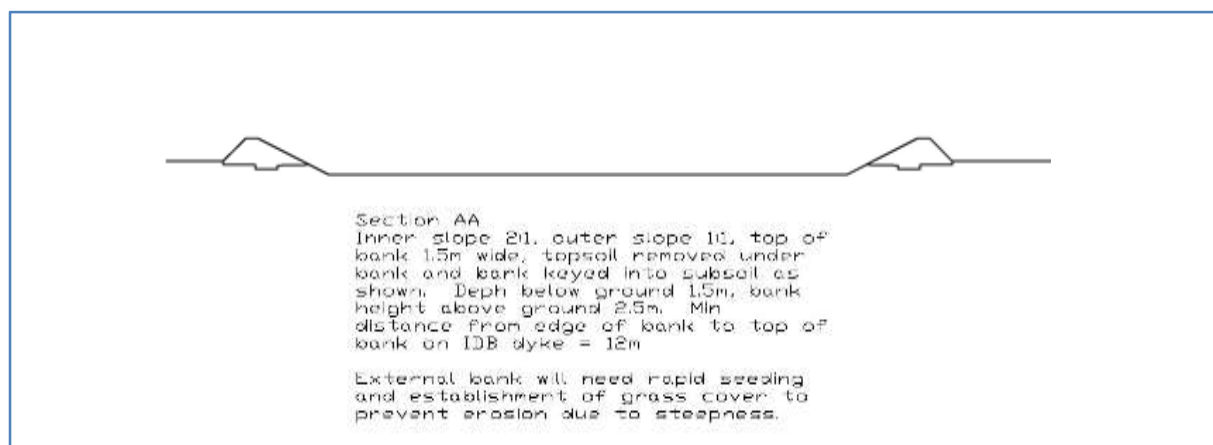
The annual collected run-off is 240,500 m³ based on average annual rainfall, which is below that currently used for irrigation purposes. This does not allow for the irrigation demands of the new greenhouses. All collected rainwater will be utilised for irrigation purposes, thus reducing the amount of mains water used.

3.4 Space for flooding

Construction of the buffer reservoir can be thought of as creation of a space for flooding. Therefore, creation of the structure will not significantly reduce the flood storage of the surrounding area. This addresses the third point listed in Table 1 of the *Technical Guidance* for Zone 3a.

Water collected from the roof of the new structures will be collected and stored for irrigation uses. As a result, this storage and gradual use of water can be thought of as a sustainable drainage scheme. The water enters the ground for the purpose of irrigation, and some of this water will be lost to the groundwater table below the root zone. This addresses the first point listed in Table 1 of the *Technical Guidance* for Zone 3a.

The buffer reservoir will be formed by the excavation of soil materials from the basin area and subsequent formation of an earth embankment around the perimeter. The proposed reservoir will have a maximum storage of 38,000 m³, almost all of which will lie above the level of the lowest natural ground surrounding the reservoir. The general arrangement of the reservoir and typical cross sections are shown on the sketch below.



The buffer reservoir is designed to be non-impounding. It will only receive direct rainfall and water pumped into it. The perimeter embankment will be composed of mixed earth fill derived from soils excavated from inside the basin. The ground surface will be covered with topsoil and laid to grass. The filling mains will pass over the embankment and discharge into the basin. The outlet arrangements have yet to be designed but it is envisaged that they will comprise a pump slung from a floating pontoon that will deliver water through pipework back over the embankment and to a distribution main that will feed into the irrigation reservoir network.

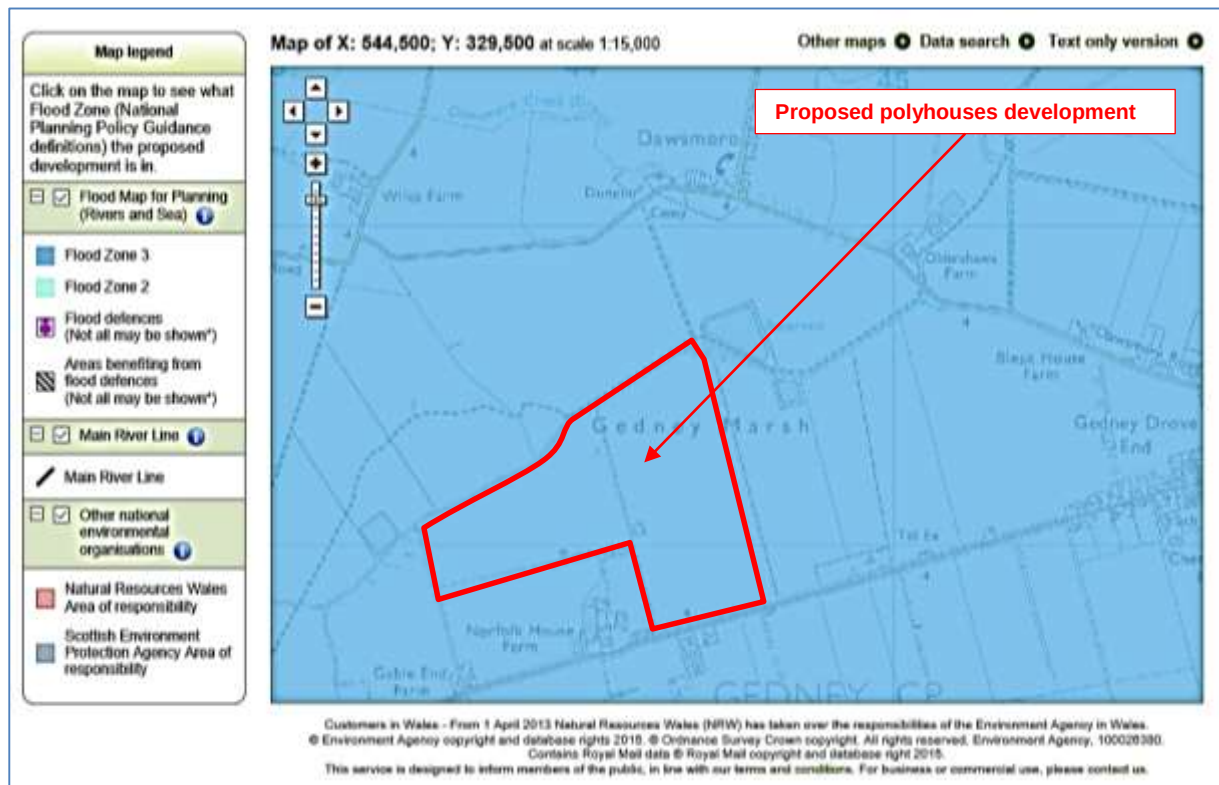
Inflow to the buffer reservoir will be automatically controlled by pumps located at the dykes. An overflow pipe and bellmouth will be installed at the reservoir full supply level (FSL). The capacity of the overflow is far in excess of that of the delivery pumps. If for some reason the reservoir should be overfilled because of a blockage of the overflow pipe, whether natural or a deliberate act of vandalism, then the water level would rise to the level of an emergency overflow sill, which is set at 300 mm below the embankment crest. The emergency overflow would pass excess water over a grass lined auxiliary spillway and discharge it into the adjacent IDB Drain. This feature prevents general overtopping of the embankment.

4. FLUVIAL FLOOD RISK

4.1 Flood Zone

The entire site currently falls within Flood Zone 3a, indicating that the site is currently at risk from flooding from either the sea or rivers. Given the proximity to the coastline, and the absence of any rivers nearby it is clear that this specifically relates to storm surges and sea level rise. Classification as Flood Zone 3 indicates that the site is at risk in the 1 in 200 year maritime flooding event.

Fig 1: Extract from the EA Flood Map for Planning (Rivers and Sea)



The proposed system is a water compatible development and can be considered to fall under the following categories as listed in Table 2 of the *Technical Guidance to the National Planning Policy Framework* (referred to as the *Technical Guidance* henceforth) document:

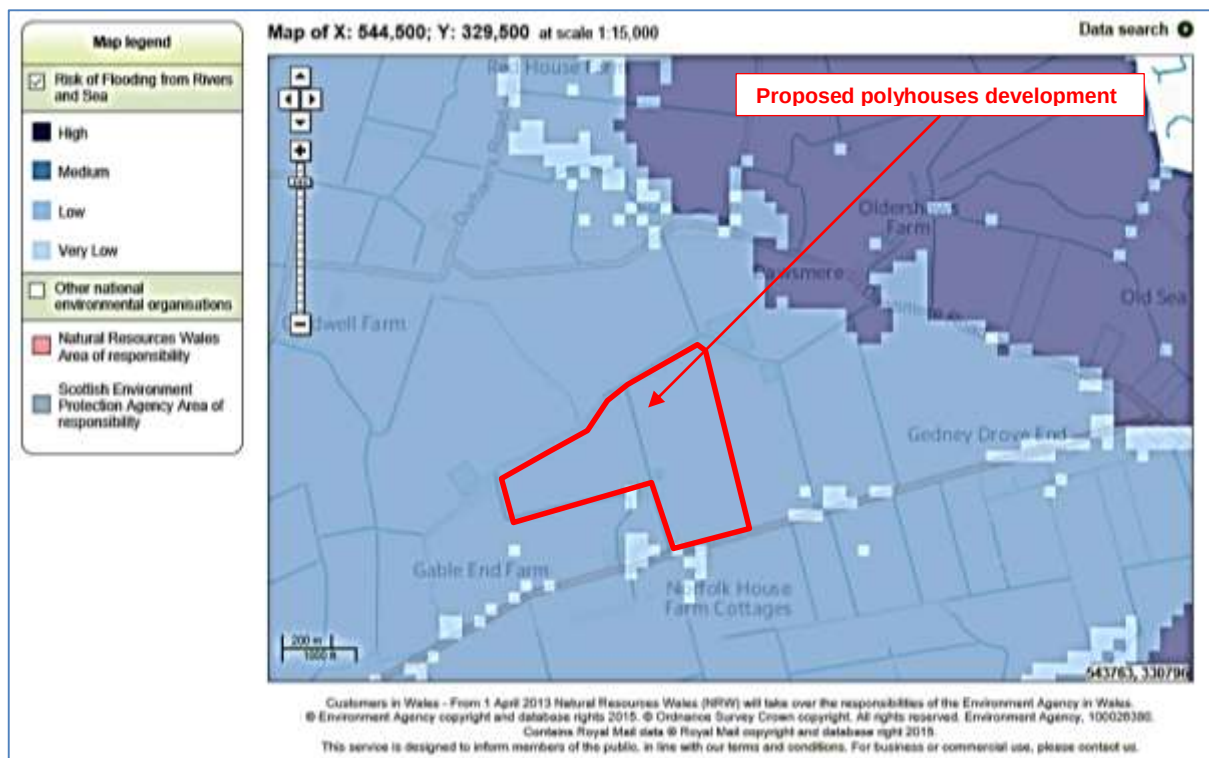
- Flood control structure: With the exception of floods exceeding the 1 in 100 year event, the system will have the capacity to collect and contain rainfall runoff. This will contain surplus water rather than producing additional runoff to be conveyed by the Internal Drainage Board who manage and maintain the local drainage system.
- Water transmission infrastructure and pumping systems: The system will collect runoff from the roofs of the polyhouses in a variety of sump pits and a buffer reservoir. Pumps will convey this water to a number of nearby storage reservoirs.

Furthermore, the proposed system is effectively a sustainable drainage system as collected water will be used to irrigate crops grown inside the new polyhouses enclosures.

These types of structure are considered to be appropriate developments within Flood Zone 3a as stated in Table 1 of the *Technical Guidance*. The listed policy aims for development in this zone are listed as follows:

- Reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage systems.
- Relocate existing development to land in zones with a lower probability of flooding; and
- Create space for flooding to occur by restoring functional flood plain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage

These aims will be addressed in the following sections. No Exception Test is required for this type of structure or development.

Fig 2: Extract from the EA Risk of flooding from Rivers and Sea Flood Map

4.2 Flooding from precipitation

A variety of flood events have been modelled in *ISIS version 3.7* using the FEH DDF curves for the area. The results for a range of storm durations have been included in the table below.

Table 1 – Summary of precipitation during the 1.0% AEP flood event + 20% contingency to account for climate change

Event Duration	5 hour	10 hour	15 hour	20 hour	30 hour	40 hour	90 hour
Peak Flow (l/s)	5040	3040	2220	1760	1270	1000	490
Peak Flow (m ³ /s)	5.04	3.04	2.22	1.76	1.26	1.00	0.49
Total Volume (m ³)	36,000	41,700	45,100	47,500	51,100	53,800	58,900
Rainfall (mm)	96	112	121	127	136	144	157

The above estimates have been produced by adopting a 100% runoff of areal rainfall as derived using the FEH methodology. The flows have been scaled been increased by a factor of 1.2, as listed in Table 5 of the *Technical Guidance*. The rainfalls shown in the table above are those that correspond to this increased flow, rather than those actually derived using the FEH methodology.

This indicates that the site will be able to safely store the 1 in 100 year event for storm durations of less than 10 hours. Longer durations will produce a greater quantity of runoff, however the peak flow is reduced. It is anticipated that the pumps will be able to safely convey this water to the other existing reservoirs in the system to ensure storage of the floodwaters.

It is also pertinent to compare the impact of the development upon the actual runoff from the site area. The FEH indicates that the SPRHOST parameter (i.e. the standard percentage runoff based on the hydrology of soil types study) is 31.2%. Table 2 overleaf outlines the anticipated increase in flood water that can be expected to run off the site during the 1 in 100 year event (including 20% climate change allowance) for the range of storm durations examined in Table 1. The calculations show that the increase in runoff would be in the range of 24,700 m³ to 40,500 m³, which ties in closely with the proposed sizing of the buffer reservoir.

Table 2 – Comparison of flood volumes before and after proposed development

1.0% AEP flood + 20%	Total Flood Volume (m ³)						
Event Duration	5 hour	10 hour	15 hour	20 hour	30 hour	40 hour	90 hour
Runoff before development	11,300	13,000	14,100	14,800	15,900	16,800	18,400
Runoff after development	36,000	41,700	45,100	47,500	51,100	53,800	58,900
Net increase in runoff	24,700	28,700	31,000	32,700	35,200	37,000	40,500

The reservoir will not form an obstruction to river flow or cause any impact upon natural flood discharge even in the most severe flood event. The polyhouses are incapable of excluding floodwater and would be expected to be inundated in the event of overland flooding. The lightness of the structures and the extensive use of membranes means that negligible amounts of floodwater would be displaced.

5. POTENTIAL IMPACT OF OUTFLOW FROM THE SITE

The site will reduce flood risk from rainfall to the surrounding area, since the rainfall from the 0.37 km² site will be collected. The structure makes no impact to the residual risk from marine flooding.

As outlined above, the system would seek to capture all flows into the existing ditches and transfer flow into the buffer reservoir without delay. In the event that the buffer reservoir is already full, or alternatively, that the pumps were unable to beat inflow, then the surplus will spill into the IDB Drain. This existing drainage watercourse has significant storage capacity. The gradient of the Drain is shallow and water in it is largely moved around by pumping either to waste or into storage reservoirs by the IDB or others.

6. DAMBREAK ASSESSMENT

A new buffer reservoir will be constructed using embankments which are raised 2.5m above the natural ground level at the site. Should the embankment fail, then the resulting breach hydrograph would have the following parameters (derived using the *Froelich* and C542 methodology)

Peak Flow: 42 m ³ /s	Time to peak: 5 minutes	Time to end: 30 minutes
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Such an event would attenuate rapidly since the surrounding land is essentially flat and the storage capacity is small. The flood path would depend upon the location of the breach, however it is reasonable to assume that it would quickly pass into the existing drains and ditches. In the absence of such features, it is pertinent to note that the unit peak flow from a flood wave radiating out over level ground from a breach would reduce to approximately 1 l/s/m at a distance of 100 m from the buffer reservoir. There are no vulnerable structures within this radius. Hence, failure of the structure can be thought to have little or no consequence in terms of harm to people or property.

7. CONCLUSIONS

The conclusions of this assessment are as follows:

- (1) The proposed development might be expected to generate between 25,000 m³ and 40,000 m³ of runoff during the 1 in 100 year flood event (including 20% allowance for climate change).
- (2) It is proposed that all rainfall is captured from the polyhouses roof drainage systems and collected by pipes and ditches prior to being pumped into a 38,000 m³ capacity buffer reservoir.
- (3) There will be minimal displacement of water and no potential for change of the flooding regime either upstream or downstream of the site.
- (4) The development will have no impact on fluvial or coastal morphology, even after increases in runoff and sea level as a result of long term climate change are taken into consideration.
- (5) Operation of the proposed reservoir will not cause flooding downstream or exacerbate any existing problem.

APPENDIX
SHORT FORM QUESTIONNAIRE

1 Development description and location

- 1a. What type of development is proposed and where will it be located? Include whether it is new development, an extension to existing development or change of use etc.
The erection of polyhouses is proposed over an area of 37 hectares at Norfolk House Farm, which lies at Gedney Marsh some 20 km to the northwest of Kings Lynn. The centre of the proposed development is located at NGR TG 433 297.
- 1b. What is its vulnerability classification?
Polyhouses are not listed in the guidance but "Water compatible" is deemed to be appropriate.
- 1c. Is the proposed development consistent with the Local Development Documents?
Yes, in that it lies in land set aside for agriculture and it will be an agricultural development.
- 1d. Please provide evidence that the Sequential Test and where necessary the Exception Test has been applied in the selection of this site for this development type?
Development is appropriate and the Exception Test need not be applied.

2. Definition of the flood hazard

- 2a. What sources of flooding could affect the site?
Primarily from rivers and the sea.
- 2b. For each identified source, describe how flooding would occur, with reference to any historic records wherever these are available.
The site lies in reclaimed fenland and within a mile of the coastline of the Wash.
- 2c. What are the existing surface water drainage arrangements for the site?
The IDB Drain passes directly to the north of the site and there are deep ditches along existing field boundaries.

3. Probability

- 3a. Which flood zone is the site within?
The EA Flood map, as shown below, indicates Zone 3a.
- 3b. If there is a Strategic Flood Risk Assessment covering this site, what does it show?
None known to be in existence.
- 3c. What is the probability of the site flooding taking account of the contents of the SFRA and of any further site-specific assessment?
None.

3d. What are the existing rates and volumes of run-off generated by the site?

The proposed polyhouses development covers an overall area of about 37 hectares. The run-off volume from the undeveloped site is estimated to be 11,300 m³ based upon an existing SPRHOST value of 31.2% for the 100 year rainfall over a 5¼ hour duration event (including 20% adjustment for climate change).

Following development, the runoff is presumed to increase to 100% and the volume is estimated to increase to 36,100 m³. The runoff will be captured from the rooves of the polyhouses and collected by a network of pipes and ditches and conveyed to a buffer reservoir with a capacity of 38,000 m³.

4. Climate change

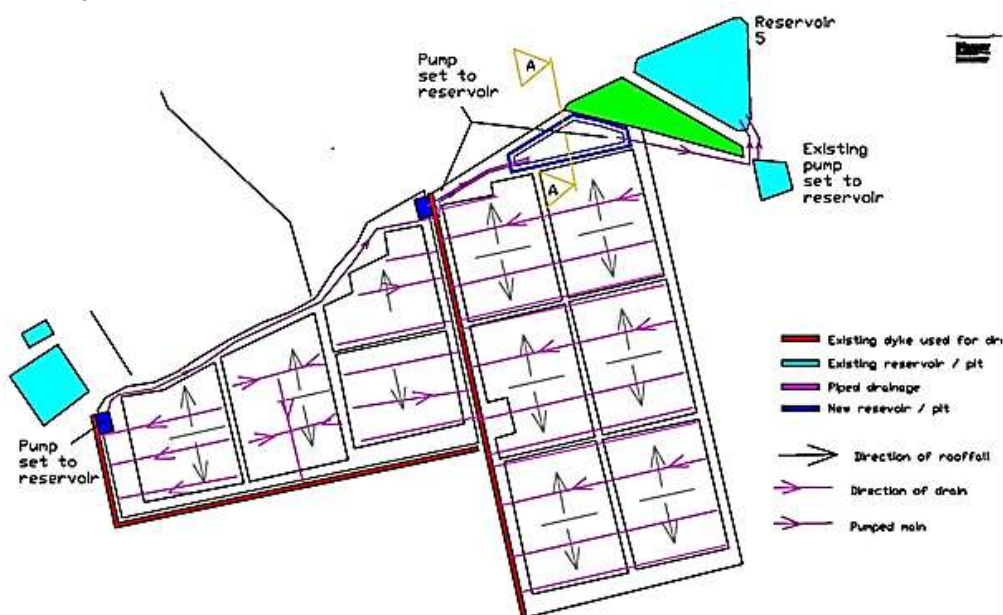
4a. How is flood risk at the site likely to be affected by climate change?

Given its proximity to the coastline of the Wash and the low-lying terrain, the flood risk is likely to increase as a result of climate change.

5. Detailed development proposals

5a. Please provide details of the development layout, referring to the relevant drawings.

The layout is shown on the schematic below.



5b. Where appropriate, demonstrate how land uses most sensitive to flood damage have been placed in areas within the site that are at least risk of flooding.

Not applicable. The proposed development is not sensitive to flooding.

6. Flood risk management measures

6a. How will the site be protected from flooding, including the potential impacts of climate change, over the development's lifetime?

Runoff will be captured and conveyed to the buffer reservoir for storage and reuse.

7. Off site impacts

- 7a. How will you ensure that your proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere?

Runoff will be captured from the rooves of the polyhouses and conveyed to a new 38,000 m³ buffer reservoir and distributed into a network of larger storage reservoirs on the estate for subsequent use as spray irrigation.

- 7b. How will you prevent run-off from the completed development causing an impact elsewhere?

By effective interception of all roof gutters from the polyhouses and surface ditches together with effective underground pipe transfers to the reservoirs.

8. Residual risks

- 8a. What flood-related risks will remain after you have implemented the measures to protect the site from flooding?

A residual risk of dam failure at the buffer reservoir will remain (albeit very small) and this will be mitigated by ensuring that the structure is designed and constructed under the supervision of an All Reservoirs Panel Engineer. The impact of a dam break would however be small because of the flatness of the terrain, the limited volume of escaping water, and the general absence of residential and commercial property in the vicinity.

- 8b. How, and by whom, will these risks be managed over the lifetime of the development?

Reservoir safety issues will be managed by the reservoir owner (i.e. Undertaker) in line with the requirements of the Reservoirs Act 1975. This legislation ensures that reservoirs are subject to regular inspection, appropriate monitoring and surveillance.