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Flood Risk Assessment
Jepco
Norfolk House Farm
Gedney Marsh Spalding PE 12 9PB, UK

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1. INTRODUCTION

This report has been prepared in support of a planning application for a new Argi tech development at Jepco Norfolk House farm Gedney Marsh Lincolnshire.

This report comprises a Flood Risk Assessment as defined in the Environment Agency Standing Advice Development and Flood Risk — England Initial Planning Response Matrix - Flood Zones v 1.0 for operational development of less than 1 ha and as agreed with the Environment Agency and Planning Policy Statement 25.

It is recognised that developments that are designed without regard to flood risk may endanger lives, damage property, cause disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works. PPS25 gives guidance on development and flood risk identifying various key aims for a development to ensure that it is sustainable in flood risk terms. These key aims are as follows:

- The development should not be at a significant risk of flooding and should not be susceptible to damage due to flooding.
- The development should not be exposed to flood risk such that the health, safety and welfare of the users of the development, or the population elsewhere, is threatened.
- normal operation of the development should not be susceptible to disruption as a result of flooding.
- safe access to and from the development should be possible during flood events.
- the development should not increase flood risk elsewhere.
- the development should not prevent safe maintenance of watercourses or maintenance and operation of flood defences.
- the development should not be associated with an onerous or difficult operation and maintenance regime to manage flood risk. The responsibility for any operation and maintenance required should be clearly defined.
- future users of the development should be made aware of any flood risk issues relating to the development.
- the development design should be such that future users will not have difficulty obtaining insurance or mortgage finance, or in selling all or part of the development, as a result of flood risk issues.
- the development should not lead to degradation of the environment; and
- the development should meet all of the above criteria for its entire lifetime, including consideration of the potential effects of climate change.

This report is undertaken with due consideration of these sustainability aims. The key objectives of this report are:

- to assess the flood risk to the proposed development and to demonstrate the feasibility of appropriately designing the development such that any residual flood risk to the development and its users would be acceptable.
- to assess the potential impact of the proposed development on flood risk elsewhere and to demonstrate the feasibility of appropriately designing the development such that the development would not increase flood risk elsewhere

1.1. Flood Risk Appraisal

The Environment Agency Flood Risk Assessment (FRA) Guidance Note 3 states what should be in an FRA.

"An FRA is required to ensure flood risk to the proposed development is considered, as well as the impact the development will have elsewhere on people and property. The scale, nature and location of the proposed development will inform the scope of the FRA required"

This report has been prepared for the sole use of the named client and consequently, is confidential to the client and his professional advisors. The Contracts (Rights of Third Parties) Act 1999 does not apply, nothing in this report confers or purports to confer on any third party any benefit or right. No responsibility whatsoever is accepted to any other person than the named client and, consequently, the contents of this report should not be relied upon by third parties for the whole or any part of its contents.

2. Sources of Information

General information regarding the site and local hydrology was obtained from the Ordinance Survey and local Authority maps. Information regarding the current flood risk was garnered from the Environment Agency.

3. Description of the Site

3.1. Site Location

JEPCO occupies over 300 hectares of essentially flat and fertile land approximately 2.5km from the Lincolnshire coast and the Wash, an expansive protected area designated as a Special Area of Conservation, Special Protection Area and Site of Special Scientific Interest bordering the site to the North and East.

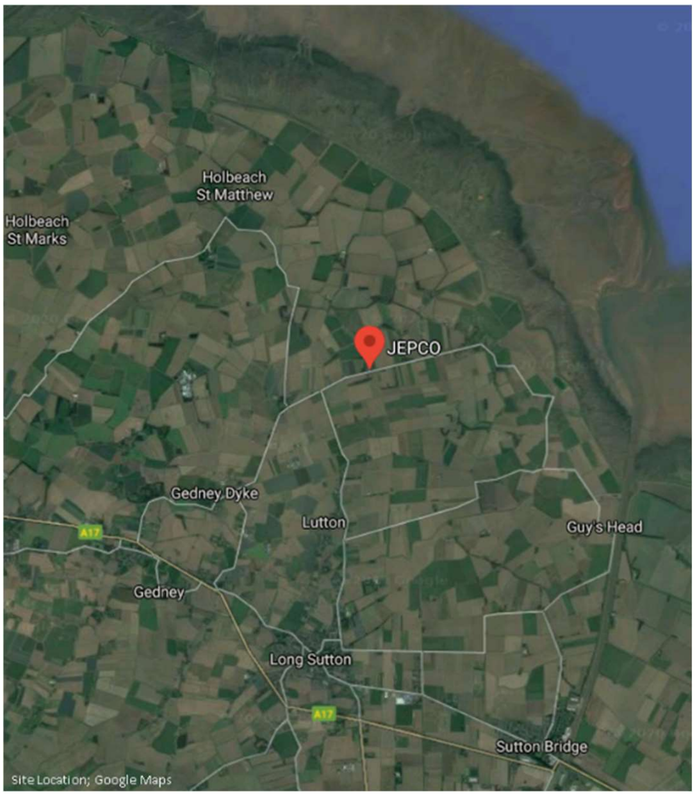


Figure 1 Site Location.

3.2 Site Location

The subject site of this particular planning permission is located on reclaimed fenland to the east and adjoining the existing Norfolk Farm site and covers approximately 15 ha

Figure 2 Existing Site.

The site is currently in agricultural use and houses on its Western side one of a number of lagoons which are utilised as rainwater attenuation for storage in the growing processes.
The site is bounded on the North, East and West by additional Jepco holdings and on its South by the Main Road.

4 PROPOSED DEVELOPMENT

The proposed development consists of the covering of 10 hectares of land to enable undercover growing within glasshouses and to support same with an integrated preparation, processing, storage and dispatch facility and the associated required infrastructure. The overall scope can therefore be sub divided into the following components:

- Main Glasshouse Area containing Hydroponic Growing System.
- Glasshouse Annex containing Seeding and Germination processes
- Main Pack Building.
- Administration and Welfare Building
- Main Plant Room
- External Roads & Hardstandings

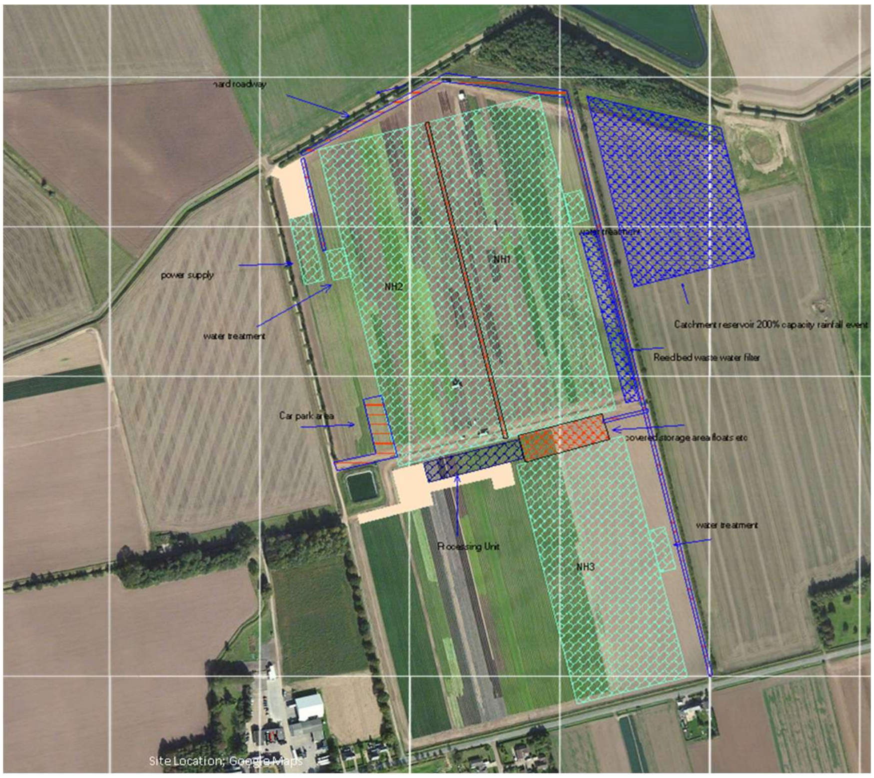


Figure 4 Proposed Site Layout

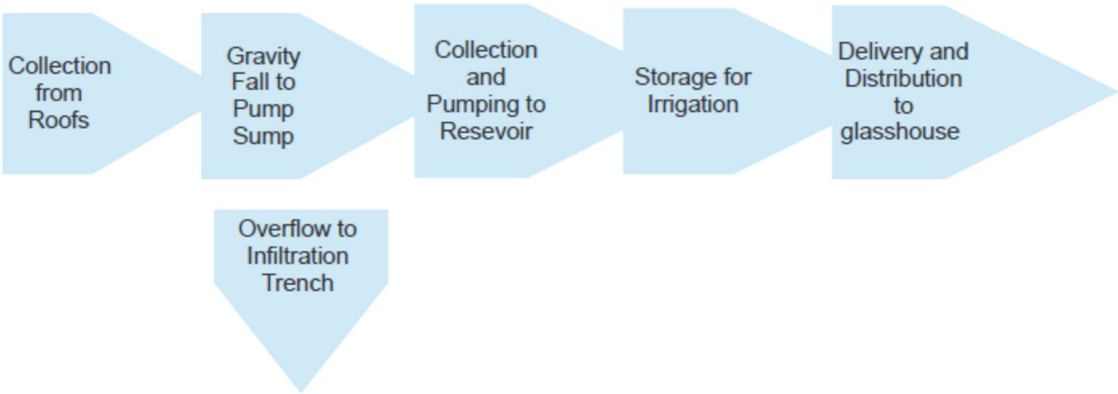
4.1 Proposed Drainage System

The proposed surface water drainage system is intended to be split into two distinct systems,

- Roof Rainwater
- Yard Drainage

4.1.1 Roof Rainwater System

This system represents the largest volume will involve capture and reuse of the of the roof rainwater from the entire glasshouse and Production area which amounts to an area of 14ha which will be captured and conveyed to the Previously approved Reservoir as per planning application notice H06-0590-21.



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 to the new buffer reservoir.

The buffer reservoir will have a capacity of 45,500 m^3, which is more than sufficient to accept a rainfall event in excess of 100mm over the 14-ha glasshouse and production roof.

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.

Underground drainage – This will comprise suitably laid network of headers and sub headers, ranging from 450 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 glasshouse will be located and hence this flow will reduce to that being applied by the yards and roads. The dykes currently drain into the IDB drain

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 one's 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 45,500 m^3. The proposed reservoir will be a large, raised reservoir, as defined by the *Reservoirs Act 1975*, as it will store more than 55,000m^3 above the lowest level of the surrounding natural ground.

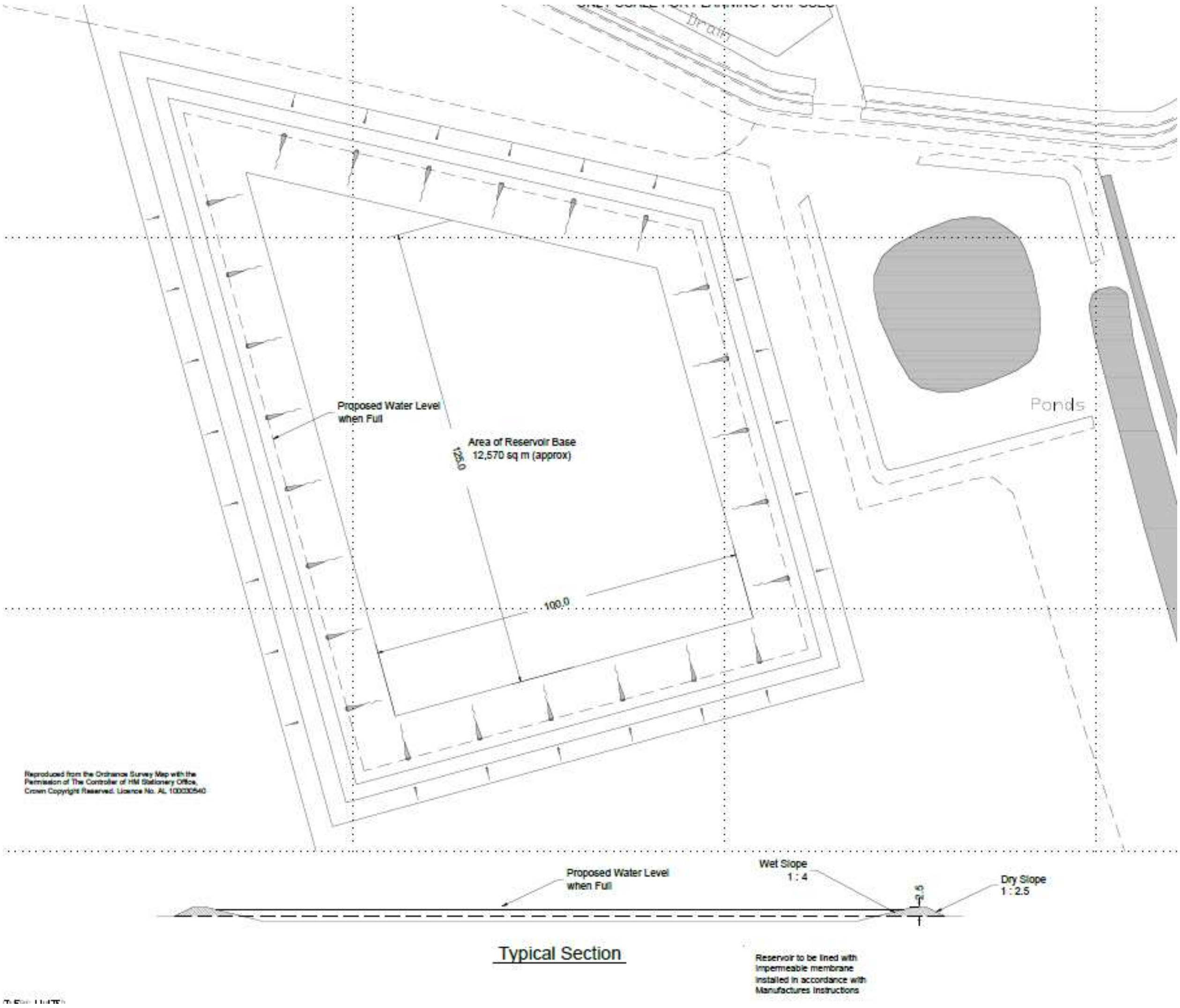


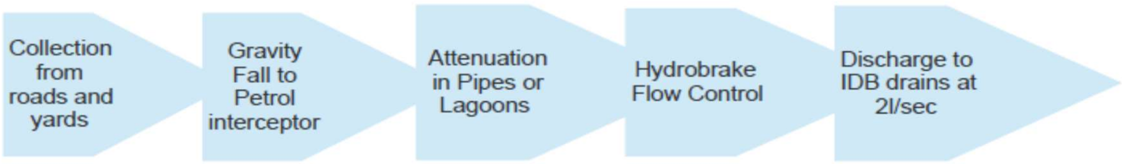
Figure 5: Approved Storage Reservoir

Existing reservoir network - There are five existing reservoirs, four of which have a storage capacity of 45,000 m^3 and the other has a capacity of 22,500 m^3. They are all linked via a pumped transfer networkso that any reservoir can pump to any other. These are currently used to supply water for spray irrigationof crops in nearby fields.

The annual collected run-off is 240,500 m^3 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 ofmains water used.

4.1.2 Yard Drainage

As noted above all new hardstanding and roads shall be drained via underground pipework systems to three individual points where a full retention Petrol interceptor and piped attenuation system shall be located, in total the areas associated are approximately 1.8 ha.



This attenuation system shall combine all run off and be controlled by a hydro brake limiting discharge to 2l/sec to the existing IDB drainage ditch, the location of which is indicated on the drainage layout.

The junction between the ditch and the new pipework shall be formed with a concrete headwall and stilling chamber complete with grilles across the entry to the pipe to prevent water surge into the ditch causing erosion of the banks and bed, this access point shall be maintained by the site team.

Treatment Train

Sustainable Urban Drainage systems recommend that a series of measures be considered during the design stage, the SUDS website has developed an outline of this treatment train which forms the basis of the approach to the design of the site-specific systems.

Pollution Control

There is no hydrocarbon interception system currently installed on site, it is therefore intended to incorporate a new full retention Petrol interceptor catering for the new hardstanding areas upstream of the Attenuation Area on each of the drainage routes. The petrol interceptor shall be a Molloy type Aswaclear® NS100 as outlined in figure 4 below

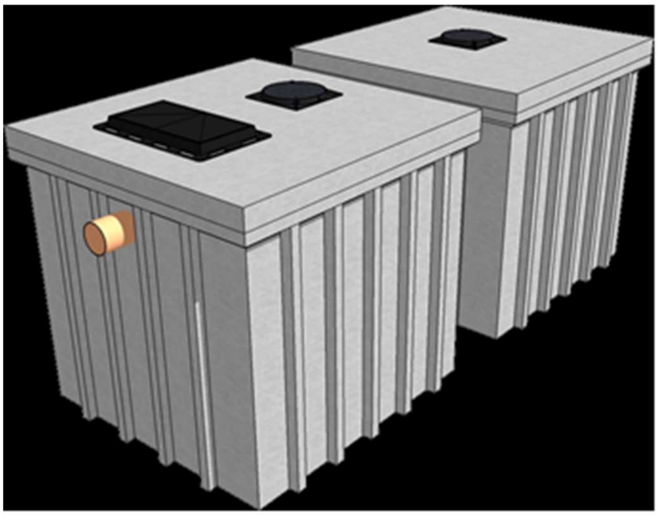


Figure 6 Petrol Interceptor

Attenuation System

The treatment train outlines several mitigation options, considering the built environment of the site it is reasonable to propose the design and installation of a sub-surface storage system within oversized pipes and a surface pond suitable to:

- Attenuate road runoff.
- Attenuate Car Park/Impermeable area runoff

The areas drained are as outlined above and are for the purposes of design separated into three sections:

- Main Loading area and Car Park
- Service Yards
- Perimeter Roadway

The attenuation system associated with the car park and loading bay area shall consist of a above ground pond storage which will be designed in accordance with the ecological requirements of the site.

The other two areas being relatively minor will be attenuated in oversized pipes.

A hydro brake limiting the discharge to 2l /sec shall be installed at end of line as outlined in figure 7 below and on drainage layout and details drawings.

Figure 7 MD 5 Hydro brake

4.1.3 Flooding Allowance Area

Construction of the buffer reservoir can be considered the 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 havea maximum storage of 45,500 m^3, almost all of which will lie above the level of the lowest natural groundsurrounding 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. Thefilling mains will pass over the embankment and discharge into the basin. The outlet arrangements haveyet to be designed but it is envisaged that they will comprise a pump slung from a floating pontoon thatwill 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 end of the drainage system. An overflowpipe and bell mouth will be installed at the reservoir full supply level (FSL). The capacity of the overflowis 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. In addition, the infiltration trench located around the perimeter of the entire building will facilitate the overflow of roof water and allow its filtration through the site.

5 Flood Risk Assessment Review

Potential Sources of Flooding — Level 1 Screening Study

It is necessary to consider all forms of flooding for any proposed development. A summary of the potential sources of flooding and a review of the potential risk posed by each source at the application site is presented in Table 1.

TABLE I — POTENTIAL RISK POSED BY FLOODING SOURCES

Potential Source	Potential Flood Risk at Application Site	Potential Source	Data Source
Fluvial flooding	Yes	Local IDB network	EA
Tidal flooding	Yes	The Wash	EA
Flooding from rising/high groundwater	No	None reported	EA
Overland flow flooding	No	None reported	EA
Flooding from artificial drainage systems	No	None reported	EA
Flooding due to infrastructure failure	No	None reported	EA

Fluvial Flooding Sources

A system of local IDB drainage ditches surround and drain the site and the adjoining areas.

Tidal Flooding Sources

The proposed development site is located approximately 2km from the nearest coast with therefore tidal flooding is considered a risk within this FRA. The tidal hazard mapping shows that the site may be subject to depths greater than 1.6 metres following a breach in the defences in a 0.5% event and 0.1% event with climate change.

Groundwater Flooding

The Companion Guide to Planning Policy Statement 25 (PP525) identified that:

"*Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rock (aquifers).*"

The ground level of the proposed development site is approximately 3.1 m AOD ground investigation report found that will there are layers of silts and clay to a depth of 1m below topsoil; this did not give rise to any flooding.

Flooding from artificial drainage systems
Under the planning application a new surface water drainage and attenuation system will be put in place. The purpose of this system is to retain accumulated rainwater from the 14ha of new roof area and to store and to store same within the storage reservoir as approved under Planning Permission H06-0590-21 for reuse within the Growing Process for this development and the operations in general.

As a potential overflow from this system a 5m wide x 1.5m deep stone channel shall be installed for the full perimeter of the glass house which will act as a soakaway and facilitate the free drainage of the site to the IDB drains in similar timescales to the existing fields.

In addition, it is intended to collect all yard and road rainwater and pass-through hydrocarbon interceptor before controlling the discharge to the IDB drains surrounding the site. These discharges shall be limited to 2l/s by hydro brakes on each line with the excess water being attenuated within oversized pipes and a surface lagoon adjacent to the car park area. In this manner the proposed development will have a positive effect on the volume discharging to local drains and therefore flooding from existing drainage systems has not been considered further within this FRA.

Overland flow Flooding
Due to the nature of the levels of the site, and it is surrounding regime of IDB drains the potential for surface flow of rainwaters is minimal other than part of the Tidal flooding as previously outlined.

Flooding due to infrastructure failure
Research into the site infrastructure and that of adjoining developments have indicated that there is no infrastructure present which could pose a flood risk. Therefore, infrastructure failure is only considered as part of the surface water back up plan, see 7.1.

Environmental Agency Flood Map

A review of the EA's flood map (extract in figure 3 overleaf, full details contained in appendix H) indicates that the development site is located within flood zones 3,
Therefore, the site as indicated is considered to have a high probability of fluvial flooding over some of its area. The EA Flood Zone references and acceptable development types are explained in Table 2.

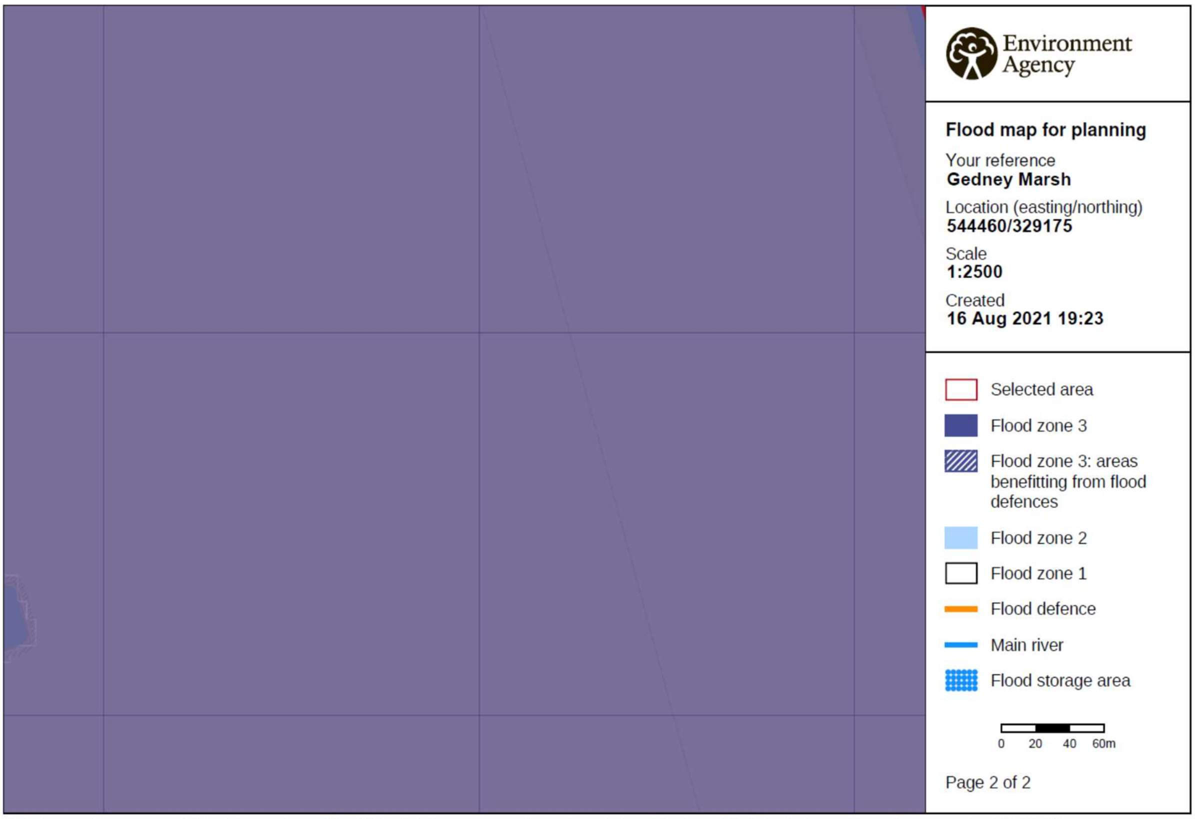


Figure 3 Environmental Agency Map

TABLE 2— FLOOD ZONES, IN PPS25 (Table D.2 of PPS25) LAND IN ENGLAND IS DIVIDED INTO THREE FLOOD RISK ZONES			
Flood Zone	**Probability**	**Explanation**	**Appropriate Land use**
Zone 1	Low	Less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)	All development types generally acceptable.
Zone 2	Medium	Between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% 0.1%) in any year	Most development types are generally acceptable. Exception and Sequential test may be required.
Zone 3a	High	A 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year	Some development types not acceptable. Exception test may be required.
Zone 3b	Functional Floodplain'	This zone comprises land where water has to flow or be stored in times of flood	Some development types not acceptable, Exception may be required.

Existing and Planned Flood Defence Measures

The entire area is protected by Environment Agency Sea flood defences from the Wash.

Current Flood Risk

As noted above the site lies within Flood Zone 3. indicating that the site is currently at risk from flooding from the sea of 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.

Therefore, the site as a whole has a high probability of flooding, and a Sequential test is required to assess the suitability of development on the site.

Table D.3[22]: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception Test required	✔	✔
	Zone 3a	Exception Test required	✔	✗	Exception Test required	✔
	Zone 3b 'Functional Floodplain'	Exception Test required	✔	✗	✗	✗

Key:

✔ Development is appropriate

✗ Development should not be permitted

Given the nature of the development is "Land and buildings used for agriculture and forestry". and deemed less vulnerable it is considered appropriate for siting within Flood Zone 3a as stated in the Technical Guidance to National Planning Policy Framework 2018.

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.
- 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

In addition, within the development it must be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location.
- the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment.
- it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate.
- any residual risk can be safely managed; and safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

In demonstration of compliance with these points, the system as proposed in conjunction with the pre-approved holding reservoir has sufficient capacity to collect and contain all rainfall runoff up to and including a 1 in 100-year event including an allowance for climate change.

This will contain surplus water rather than producing additional runoff and hence will significantly reduce the volumes of water being conveyed by the Internal Drainage Board managed local drainage system.

The pipework network system will collect run off from the roof of the glasshouse and production building and convey to the new 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 Glasshouse enclosure.

The most vulnerable areas would be considered to be the Administration areas and some Production spaces. It is intended to raise the floor levels in the General Office area to protect same potential rising waters and house all critical infrastructure on the First Floor.

The production areas are surrounded in general by a minimum 300mm high concrete kerb which shall act as a bund which shall be augmented at doors by temporary bunds to protect critical equipment. All critical plant shall be elevated on concrete plinths.

The expected attenuation volumes are as outlined in the below SUDS extract

Site characteristics

Total site area (ha):	18
Significant public open space (ha):	0
Area positively drained (ha):	18
Impermeable area (ha):	15
Percentage of drained area that is impermeable (%):	83
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	18
Net impermable area for storage volume design (ha):	15
Pervious area contribution to runoff (%):	0

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:	1.4
Urban creep allowance factor:	1.1
Volume control approach	Use long term storage
Interception rainfall depth (mm):	5
Minimum flow rate (l/s):	2

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
SPR:	0.3	0.3

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	102.41
FEH / FSR conversion factor:	1.33	1.33
SAAR (mm):	566	566
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 10 year:	1.65	1.65
Growth curve factor 30 year:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Q_{BAR} for total site area (l/s):	25.58	25.58
Q_{BAR} for net site area (l/s):	25.58	25.58

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	36	36
1 in 30 years (l/s):	62.7	62.7
1 in 100 year (l/s):	91.1	91.1

Estimated storage volumes

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Attenuation storage 1/100 years (m^3):	15236	15236
Long term storage 1/100 years (m^3):	2701	2701
Total storage 1/100 years (m^3):	17937	17937

The above estimates have been produced by adopting a 100% runoff of area rainfall as derived using the Ih124 methodology.

This indicates that the site will be able to safely store the 1 in 100-year event for the entire site area.

Table 1: 1 in 100-year flood event + 40% climate change

POTENTIAL IMPACT OF OUTFLOW FROM THE SITE

The development will reduce flood risk from rainfall to the surrounding area, since the rainfall from the 14-ha roof will be collected. The structure makes no impact to the residual risk from marine flooding. As outlined above, the system would seek to capture 88 % of 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 via the infiltration trench which surrounds the building structure. 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.

DAMBREAK ASSESSMENT

The 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**

Given the almost flat topography of the site it would be estimated that 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.

6 Conclusions

This Flood Risk Assessment has been carried out to conform to the Environment Agency Standing Advice Development and Flood Risk.

The entire site is located in flood zone 3a, the development is however considered less vulnerable and therefore development is permitted.

The surface water runoff will be collected by two distinct systems with 14 ha or 88% of the entire development being conveyed to a recently approved 45,000m3 Reservoir for use in the irrigation process thus representing a sustainable solution.
The remaining 12% shall be conveyed to existing IDB drains at a discharge rate of 2l/sec, considerably lower than the existing discharge volumes and rates.

The proposed development could generate between 16,000 and 30,000m3 of runoff during the 1 in 100-year flood event (including allowance for climate change), this can be comfortably accommodated within the approved reservoir

There will be minimal displacement of water and no potential for change of the flooding regime either upstream or downstream of the site.

The development has 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.

Operation of the proposed reservoir will not cause flooding downstream or exacerbate any existing issues.