NPPF: Flood Risk Assessment and Drainage Strategy

Land off Fowlmere Road, Foxton

Hill Residential Limited

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Land off Fowlmere Road, Thriplow

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**Executive Summary**

This report presents an FRA in accordance with the NPPF and PPG ID: 7 guidance, for a proposed grain storage facility located on land east of Fowlmere Road, Thriplow.

The report has included an assessment of the surface water drainage requirements of the Site, and details the flood risk and how this could be managed and mitigated to allow the Site to be developed in support of the outline planning application. The FRA has demonstrated the following:

- The Site is 1.8 hectares in area, which comprises agricultural (arable) land.
- The nearest watercourse is a land drain, located approximately 730m to the east of the Site. The Environment Agency flood map shows the Site is within Flood Zone 1. Fluvial (river) flood risk is assessed as negligible.
- Groundwater flood risk is assessed as ‘medium’ to ‘high’ risk.
- The risk of flooding from all other sources is assessed as negligible.
- Flood risk from groundwater flooding can be mitigated to a low and acceptable level through the following approach:
  - No below surface buildings (i.e. basements).
  - Adoption of a surface water management strategy.
  - Set finished floor levels above external levels.
- The proposed grain storage facility is classified as ‘less vulnerable’, which is considered acceptable in terms of flood risk in Flood Zone 1. As such, the Sequential Test should be passed and the Exception Test would not be required.

The FRA has considered the potential impact of the development on surface water runoff rates. These rates have been calculated, and it has been demonstrated that surface water can be managed, such that flood risk to and from the Site following development will not increase. This will be achieved using a wetland area.

The FRA demonstrates that the proposed development would be operated with minimal risk from flooding, and would not increase flood risk elsewhere. The development should therefore not be precluded on the grounds of flood risk or surface water drainage.
1.0 Introduction

1.1 Background

1.1.1 Enzygo Ltd was commissioned by Hill Residential Ltd to carry out a site-specific Flood Risk Assessment (FRA) including a surface water drainage strategy in support of a planning application for a proposed grain storage facility, located on land east of Fowlmere Road, Thriplow (hereafter referred to as ‘the Site’).

1.1.2 The proposal is for a grain storage facility, with associated hardstanding areas. A copy of the proposed layout is in Appendix 1.

1.1.3 Planning applications for development in England require an FRA\(^1\), when:

- In Flood Zone 2 or 3 including minor development and change of use.
- More than 1 hectare (ha) in Flood Zone 1.
- Less than 1 ha in Flood Zone 1, including a change of use in development type to a more vulnerable class (for example from commercial to residential), where they could be affected by sources of flooding other than rivers and the sea (for example surface water, drains, reservoirs).
- In an area within Flood Zone 1 which has critical drainage problems as notified by the Environment Agency.

1.1.4 Environment Agency indicative flood mapping shows that the Site is located within Flood Zone 1 and the Site is more than 1 hectare (ha) in area (1.8ha), and is at risk of groundwater flooding. As such, an FRA is required.

1.1.5 The purpose of this FRA is to provide sufficient flood risk information to demonstrate that the future users of the development remain safe throughout its lifetime, that the development would not increase flood risk on Site and elsewhere and, where practicable, that the development would reduce flood risk overall.

1.2 Scope of the Assessment

1.2.1 Government policy on development and flood risk is set out in the National Planning Policy Framework (NPPF)\(^2\) and the supporting Planning Practice Guidance: Flood Risk and Coastal Change [PPG ID7]\(^3\).

1.2.2 NPPF paragraphs 99-104 set out the need for an appropriate assessment of flood risk at all levels of the planning process and requires the application of a sequential risk-based approach to assess the suitability of land for development in flood risk areas.

1.2.3 The FRA should also consider the effects of climate change\(^4\). The climate change allowances are predictions of anticipated change for:

- Peak river flow by river basin district;
- Peak rainfall intensity;

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- Sea level rise; and
- Offshore wind speed and extreme wave height.

1.2.4 They are based on climate change projections and different scenarios of carbon dioxide emissions to the atmosphere. There are different allowances for different periods of time over the next century.

1.2.5 Site-specific FRAs provide an assessment of the flood risk to and from a development site, over its lifetime, to satisfy the requirements of the local planning authority. They are categorised as Level 1 Screening studies to give a general indication of the potential flood risk to a site and identify whether more detailed Level 2 scoping assessment is required. A Level 2 assessment is a qualitative appraisal to develop understanding of flood risk to a site and the effects of the site on flooding elsewhere including recommended mitigation measures. Level 2 reporting is the minimum required to accord with the NPPF. Level 3 assessments are more detailed quantitative studies, for example modelling to establish flood levels at a site in the absence of Environment Agency data, or providing detailed outline drainage designs.

1.2.6 This report is a Level 2 qualitative FRA but includes a Level 3 assessment of the surface water drainage requirements for the proposed development.

1.3 Aims

1.3.1 This FRA aims to provide sufficient flood risk information to satisfy the requirements of the NPPF, PPG ID7 and regional/local government plans and policies. It describes the potential for the Site to be impacted by flooding, the impacts of the proposed development on flooding elsewhere near the Site, and the proposed measures that could be incorporated into the development to mitigate the identified risks.

1.4 Planning Context

National Policy

1.4.1 The FRA was prepared in accordance with the NPPF and PPG ID7.

Regional/Local Policy

1.4.2 The FRA also considers the following Development Control Policies of South Cambridgeshire District Council:

- **Policy DP/1**: Sustainable Development
- **Policy DP/3**: Development Criteria
- **Policy DP/4**: Infrastructure and New Developments
- **Policy NE/8**: Groundwater
- **Policy NE/9**: Water and Drainage Infrastructure
- **Policy NE/11**: Flood Risk

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1.5  Report Structure

1.5.1  This report is structured as follows:

- Section 2 identifies the sources of information that were consulted;
- Section 3 describes the Site and the existing and proposed development;
- Section 4 outlines the flood risk to the existing site and proposed development;
- Section 5 details the proposed mitigation measures against identified flooding sources;
- Section 6 assesses the potential impacts of the proposed development on surface water drainage and proposes mitigation for those effects; and
- Section 7 presents a summary and conclusions.
2.0 Sources of Information

2.1 Sources of Information

The following information was used in preparation of this FRA:

- Ordnance Survey 1:25,000 mapping (Explorer 209: Cambridge, Royston, Duxford & Linton).
- Detailed topographic survey (Appendix 2).
- River Basin District (RBD) Maps (Anglian RBD) together with guidance on climate change allowances.
- National River Flow Archive.
- South Cambridgeshire District Council Strategic Flood Risk Assessment (SFRA) and associated mapping (Appendix 3).
- Catchment Flood Management Plans (CFMP) 1402 - Final Great Ouse Catchment Flood Management Plan.
- National Soils Resources Institute: Soilscape online mapping.
- Landmark’s Promap: Flood Data package: Additional flood mapping.
- Geosmart 1 in 100-year groundwater flood risk map.
- Anglian Water sewer asset plans (Appendix 4).
- DEFRA’s Magic Map for identifying Designated Sites.

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6 https://flood-map-for-planning.service.gov.uk/
8 http://maps.environment-agency.gov.uk/wiiby/wiibyController?ep=maptopics&lang=_e
10 https://www.gov.uk/guidance/flood-risk-assessments-climate-change_allowances
11 http://nrfa.ceh.ac.uk
13 http://www.landis.org.uk/soilscape/
14 http://mapapps.bgs.ac.uk/geologyofbritain/home.html
15 http://www.natureonthemap.naturalengland.org.uk/
2.2 Consultation and Discussion with Regulators

2.2.1 Consultation and discussions were undertaken with the Environment Agency, the Local Planning Authority (LPA)/Lead Local Flood Authority (LLFA), and Water Utility.

Environment Agency

2.2.2 The Environment Agency is a statutory consultee on flood risk and planning and is directly responsible for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas; and it has a strategic overview for all forms of flooding.

2.2.3 Environment Agency Standing Advice\textsuperscript{16} and the NPPF/PPG ID: 7 was consulted and reviewed.

2.2.4 Correspondence with the Environment Agency is included in Appendix 5.

Lead Local Food Authority

2.2.5 Cambridgeshire County Council as the LLFA responsible for surface water, groundwater and ordinary watercourses was consulted on flood risk issues at this Site. At the time the report was written a consultation response had not been received.

Water Utility

2.5.2 All Water Companies have a statutory obligation to maintain the DG5 Flood Register of properties which are at risk of flooding from the public sewerage system.

2.5.3 Anglian Water is responsible for the disposal of wastewater within the area. A copy of the asset plan is included in Appendix 4.

2.3 Site Walkover

2.3.1 Enzygo staff conducted a walkover of the Site during August 2017. Observations made were used to inform the Site description.

\textsuperscript{16} https://www.gov.uk/guidance/flood-risk-assessment-standing-advice
3.0 Site Location and Description

3.1 Location

3.1.1 The Site is located on land east of Fowlmere Road, Thriplow, Cambridgeshire, CB22 6TA.

3.1.2 The Site is centred on National Grid Reference (NGR) 542184, 247142.

3.1.3 The Site location is shown in Drawing 001 and in more detail in Drawing 002, which shows the red line boundary enclosing an area of 1.8ha.

3.2 Existing Use

3.2.1 The current land use comprises agricultural (arable) land (Figure 3.1).

Figure 3.1: Photograph of Site

View looking east across site from Fowlmere Road

3.2.2 The Site is bounded by Fowlmere Road to the west and arable agricultural land to the north, east and south.

3.2.3 The Site is currently accessed along the western boundary, via Fowlmere Road.

3.3 Topographic Information

3.3.1 The topographic survey shows the Site is relatively flat. The Site falls gently in a north-easterly direction from a topographic high of 19.88m AOD (towards the south-west corner) to a topographic low of 19.31m AOD (towards the north-east corner). This is a fall of 0.57m over approximately 175m (1:307).

3.4 Catchment Hydrology

3.4.1 The Site lies in the catchment of the Hoffer Brook, which passes within 1.05km of the Site to the north at its closest point. The Hoffer Brook is a tributary of the River Cam (3km north), which in turn is a tributary of the River Great Ouse, where it joins south of Ely. The River Great Ouse is part of the larger Anglian River Basin District.
3.4.2 Environment Agency online flood mapping and Ordnance Survey Mapping (Drawing 002) identifies there are no ‘main rivers’ (where flood risk work is carried out by the Environment Agency) within the vicinity of the Site.

3.4.3 There is an ‘ordinary watercourse’ (where flood risk work is carried out by local drainage authority/riparian landowner) conveying flows eastwards, approximately 730m to the east of the Site. The drain eventually converges with the Hoffer Brook approximately 1.35km to the north of the Site.

3.4.4 During the site walkover, the land drain was observed to be informal, heavily vegetated and carrying no flows (Figure 3.2).

Figure 3.2: Land drain to north of Site

3.5 Sewerage Assets

3.5.1 Anglian Water asset plans show no sewers located within the Site. To the west of the Site a rising foul sewer flows northwards along Fowlmere road.

3.6 Soils and Geology

i. Online Mapping

3.6.1 The Soilscape online soils map viewer shows that the Site is underlain by freely draining loamy soils.

3.6.2 The Geology of Britain online map viewer shows that there are no superficial deposits beneath the Site. The bedrock beneath the Site is Zig Zag Chalk Formation.

ii. Soakaway Testing

3.6.3 Soakaway testing (Appendix 6) found the Site’s geology to be reflective of the online mapping and borehole log.
3.6.4 No groundwater was encountered within either soakaway.

3.7 Hydrogeology

3.7.1 The Geology of Britain online map viewer shows boreholes located 50m to the west of the Site. Borehole logs show chalk between 0.5m - 26m, Marl between 26 - 37m and Clay for the remainder of the borehole log to 38m. Copies of the borehole logs are included in Appendix 7.

3.7.2 The Environment Agency online groundwater mapping show the Site is located outside the Groundwater Sources Protection Zone.

3.8 Designated Sites

3.8.1 The DEFRA Magic Map (England and Wales)\(^\text{17}\) shows there are no designated sites in or close to the Site including downstream (from a flood risk and drainage perspective).

3.8.2 The Site and wider area is located within a Nitrate Vulnerable Area (NVA).

\(^{17}\) http://www.natureonthemap.naturalengland.org.uk/MagicMap.aspx
4.0 Flood Risk Assessment

4.1 Potential Sources of Flooding

4.1.1 A summary of the potential sources of flooding and the potential risk posed by each source at the Site is presented in Table 4.1. Each source of flooding and level of risk is then assessed in further detail.

<table>
<thead>
<tr>
<th>Flooding Source</th>
<th>Potential Flood Risk at Application Site (Yes/No)</th>
<th>Potential Source</th>
<th>Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluvial</td>
<td>No</td>
<td>Unnamed land drain</td>
<td>Surface Water Features (Drawing 002), Environment Agency flood mapping (Drawing 005) and SFRA mapping.</td>
</tr>
<tr>
<td>Tidal</td>
<td>No</td>
<td>None identified</td>
<td>Surface Water Features (Drawing 002), Environment Agency flood mapping (Drawing 005) and SFRA mapping.</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Yes</td>
<td>Aquifer</td>
<td>BGS mapping (Drawing 003), Geosmart Groundwater (Drawing 006), BGS borehole log, soakaway testing and SFRA mapping.</td>
</tr>
<tr>
<td>Surface Water</td>
<td>No</td>
<td>Poor permeability</td>
<td>Environment Agency online flood mapping, JBA (Drawing 004.1) and SFRA mapping.</td>
</tr>
<tr>
<td>Sewer</td>
<td>Yes</td>
<td>Public sewers</td>
<td>Anglian Water asset plans and SFRA mapping.</td>
</tr>
<tr>
<td>Infrastructure Failure</td>
<td>No</td>
<td>Reservoir failure</td>
<td>Environment Agency online flood mapping.</td>
</tr>
</tbody>
</table>

4.2 Fluvial Flooding

*Environment Agency*

4.2.1 The Flood Zones are the current best information on the extent of the extremes of flooding from rivers or the sea that would occur without the presence of flood defences, since these can be breached, overtopped and may not be in existence for the lifetime of a development.

4.2.2 The Environment Agency online flood map shows the Site is located within Flood Zone 1; outside the 1 in 1000-year probability of fluvial (river) flooding (0.1% Annual Exceedance Probability [AEP]). The Site is assessed as being at ‘low’ risk of fluvial flooding.

*SFRA Mapping*

4.2.3 The SFRA mapping confirms the Site is located within Flood Zone 1 and shows that there have been no historical fluvial flood events within the Site boundary.
Flood Defences

4.2.4 Environment Agency online flood mapping shows that the Site does not benefit from flood defences.

Flood Warning

4.2.5 Environment Agency online flood mapping shows the Site is not located within an area which received flood warnings.

Flood Risk

4.2.6 The risk of fluvial flooding is assessed as negligible.

4.3 Tidal Flooding

4.3.1 The Site is located close to tidally affected flooding sources and so the flood risk from this source is assessed as negligible.

4.4 Groundwater Flooding

4.4.1 Groundwater flooding occurs when subsurface water emerges either at surface or in made ground or in subsurface structures such as basements and services ducts. It occurs as diffuse seepage, emergence from new point source springs or an increase in flow from existing springs. It results from aquifer recharge from infiltrating rainfall, from sinking streams entering aquifers from adjacent non-aquifers, or from high river levels or tides driving water through near surface deposits. It tends to occur with a delay following rainfall and can last for several weeks or months. Groundwater flooding or shallow water tables also prevent or reduce infiltration and so can worsen surface water flooding.

BGS Groundwater Flooding Susceptibility Map

4.4.2 The BGS Groundwater Flooding Susceptibility Map (Drawing 003) data does not cover the Site. However, the immediate vicinity of the Site has potential for groundwater flooding to occur at the surface.

Geosmart Groundwater Flood Risk Map

4.4.3 The Geosmart 1 in 100-year groundwater flood risk map (Drawing 006) shows that the Site is at ‘moderate’ to ‘high’ risk of groundwater flooding. The risk of groundwater flooding is likely to be linked to the underlying chalk bedrock.

4.4.4 Mapped classes combine understanding of likelihood, model and data uncertainty, and possible severity. Likelihood is ranked according to whether we expect groundwater flooding at a site due to extreme elevated groundwater levels with an annual probability of occurrence greater than 1%, considering model and data uncertainty. Severity relates to expectations of the amount of property damage or other harm that groundwater flooding at that location might cause (Table 4.2).
Table 4.2: Groundwater flood risk classification

<table>
<thead>
<tr>
<th>Risk Class</th>
<th>Probability of Groundwater Flooding</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>4: Negligible</td>
<td>Annual probability less than 1%</td>
<td>Negligible unless unusually sensitive use.</td>
</tr>
<tr>
<td>3: Low</td>
<td>Annual probability greater than 1%</td>
<td>Remote possibility of damage to property or harm to sensitive receptors. Flooding likely to be limited to seepages and waterlogged ground, damage to basements and subsurface infrastructure, and should pose no significant risk to life. Surface water flooding may be worsened.</td>
</tr>
<tr>
<td>2: Moderate</td>
<td>Annual probability greater than 1%</td>
<td>Significant possibility of damage to property or harm to other sensitive receptors at or near this location. Flooding is likely to be in the form of shallow pools or streams. Surface water flooding and failure of drainage systems may be worsened when groundwater levels are high.</td>
</tr>
<tr>
<td>1: High</td>
<td>Annual probability greater than 1%</td>
<td>Groundwater flooding will occur which could lead to damage to property or harm to other sensitive receptors at or near this location. Flooding may result in damage to property, road or rail closures and, in exceptional cases, may pose a risk to life. Surface water flooding and failure of drainage systems may be worsened when groundwater levels are high.</td>
</tr>
</tbody>
</table>

**BGS Borehole Log and Soakway Testing**

4.4.5 Borehole Log taken adjacent to the Site struck groundwater at 5.5m below ground level and as such, is unlikely to rise to the surface. Soakaway testing encountered no groundwater. However, this data source provides no temporal information on groundwater level variation.

**SFRA Mapping**

4.4.6 A review of the SFRA report shows no recorded groundwater flooding incidents located within the Site boundary.

**Flood Risk**

4.4.7 The risk of groundwater flooding is assessed as high.

4.4.8 Mitigation measures against groundwater flooding are discussed in Section 5.
4.5 Surface Water Flooding

**Introduction**

4.5.1 Surface water flooding occurs following rainfall on ground where infiltration rates are less than the rainfall precipitation rate. This can occur when either:

- Soils or ground materials are naturally of low permeability or have been compacted (infiltration excess runoff);
- Soils or ground materials are saturated from previous rainfall either directly or from upslope (saturation excess runoff and return flow).

**JBA Surface Water Flood Map**

4.5.2 The JBA Surface Water Flood Map (Drawing 004) shows that the Site is located outside the mapped extent of surface water flooding.

**Environment Agency Online Flood Map**

4.5.3 The Environment online flood map Agency Map (Figure 4.1) shows that the Site is located outside the mapped extent of surface water flooding.

![Figure 4.1: Flood Risk from Surface Water](image)

**SFRA Mapping**

A review of the SFRA report shows no recorded surface water flooding incidents located within the Site boundary.
Flood Risk

4.5.4 The risk of surface water flooding is assessed as negligible.

4.6 Sewer Flooding

4.6.1 Sewer flooding occurs when urban drainage networks become overwhelmed after heavy or prolonged rainfall due to restrictions or blockage in the sewer network or if the volume of water draining into the system exceeds the sewer design capacity.

4.6.2 New sewers are built to the guidelines within Sewers for Adoption\(^\text{18}\) and have a design standard to the 1 in 30-year flood event. Older sewers were not designed to any particular standard. Modern sewer systems will only surcharge during rainstorm events with a return period greater than 1 in 30-years (e.g. 1 in 100-years).

4.6.3 There is a rising foul main located within Fowlmere road to the west of the Site. A review of the SFRA report shows no recorded sewer flooding incidents located within the Site boundary. The risk of flooding from sewers is assessed as negligible.

4.7 Flooding from Infrastructure Failure

Reservoir

4.7.1 The Environment Agency online flood mapping shows the Site is located outside the extent of flooding sourced from reservoirs. The risk of flooding from reservoirs is assessed as negligible.

5.0 Flood Risk Mitigation Measures

5.1 Introduction

5.1.1 The following sources of flooding were identified:
- Groundwater flooding.

5.2 Mitigation Measures

5.2.1 Groundwater flood risk can be mitigated to a low and acceptable level through the following approach:
- No below surface buildings (i.e. basements).
- Adoption of a surface water management strategy.
- Set finished floor levels a minimum of +150mm above external levels.

5.3 Summary of Flood Risk

5.3.1 Table 5.1 summarises the probability and level of risk, both with and without mitigation measures.

Table 5.1: Probability and consequences of all sources of flooding

<table>
<thead>
<tr>
<th>Flooding Source</th>
<th>Potential Source</th>
<th>Probability</th>
<th>Consequence &amp; Impact Without Mitigation</th>
<th>Consequence &amp; Impact with Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluvial</td>
<td>Land Drain</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Tidal</td>
<td>None</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Aquifer</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Surface Water</td>
<td>None</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Sewer</td>
<td>Public sewers</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Infrastructure Failure</td>
<td>Reservoir Failure</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
</tbody>
</table>

Key: Green - Negligible, Yellow - Low, Orange - Medium and Red - High; based on consequence and impact with mitigation from each flooding source.

5.4 Flood Guidance and Sequential Test

5.4.1 The proposal is for a grain storage facility. Table 2 of PPG ID: 7 (not included in this report) classifies the proposed use as ‘less vulnerable’.

5.4.2 The Environment Agency Flood Zones and acceptable development types are listed in Table 5.2. All development types (including less vulnerable uses) are acceptable in Flood Zone 1 (low...
risk). As such, the Sequential Test would be passed and the Exception Test would not be required as indicated in Table 5.3.

Table 5.2: Environment Agency Flood Zones and Appropriate Land Use

<table>
<thead>
<tr>
<th>Flood Zone</th>
<th>Probability</th>
<th>Explanation</th>
<th>Appropriate Land use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>Low</td>
<td>Less than 1 in 1000 annual probability of river or sea flooding in any year (&lt;0.1%).</td>
<td>All development types generally acceptable.</td>
</tr>
<tr>
<td>Zone 2</td>
<td>Medium</td>
<td>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.</td>
<td>Most development type are generally acceptable.</td>
</tr>
<tr>
<td>Zone 3a</td>
<td>High</td>
<td>A 1 in 100 or greater annual probability of river flooding (&gt;1%) or a 1 in 200 or greater annual probability of flooding from the sea (&gt;0.5%) in any year.</td>
<td>Some development types not acceptable.</td>
</tr>
<tr>
<td>Zone 3b ‘Functional Floodplain’</td>
<td></td>
<td>Land where water must flow or be stored in times of flood. SFRAs should identify this zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1% flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).</td>
<td>Some development types not acceptable.</td>
</tr>
</tbody>
</table>

Note: The Flood Zones are the current best information on the extent of the extreme flood from rivers or the sea that would occur without the presence of flood defences, because these can be breached, overtopped and may not be in existence for the lifetime of the development. The identified risk of fluvial flooding is highlighted green.

Table 5.3: Vulnerability and Flood Zone ‘Compatibility’ as identified in Table 3 of PPG ID: 7

<table>
<thead>
<tr>
<th>Flood Risk Vulnerability classification (see Table 1 of PPG ID: 7)</th>
<th>Essential Infrastructure</th>
<th>Water Compatible</th>
<th>Highly Vulnerable</th>
<th>More Vulnerable</th>
<th>Less Vulnerable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone 2</td>
<td>Yes</td>
<td>Yes</td>
<td>Exception test required</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone 3a</td>
<td>Exception test required</td>
<td>Yes</td>
<td>No</td>
<td>Exception test required</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone 3b ‘Functional Floodplain’</td>
<td>Exception test required</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Key: Yes: Development is appropriate, No: Development should not be permitted. The identified risk of fluvial flooding is highlighted green.
6.0 Site Drainage

6.1 Surface Water Drainage

6.1.1 Consideration of flood issues is not confined to the floodplain. This is recognised in the NPPF and associated guidance where all proposed development of 1ha or more in Flood Zone 1 and so outside the floodplain nevertheless requires an FRA. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in a catchment, particularly flooding downstream; and replacing permeable vegetated areas with low permeability roofs, roads and other paved areas will increase the speed, volume and peak flow of surface water runoff.

6.1.2 A surface water management strategy for the development is proposed to manage and reduce the flood risk posed by surface water runoff from the Site. The developer will be required to ensure that any scheme for surface water should build in sufficient capacity for the entire Site.

6.1.3 The surface water drainage arrangements for any development Site should be such that the volume and peak flow rates of surface water leaving a developed Site are no greater than the rates prior to the proposed development, unless specific off-Site arrangements are made and result in the same net effect.

6.1.4 An assessment of the surface water runoff rates was undertaken to determine the surface water options and attenuation requirements for the Site.

6.2 Existing Drainage System

6.2.1 The Site is 1.8ha in area and current land use comprises agricultural (arable) fields. There is currently no formal surface water drainage serving the Site.

6.2.2 The Site is underlain by permeable soils and bedrock. It is likely that drainage is predominantly via infiltration to bedrock, with a small amount of overland flow, following the topography of the Site to the topographic low points, and throughflow to watercourse.

6.3 Proposed Development

6.3.1 The proposal is for a grain storage facility.

6.3.2 A figure of 48% impermeable area was applied to the 1.8ha Site (Drawing 008). The existing and proposed impermeable areas are shown in Table 6.1.

<table>
<thead>
<tr>
<th>Area</th>
<th>Existing Buildings and Hardstanding</th>
<th>Proposed Buildings and Hardstanding</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (ha)</td>
<td>0</td>
<td>0.87</td>
<td>+0.87</td>
</tr>
<tr>
<td>Percentage of Total Site Area (%)</td>
<td>0</td>
<td>48</td>
<td>+48</td>
</tr>
</tbody>
</table>

6.3.3 The proposed development will increase the impermeable surfaces and therefore increase the amount of runoff.
6.4 Greenfield Runoff Rates

6.4.1 An assessment of greenfield runoff rates was undertaken to determine the attenuation requirements for the proposed development.

6.4.2 The runoff rates were calculated using Microdrainage design software using the current ‘industry best practice’ guidelines as outlined in the Interim Code of Practice for SUDS\textsuperscript{19}, and the Environment Agency Report SC030219 – Rainfall runoff management for developments. The recommended methodology for Sites up to 50 hectares in area is the ICP SUDS method.

6.4.3 The following parameters were used in the runoff calculations:

- Impermeable Area: 0.87ha
- Average Annual Rainfall (SAAR): 539 mm/year;
- Soil: 0.3;
- Impermeable Areas: 48% (0.87ha)
- Region No.: 5

6.4.4 While the HR Wallingford greenfield runoff rate estimation tool uses a specific SOIL type of 0.1, soakaway testing within the Site recorded less permeable soils. Therefore, a specific SOIL type of 0.3 (Figure 6.1) was used.

![Figure 6.1: Soil Index (Sourced from Microdrainage)](image)

6.4.5 Table 6.2 shows the calculated greenfield runoff rates. Extracts from Microdrainage calculations are included in Appendix 8.

\textsuperscript{19} Office of the Deputy Prime Minister, National SUDS Working Group, July 2004, Interim Code of Practice for sustainable drainage systems.
Table 6.2: Greenfield Runoff Rates

<table>
<thead>
<tr>
<th>Annual Probability (Return Period, years)</th>
<th>Greenfield Runoff (l/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QBAR</td>
<td>3.6</td>
</tr>
<tr>
<td>50% (2)</td>
<td>3.2</td>
</tr>
<tr>
<td>3.33% (30)</td>
<td>8.9</td>
</tr>
<tr>
<td>1% (100)</td>
<td>12.9</td>
</tr>
<tr>
<td>1% + Climate Change</td>
<td>18.1</td>
</tr>
</tbody>
</table>

*Note: 40% added to the data to account for long-term climate change as stated in ‘Flood Risk Assessment: Climate Change Allowance’. The 1 in 2-year, 30-year and 100-year annual probability events are of importance to the Water Companies and the Environment Agency when looking at sewage discharge and flood risk.*

6.5 Sustainable Drainage Options (SUDS)

i. Feasibility of SuDS

5.6.1 Soakaway testing was undertaken during August 2017. A copy of the Infiltration Test Report is included in Appendix 6. Findings from the infiltration-based SUDS were inconclusive due to time constraints.

5.6.2 Locally sourced information from a Phase 1 geo-environmental report found conservative infiltration rates from falling head tests to be between 1.2x10^-7 and 2.5x10^-7 m/s within the same bedrock, indicating low permeability.

ii. Choice of SuDS Options

6.5.1 Sustainable water management measures should be used to control the surface water runoff from the proposed development Site, thereby managing the flood risk to the Site and surrounding areas from surface water runoff. These measures will also improve the quality of water discharged from the Site.

6.5.2 Current guidance promotes sustainable water management using SuDS. Options applicable to this Site are identified in Table 6.3.

<table>
<thead>
<tr>
<th>Green roofs</th>
<th>Infiltration basins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water butts</td>
<td>Detention basins</td>
</tr>
<tr>
<td>Permeable paving</td>
<td>Oversized pipes</td>
</tr>
<tr>
<td>Rainwater harvesting</td>
<td>Brown roofs</td>
</tr>
<tr>
<td>Filter strips</td>
<td>Swales</td>
</tr>
<tr>
<td>Wetland Areas</td>
<td>Cellular Storage</td>
</tr>
</tbody>
</table>

*Note: SUDS appropriate to the development are highlighted green.*
6.5.3 A hierarchy of SuDS techniques is identified:\(^{20}\):

1. **Prevention** – the use of good Site design and housekeeping measures on individual Sites to prevent runoff and pollution (e.g. minimise areas of hard standing).

2. **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting).

3. **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole Site).

4. **Regional Control** – management of runoff from several Sites, typically in a detention pond or wetland.

6.5.4 Using SUDS as opposed to conventional drainage systems provides several benefits by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed Sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open spaces and wildlife habitat; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

**iii. SuDS Maintenance**

6.5.5 An wetland area will form the main attenuation feature within the development Site.

6.5.6 Maintenance of the SUDS features would be in line with the SUDS Manual (CIRIA C753, 2015), as detailed in Figure 6.1. The maintenance would be undertaken by a private maintenance company.

6.5.7 Details of other SUDS features and maintenance would be considered further at detailed design, when a detailed layout has been produced. The level of detailed provided within this FRA should be sufficient at outline stage to demonstrate that SUDS would be deliverable.

---

Figure 6.1: Operation and Maintenance Requirements of Wetland Areas (Table 23.1 of the SUDS Manual)

<table>
<thead>
<tr>
<th>TABLE 23.1</th>
<th>Operation and maintenance requirements for ponds and wetlands</th>
<th>Typical frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance schedule</td>
<td>Required action</td>
<td></td>
</tr>
<tr>
<td>Regular maintenance</td>
<td>Remove litter and debris</td>
<td>Monthly (or as required)</td>
</tr>
<tr>
<td></td>
<td>Cut the grass – public areas</td>
<td>Monthly (during growing season)</td>
</tr>
<tr>
<td></td>
<td>Cut the meadow grass</td>
<td>Half yearly (spring, before nesting season, and autumn)</td>
</tr>
<tr>
<td></td>
<td>Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)</td>
<td>Monthly (at start, then as required)</td>
</tr>
<tr>
<td></td>
<td>Inspect inlets, outlets, banksides, structures, pipework etc for evidence of blockage and/or physical damage</td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td>Inspect water body for signs of poor water quality</td>
<td>Monthly (May – October)</td>
</tr>
<tr>
<td></td>
<td>Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options</td>
<td>Half yearly</td>
</tr>
<tr>
<td></td>
<td>Check any mechanical devices, e.g. peristocks</td>
<td>Half yearly</td>
</tr>
<tr>
<td></td>
<td>Hand out submerged and emergent aquatic plants (at minimum of 0.1 m above pond base; include max 25% of pond surface)</td>
<td>Annually</td>
</tr>
<tr>
<td></td>
<td>Remove 25% of bank vegetation from water’s edge to a minimum of 1 m above water level</td>
<td>Annually</td>
</tr>
<tr>
<td></td>
<td>Tidy all dead growth (scrub clearance) before start of growing season (Note: tree maintenance is usually part of overall landscape management contract)</td>
<td>Annually</td>
</tr>
<tr>
<td></td>
<td>Remove sediment from any forebay.</td>
<td>Every 1–5 years, or as required</td>
</tr>
<tr>
<td></td>
<td>Remove sediment and planting from one quadrant of the main body of ponds without sediment forebays.</td>
<td>Every 5 years, or as required</td>
</tr>
<tr>
<td>Occasional maintenance</td>
<td>Remove sediment from the main body of big ponds when pool volume is reduced by 20%</td>
<td>With effective pre-treatment, this will only be required rarely, e.g. every 25–50 years</td>
</tr>
<tr>
<td>Remedial actions</td>
<td>Repair erosion or other damage</td>
<td>As required</td>
</tr>
<tr>
<td></td>
<td>Replant, where necessary</td>
<td>As required</td>
</tr>
<tr>
<td></td>
<td>Aerate pond when signs of eutrophication are detected</td>
<td>As required</td>
</tr>
<tr>
<td></td>
<td>Realign rip-rap or repair other damage</td>
<td>As required</td>
</tr>
<tr>
<td></td>
<td>Repair / rehabilitate inlets, outlets and overflows.</td>
<td>As required</td>
</tr>
</tbody>
</table>
6.6 Surface Water Management Strategy

i. Hierarchy of Discharge

6.6.1 In accordance with requirement H3 of the Building Regulations 200021 rainwater runoff must discharge to one of the following, listed in order of priority:

1. An adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable: The use of infiltration based SUDs is feasible with a conservative figure of 2.5x10-7 m/s deemed appropriate for the geology type.

2. A watercourse; or where that is not reasonably practicable: There are no land drains within the immediate vicinity of the Site.

3. A sewer: There are no public surface water sewers located within the immediate vicinity of the Site.

6.6.2 The potential route to discharge from the Site will be to a wetland area.

ii. Drainage Design

6.6.3 Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

6.6.4 Landscaped areas should be incorporated into the layout where possible, and the associated gardens of each unit will allow a proportion of the rainfall to infiltrate into the soil substrate.

6.6.5 It is recommended that surface water will be managed by a wetland area. The wetland area will be designed to attenuate the 7-day storm event from the Site.

6.6.6 The following input parameters were assumed in the calculations:

- Impermeable Area: 0.87ha
- Cv (proportion of rainfall forming surface water runoff): 75% summer, 84% winter,
- Infiltration losses: 2.5x10-7m/s.

6.6.7 The wetland area will provide enough volume required to attenuate the 1in 100year+40% CC storm event (Drawing 010).

6.6.8 The surface water runoff from the Site currently infiltrates at source/sheds overland. As such the introduction of an wetland area to attenuate the small increase in impermeable area will improve existing conditions (Drawing 009).

6.6.9 Furthermore, if the flooding was to occur the exceedance route would follow the topography to the north, shedding onto adjacent fields as per existing conditions.

6.7 Foul Drainage

6.7.1 The proposal is a for a grain storage facility, as such it is anticipated no foul flows will arise from the proposed development, therefore no foul drainage would be required.

---

7.0 Summary and Conclusions

7.1 Introduction

7.1.1 A site-specific Flood Risk Assessment (FRA) has been undertaken for the proposed grain storage facility development, located on a 1.8ha Site on land east of Fowlmere Road, Thriplow, Cambridgeshire.

7.2 Flood Risk

7.2.1 The risk of fluvial and surface water flooding is assessed as negligible.
7.2.2 The risk of groundwater flooding is assessed as high.
7.2.3 The risk of flooding from all other sources is assessed as negligible.

7.3 Mitigation Measures

7.3.1 Groundwater flooding can be mitigated to a negligible level through the following approach:
   - No below surface buildings (i.e. basements).
   - Adoption of a surface water management strategy.
   - Set finished floor levels a minimum of +150mm above external levels.

7.4 Flood Guidance

7.4.1 The proposed grain storage facility use is classified as ‘less vulnerable’.
7.4.2 All development is acceptable within Flood Zone 1. As such, the Sequential Test will be passed and the Exception Test would not be required.

7.5 Site Drainage

   Surface Water

7.5.1 The proposed development will increase the impermeable surfaces and therefore increase the amount of runoff.
7.5.2 A SuDS drainage scheme is proposed to manage excess runoff from the development, comprising a wetland area.
7.5.3 The wetland area would attenuate the 1 in 100 year +40% CC storm event.

7.6 Conclusion

7.6.1 This FRA demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of national policy and guidance.
7.6.2 The development should not therefore be precluded on the grounds of flood risk and surface water drainage.
Key
- Site Boundary
- Potential for Groundwater Flooding to Occur at Surface
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Limited Potential for Groundwater Flooding to Occur

Potential for Groundwater Flooding to Occur at Surface
Limited Potential for Groundwater Flooding to Occur
Potential for Groundwater Flooding of Property Situated Below Ground Level
Limited Potential for Groundwater Flooding to Occur
Geological Indicators of Flooding
(based on geological deposits)

Client: Hill

Scale: 1:5,000 @ A3

Date: Sept 2017

Project Reference: SHF.1027.002

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