APPENDIX 3 – FLOOD MANAGEMENT

Project:	**Aberford Masterplan**	Job No:	**60188363**
Subject:	**Flood Risk Management Section of Aberford Masterplan**		
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1 Flood Risk

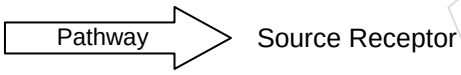
1.1 Introduction

Flood risk takes account of both the probability and the consequences of flooding.

Flood risk = probability of flooding x consequence of flooding

Probability is usually interpreted in terms of the return period, e.g. 1 in 100 and 1 in 200 year event etc. In terms of probability, there is a 1 in 100 (1%) chance of one or more 1 in 100 year floods occurring in a given year. The consequence of flooding depends on how vulnerable a receptor is to flooding.

The components of flood risk can be considered using the source-pathway-receptor model.



Sources constitute flood hazards, which are anything with the potential to cause harm through flooding (e.g. rainfall, extreme sea levels, river flows and canals). Pathways represent the mechanism by which the flood hazard would cause harm to a receptor (e.g. overtopping and failure of embankments and flood defences, inadequate drainage and inundation of floodplains). Receptors comprise of the people, property, infrastructure and ecosystems that could potentially be affected should a flood occur.

1.2 Flood Risk Planning Policy

Planning Policy Statement 25 (PPS25): Development and Flood Risk (Communities and Local Government, 2010) is the current planning policy on flood risk in England. PPS25 is supplemented by 'Development and Flood Risk: A Practice Guide' (Communities and Local Government, 2009) and together these documents provide guidance on how to evaluate sites with respect to flood risk.

A summary of the requirements of PPS25 is provided below.

1.2.1 Sources of Flooding

PPS25 requires an assessment of flood risk to consider all forms of flooding, and lists six forms of flooding that should be considered. These forms of flooding are listed in Table 1, along with an explanation of each form of flooding.

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Table 1: Forms of Flooding (Extract from PPS25, Annex C)

Flooding From Rivers (Fluvial)
Watercourses flood when the amount of water in them exceeds the flow capacity of the river channel. Flooding can either develop gradually or rapidly, depending on the characteristics of the catchment. Land use, topography and the development can have a strong influence on flooding from rivers.
Flooding From the Sea (Tidal)
Flooding to low-lying land from the sea and tidal estuaries is caused by storm surges and high tides. Where tidal defences exist, they can be overtopped or breached during a severe storm, which may be more likely with climate change.

Flooding from Land (Pluvial)
Intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems can run quickly off land and result in local flooding. In developed areas, this flood water can be polluted with domestic sewage where foul sewers surcharge and overflow. Local topography and built form can have a strong influence on the direction and depth of flow. The design of development down to a micro-level can influence or exacerbate this. Overland flow paths should be taken into account in spatial planning for urban developments. Flooding can be exacerbated if development increases the percentage of impervious area.
Flooding from Groundwater
Groundwater flooding occurs when groundwater levels in the rise above ground level (i.e. groundwater issues) and is most is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). Chalk is the most extensive source of groundwater flooding.
Flooding from Sewers
In urban areas, rainwater is frequently drained into sewers. Flooding can occur when sewers are overwhelmed by heavy rainfall, and become blocked. Sewer flooding continues until the water drains away.
Flooding from Other Artificial Sources (i.e. reservoirs, canals, lakes and ponds)
Non-natural or artificial sources of flooding can include reservoirs, canals and lakes. Reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

1.2.2 Flood Zones

For river and sea flooding, PPS25 uses four Flood Zones to characterise flood risk. These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences, and are detailed in Table 2 on the following page.

Table 2: Flood Zones (Adapted from PPS25, Table D.1)

Flood Zone	Definition
1	Low probability (less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%))
2	Medium probability (between 1 in 100 and 1 in 1,000 annual probability of river flooding (1%-0.1%)or between 1 in 200 and 1 in 1,000 annual probability of sea flooding(0.5%-0.1%) in any year).
3a	High probability (1 in 100 or greater annual probability of river flooding (>1%)in any year or 1 in 200 or greater annual probability of sea flooding (>0.5%) in any given year).
3b	This zone comprises land where water has to flow or be stored in times of flood. Land which would flood with an annual probability of 1 in 20 (5%), or is designed to flood in an extreme flood (0.1%) should provide a starting point for discussions to identify functional floodplain.

1.2.3 Vulnerability

PPS25 classifies the vulnerability of developments to flooding into five categories. These categories are detailed in Table 3.

Table 3: Flood Risk Vulnerability Classification (Adapted from PPS25, Table D.2)

Flood Risk Vulnerability Classification	Examples of Development Types
Essential Infrastructure	- Transport Infrastructure - Utility Infrastructure (e.g. water treatment works and wind turbines)
Water Compatible	- Flood Control Infrastructure - Water and Sewerage Infrastructure - Navigation Facilities
Highly Vulnerable	- Emergency Services - Basement Dwellings - Mobile home parks
More Vulnerable	- Hospitals and other health services - Residential Establishments - Educational Establishments
Less Vulnerable	- Commercial Establishments (e.g. shops, restaurants and offices)

Based on the vulnerability of a development, PPS25 states what Flood Zone(s) the development is appropriate within. The flood risk vulnerability and Flood Zone 'compatibility' of developments is summarised in Table 4 below.

Table 4: Flood Risk Vulnerability and Flood Zone Compatibility (Extract from PPS25, Table D.3)

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test	✓	✓
	3a	Exception Test	✓	×	Exception Test	✓
	3b	Exception Test	✓	×	×	×

1.2.4 The Sequential Test, Exception Test and Sequential Approach

The Sequential Test is a risk-based test that should be applied at all stages of development and aims to steer new development to areas with the lowest probability of flooding (Zone 1). This is applied by the Local Planning Authority by means of a Strategic Flood Risk Assessment (SFRA).

The SFRA and PPS25 may require the Exception Test to be applied to certain forms of new development. The test considers the vulnerability of the new development to flood risk and, to be passed, must demonstrate that:

- There are sustainability benefits that outweigh the flood risk;
- It is on previously developed land or there are no other suitable previously developed sites in lower flood risk zones; and
- The new development is safe and does not increase flood risk elsewhere.

The Sequential Approach is also a risk based approach to development. In a development site located in several Flood Zones or with other flood risks, the sequential approach directs the most vulnerable types of development towards the areas of least risk within the site.

1.2.5 Climate Change

PPS25 makes it a planning requirement to account for climate change in the proposed design. The recommended allowances are summarised in Table 5 below.

Table 5: Climate Change Allowances (Extract from PPS25, Table B.2)

Parameter / Horizon	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

1.2.6 Sustainable Drainage

The key planning objectives in PPS25 are to appraise, manage and where possible, reduce flood risk. Sustainable Drainage Systems (SuDS) provide an effective way of achieving some of these objective, and PPS25 and Part H of the Building Regulations (DTLR, 2002) directs developers towards the use of SuDS wherever possible.

PPS25 and Part H of the Building Regulations state a hierarchy of where surface water should be discharged. This should be followed were practicable, and is listed below:

1) Infiltration
2) Watercourses
3) Public Sewers

1.3 Consultation

The Environment Agency and Leeds City Council have both been consulted as part of the flood risk work. However, we are currently awaiting a response from the Environment Agency. The response received from Leeds City Council is summarised below.

1.4.1 Leeds City Council

Leeds City Council explained that the Aberford and District Parish Council study area is extensive, and as a result it is difficult to add to the information provided within the Strategic Flood Risk Assessment (Leeds City Council, 2007). In the future, the Council would provide further information on specific areas within the study area. The information provided within the Strategic Flood Risk Assessment (Leeds City Council, 2007) is considered in Section 1.4.2 below, as part of the flood risk assessment. The Council explained that the Strategic Flood Risk Assessment includes drainage standards for surface water disposal and also details of the Council's minimum development control standards for flood risk.

With regards to Cock Beck, the Council explained that there records show numerous flooding problems in the area south of Aberford Bridge. These flooding incidents can be attributed to Cock Beck and the River Crow tributary. The River Crow tributary emanates from Aberford Park, and outfalls into Cock Beck downstream of Aberford Bridge.

The Council also explained that surface water runoff from the area of Garforth discharges to Hawks Nest Wood, which has a tributary outfall to Cock Beck. There have been flooding problems in this area, which require further investigations to determine the extent of the problems and provide appropriate solution(s) for the management of the flood risk in the area.

1.4 Flood Risk to the Aberford and District Parish Council study area

In accordance with PPS25, flood risk must be assessed for all sources of flooding. Based on the information currently available, this section considers all possible sources of flooding within the Aberford and District Parish Council study area.

1.4.2 Sea Flooding (Tidal)

The Aberford and District Parish Council study area is located over 40km from the sea, at above 50mOD. None of the watercourse located within the vicinity of the area (as detailed below under river flooding) are tidally influenced.

The risk to the Aberford and District Parish Council study area from tidal flooding is therefore considered to be negligible, and any development within the parish would have no impact on tidal flood risk.

1.4.3 River Flooding (Fluvial)

The Aberford and District Parish Council study area is located within the Cock Beck catchment. Cock Beck flows along western boundary of the Aberford and District Parish Council study area, to the south of Aberford, before flowing through the centre of Aberford. In the centre of Aberford, Cock Beck flows under the Main Street at Aberford Bridge. The River Crow also flows through Aberford, to the south of Cock Beck, and flows into Cock Beck to the west of Aberford Bridge.

The Brickpond Runner flows through the northern part of the Aberford and District Parish Council study area, through Beccamoor Wood and Beccamoor Plantation, to the north east of Aberford. There are also a number of unnamed drains located within the Aberford and District Parish Council study area. To the west of Aberford, and outside the Aberford and District Parish Council study area, Potterton Beck flows into Cock Beck.

The Strategic Flood Risk Assessment explains that detailed flood risk modelling of Cock Beck has not been carried out to date, and therefore the Strategic Flood Risk Assessment is reliant upon the Environment Agency Flood Zone Map (March 2007). The predicted 1 in 100 year flood event is contained largely within the waterway corridor of Cock Beck, but becomes generally more widespread downstream of the confluence with Potterton Beck.

The Strategic Flood Risk Assessment details that residential properties in Aberford, around Aberford Bridge, are predicted to be at risk of flooding from Cock Beck during a 1 in 100 year flood event. Residential properties are also predicted to be at risk of flooding from Cock Beck (during a 1 in 100 year flood event) Aberford and District Parish Council study area. However, Swarcliffe is not located within the Aberford and District Parish Council study area. Based on the Strategic Flood Risk Assessment, there are records of residential housing flooding from Cock Beck in Aberford.

As part of the Strategic Flood Risk Assessment, Leeds City Council identified a number of localised flooding issues with Cock Beck, including the blockage of trash screens. Blocked watercourses can cause serious flooding, and regular proactive maintenance is required to keep local waterway corridors clear of debris.

Based on the Environment Agency's Flood Map, the majority of the Aberford and District Parish Council study area is located within Flood Zone 1. The annual probability of fluvial flooding occurring in Flood Zone 1 is less than 0.1%, and is considered low.

A narrow strip of Flood Zone 3 runs approximately west to east through the centre Aberford and District Parish Council study area, along the flow path of Cock Beck. Along the edge of the Flood Zone 3 outline, there are several small areas of Flood Zone 2. A narrow strip of Flood Zone 3 also runs along the flow path of the River Crow, between the Main Street in Aberford and the M1.

The annual probability of fluvial flooding occurring in Flood Zone 2 is between 0.1 and 1%, and is considered medium. The annual probability of fluvial flooding occurring in Flood Zone 3 is greater than 1%, and is considered high.

1.4.4 Flooding from Land (Pluvial)

The only information the Strategic Flood Risk Assessment (Leeds City Council, 2007) provides on pluvial flooding within the Aberford and District Parish Council study area is pluvial flooding occurring as a result of under capacity sewers. Flooding as a result of under capacity sewers is considered further under sewer flooding below (Section 1.4.5).

1.4.5 Groundwater Flooding

The Strategic Flood Risk Assessment (Leeds City Council, 2007) explains that the risk of groundwater flooding is highly variable, and is heavily dependent upon local ground conditions. The Strategic Flood Risk Assessment does not provide any information on the groundwater flood risk in the Aberford and District Parish Council study area, but does explain that groundwater flooding should not normally preclude development.

1.4.6 Flooding from Public Sewers

The Strategic Flood Risk Assessment (Leeds City Council, 2007) explains that flood problems are known to exist in the Stanks Bridge area (Swarcliffe) of the Cock Beck catchment, where roads and properties have flooded in the past as a result of public surface water sewers backing up. Although the Stanks Bridge area is not located within the Aberford and District Parish Council study area, Leeds City Council has identified a number of issues with under capacity surface water sewers within the Cock Beck catchment. Under capacity sewers can result in relatively serious surface water flooding, and surface water flooding incidences are virtually impossible to predict.

1.4.7 Flooding from Artificial Sources (excluding sewers)

The Strategic Flood Risk Assessment (Leeds City Council, 2007) does not provide any information on flooding from artificial sources (excluding sewers) within the Aberford and District Parish Council study area.

Based on Ordnance Survey mapping, the only artificial water bodes located with the study area are a number of small ponds. There are no significant artificial bodies of water (i.e canals, reservoirs and lakes) located within the study area. The small ponds within the study area are not considered to pose a significant flood risk.

1.5 Development

As outlined in Section 1.2, PPS25 (and its supplementary practice guide) consider the vulnerability of different types of development to flooding. Based on vulnerability, PPS25 states what Flood Zone(s) development is appropriate within. The Aberford and District Parish Council study area is located within Flood Zones 1, 2 and 3, and the type of development that is appropriate within these flood zones is detailed below. Please refer to Table 3 for examples of development types.

It should be highlighted that the Environment Agency's Flood Map does not distinguish between Flood Zones 3a and 3b, and it should be determined whether any of the Aberford and District Parish Council study area is located within Flood Zone 3b. As detailed below, development options within Flood Zone 3b are limited.

Flood Zone 1

Based on PPS25, all forms of development are appropriate in Flood Zone 1. Neither the Sequential nor the Exception Tests would be required for development in Flood Zone 1.

Flood Zone 2

Based on PPS25, 'Essential Infrastructure', 'Water Compatible', 'More Vulnerable' and 'Less Vulnerable' development is appropriate in Flood Zone 2. The Exception Test would need to be satisfied for 'High Vulnerable' development to be located in Flood Zone 2.

The Sequential Test would also need to be passed for any development in Flood Zone 2.

Flood Zone 3a

Based on PPS25, 'Water Compatible' and 'Less Vulnerable' development is appropriate in Flood Zone 3a. The Exception Test would need to be satisfied for 'Essential Infrastructure' and 'More Vulnerable' development to be located in Flood Zone 3a, and 'Highly Vulnerable' development is not permitted within Flood Zone 3a.

The Sequential Test would also need to be passed for any development in Flood Zone 3a.

Flood Zone 3b

Based on PPS25, 'Water Compatible' development is appropriate in Flood Zone 3b. The Exception Test would need to be satisfied for 'Essential Infrastructure' to be located in Flood Zone 3b, and 'Highly Vulnerable', 'More Vulnerable' and 'Less Vulnerable' development is not permitted within Flood Zone 3b.

The Sequential Test would also need to be passed for any development in Flood Zone 3b.

1.6 Restoration of Parlington Lake

There is support within Aberford for the restoration of the lake on the Parlington Estate. The boating lake on Parlington Estate was drained in the early twentieth century, and was originally formed by containing Cock Beck after it passed beneath bridge between Barwick in Elmet and Garforth. The Parlington Estate has considered restoring the lake for fishing, but the lake would also have the potential to store water and alleviate flood risk downstream (in Aberford).

The potential restoration on Parlington Lake has been discussed initially with the Environment Agency. More detailed discussions now need to be held with the Environment Agency, and the potential flood risk benefits of restoring the lake needs to be assessed through hydraulic modelling. Based on the Environment Agency's role in this masterplanning project, it is anticipated that the Environment Agency may carry out this hydraulic modelling work.

Based on the results of the hydraulic modeling (and the impacts of restoring the lake on flood risk), it needs to be discussed whether the Environment would accept any changes to their Flood Map and the flood zone extents. The Environment Agency's Flood Map ignores the presence of flood defences, so it would need to be established whether the Environment Agency would update their Flood Map based on the restored Parlington Lake providing flood storage.

Finally, restoring Parlington Lakes could also potentially provide a means of implementing SuDS, depending on where development is proposed in relation to the lake within the study area.

1.7 Flood Risk Development Requirements

Based on PPS25, and the fact the majority of the Aberford and District Parish Council study area is located within Flood Zone 1, the sequential approach should be adopted in developing the area. Any development with the study area should preferentially be located in Flood Zone 1, then Flood Zone 2 and lastly Flood Zone 3.

The Sequential Test will need to be passed if any development is located within Flood Zones 2 and 3. The Exception Test may also need to be passed if development is located within Flood Zones 2 and the 3. Whether the Exception will be required is dependent on the type of development proposed within Flood Zones 2 and 3.

If any development is proposed in Flood Zone 3, stringent flood risk mitigation measures are likely to be required. Mitigation measures that should be considered when developing in Flood Zone 3 include raised finished floor levels (at least 300mm above the 1 in 100 year flood levels (on Cock Beck and the River Crow)), registering for the Environment Agency's flood warning service, preparing a flood management plan, providing buffers around watercourse corridors (at least 8m), utilising flood resilient and/ or flood resistant construction techniques, providing level for level floodplain compensation storage, installing flood defences, providing safe access and egress and providing safe refuge areas above the 1 in 100 year flood level.

In line with PPS25, and the Strategic Flood Risk Assessment requirements, any future development (in any flood zone) should install an appropriate surface water drainage strategy. Future development should implement sustainable drainage techniques (SUDS) where possible, and the rate of surface runoff should be limited to the greenfield equivalent. There should be no increase in the rate of surface runoff from a development site to watercourse.

Adopting a precautionary approach, in line with PPS25, finished floor levels of any development should be at least 150mm above surrounding ground levels. This should prevent any development flooding from any groundwater, pluvial or sewer flooding. As detailed above, finished floor levels in Flood Zone 3 should be located atleast 300mm above the 1 in 100 year flood level.

1.8 Recommendations for Further Work

Recommendations for further flood risk work:

- Consider the information the Environment Agency has available, once we receive a response
- Undertake a site visit, to assess watercourses in the study area
- Consider surface water drainage arrangements, once the masterplanning progresses
- Discuss the Lake Parlington restoration proposals with the Environment Agency in greater detail
- If development is proposed within Flood Zone 3 as part of the Masterplan:
    - Establish whether any of the study area is located within Flood Zone 3b
    - Obtain flood level information (for Cock Beck and the River Crow)
    - Consider flood risk mitigation measures in greater detail

1.9 References

Communities and Local Government (2010) Planning Policy Statement 25: Development and Flood Risk [Online]
http://www.communities.gov.uk/documents/planningandbuilding/pdf/planningpolicystatement25.pdf

Communities and Local Government (2009) Planning Policy Statement 25: Development and Flood Risk Practice Guide [Online]
http://www.communities.gov.uk/documents/planningandbuilding/pdf/pps25guideupdate.pdf

Leeds City Council (2007) Strategic Flood Risk Assessment [Online] http://www.leeds.gov.uk/Environment_and_planning/Planning/Planning_policy/page.aspx?pageidentifier=a67a6436-9ecc-4af1-9110-52a82aeeee7b