CHAPTER 11: FLOOD RISK AND HYDROLOGY

Introduction

11.1 This chapter provides an assessment of the potential impact of the proposed development on flood risk and surface water in the study area. The assessment has been undertaken through establishing the existing baseline environment and then assessing the magnitude and significance of potential impacts resulting from the proposed development upon these baseline conditions.

Methodology

11.2 The assessment of the potentially significant environmental effects on flood risk and surface water features has been based on the following set of sensitivity criteria in Table 11.1. The criteria descriptors are intended to provide an indication of the likely impacts on surface water receptors for each sensitivity band and do not necessarily provide a description of site specific issues.

Table 11.1 Sensitivity of Surface Water Receptors

Sensitivity	**Typical Criteria Descriptors**
Very Significant	Main River >10m wide. Flood Zone 3b (Functional Floodplain) at risk from a flood event less than or equal to the 1 in 20 year event (greater than 5% annual probability of flooding each year). Functional floodplain storage area.
Significant	Main River >10m wide. Flood Zone 3a (Floodplain). At high risk from flood event less than or equal to the 1 in 100 year event (greater than 1% annual probability of flooding each year). (Not functional floodplain). Potential floodplain storage area during the 1% event. Public surface water and combined sewers with known history of flooding.

Moderate	Main River <10m wide or estuary with no nature conservation designation or Ordinary Watercourse >5m wide. Flood Zone 2 (area at medium risk from flood event between the 1 in 100 and 1 in 1000 year event, between 1% and 0.1% annual probability of flooding each year). Not functional floodplain. Public surface water and combined sewers without known flooding issues.
Slight	Ordinary Watercourse <5m wide. Land designated as Flood Zone 1 – low risk of flooding.

11.3 It is considered that the magnitude of change associated with the flood risk and surface water impacts can be broadly defined as follows in Table 11.2.

Table 11.2 Assessing the Magnitude of Impact on Surface Water Receptors

Magnitude of Impact	**Typical Criteria Description**
Major Adverse	A pollution incident or release during construction resulting in a major pollution incident. Increase in peak flood level (1 in 100 year flood event) > 100mm. Loss of Floodplain Zone 3b. Significant increase in surface water discharge.
Moderate Adverse	Moderate risks of pollution. Increase in peak flood level (1 in 100 year flood event) > 50mm. Loss of Floodplain Zone 3a. Moderate increase in surface water discharge.
Slight Adverse	Increase in peak flood level (1 in 100 year flood event) > 10mm. Location within Flood Risk Zone 2. Low risk of pollution from accidental spillages. Minor increase in surface water discharge.
Neutral / Negligible	Very low risk of pollution from accidental spillages. Negligible change in peak flood level (1 in 100 year flood event) < + / - 10mm. No loss of floodplain (i.e. this would involve only land take/structures within Zone 1).

	No increase in surface water discharge.
Slight Beneficial	Reduction in peak flood level (1 in 100 year flood event) > 10mm. Creation of a small area of additional floodplain storage (over that required to maintain status quo). Minor reduction in surface water discharge.
Moderate Beneficial	Reduction in peak flood level (1 in 100 year flood event) > 50mm. Creation of moderate area of additional floodplain storage (over that required to maintain the status quo). Moderate reduction in surface water discharge.
Major Beneficial	Reduction in peak flood level (1 in 100 year flood event) > 100mm. Creation of substantial additional floodplain storage (over that required to maintain status quo). Substantial reduction in surface water discharge.

11.4 The level of significance is determined by combining the impact risk with the sensitivity of the receptors. Any level of significance of greater than minor adverse is defined as being significant.

Planning Policy Context

National Policy

11.5 Planning Policy Statement 23: Planning and Pollution Control (2004) is taken into account by regional planning bodies and by local planning authorities in the preparation of local development documents and may also be material to decisions on individual planning applications. This statement advises that any consideration of the quality of land, air or water and potential impacts arising from development, possibly leading to impacts on health, is capable of being a material planning consideration, in so far as it arises or may arise from or may affect any land use.

11.6 Core policies on flooding and land use planning can be found in PPS 25: Development and Flood Risk (2010). These have been considered in the accompanying Flood Risk Assessment (FRA) undertaken for the proposed development (Barnsley Markets Flood Risk Assessment, WYG, May 2011) as included in Volume 2 of the ES, and thus considered within this impact assessment thereby providing an assessment of the impact on the objectives of PPS25 (Appendix 7.1).

11.7 The Development and Flood Risk Guidance for the Construction Industry, CIRIA C624 (2004) provides guidance to developers and the construction industry on the implementation of good practice in the assessment and management of flood risk as part of the development process. This document is intended to promote development that is sustainable in terms of flood risk.

11.8 Control of Water Pollution from Construction Sites: Guidance for Consultants and Contractors, CIRIA C532 (2001) provides environmental good practice for control of water pollution arising from construction activities. This document is relevant to all organisations represented on a construction site.

11.9 The Interim Code of Practice for Sustainable Drainage System (2004) aims to facilitate the implementation of sustainable drainage in developments by providing model maintenance agreements and advice on their use. Its specific objectives are to:

- Encourage the implementation of SUDS in new and existing developments;
- Provide basic guidance for practitioners on the implementation of SUDS in new developments;
- Make the adoption and allocation of maintenance of SUDS more straightforward.

11.10 The Water Resources Act 1991 is the statutory framework for regulating discharges to surface waters. A discharge consent would be required from the Environment Agency where the discharge has a high risk of contamination and / or the runoff requires treatment before it can be discharged to a controlled water.

Regional Policy

11.11 The Government published The Yorkshire and Humber Plan (The Regional Spatial Strategy) in May 2008. The Plan sets out the broad development strategy for the Region. It covers topics such as housing, economic development, transport, the environment and regeneration.

11.12 A number of the policies within The Yorkshire and Humber RSS relate to flood risk as follows:

- RH1:B8; which states that Plans, strategies, investment decisions and programmes should aim to avoid increasing flood risk, and manage land and river catchments for flood mitigation, renewable energy generation, biodiversity enhancement and increased tree cover.
- RH2:B1; which identifies the need to plan for the successful adaptation to the predicted impacts of climate change by Minimising threats from and impact of coastal erosion, increased flood risk, increased storminess, habitat disturbance, increased pressure on water resources, supply and drainage systems.
- ENV 1; which describes the broad policy for Development and Flood Risk.
- ENV 3; which describes the broad policy for Water Quality.

Local Policy

11.13 The Draft Barnsley Core Strategy was the subject of an Examination in Public in March 2011 and sets out the spatial strategy for the borough and details where new development in the borough should be. Core policies within this document will be used to direct future development to preferred geographical areas. The document contains core policies that relate to flood risk including the requirement for sustainable drainage systems, the need to reduce runoff when brownfield sites are re-developed, avoiding inappropriate development within areas prone to flooding etc.

11.14 The Level 1 Barnsley Strategic Flood Risk Assessment (2010) provides an overview of flood risks throughout the Borough from sources including fluvial, pluvial (runoff from impermeable surfaces), ground water, sewers and artificial sources. In addition to this information the report provides guidance for the production of site specific flood risk assessments.

Existing Situation

Study Area

11.15 The existing areas of the site are covered by roofs, paved areas, and roof level parking. As a result the existing site is considered 100% impermeable.

11.16 Ground levels generally fall across the site from west to east, however due to the urban nature of the sites current use there is some variation in this trend. The Charter Oaks Ltd topographical survey of the site indicates a peak level of approximately 98.4m AOD where Cheapside enters the site in the south west and a minimum level of approximately 89.5m AOD to the south of the existing office building within the former CEAG site (east of the railway line). Ground levels within the site form two low points where surface water runoff from the surrounding area of the town could potentially collect. The low points are located adjacent the existing May Day Green entrance to the open market (95.9m AOD) and to the south of the existing office building within the former CEAG site (89.5m AOD).

11.17 Ground levels within the surrounding area generally fall in an easterly direction towards the River Dearne approximately 1km away. Much of the town centre to the north and west of the site contains a high percentage of impermeable surfaces and falls toward the site boundaries.

11.18 Water bodies in the site surrounding area include the River Dearne which flows in a south easterly direction and is situated approximately 1km to the north east of the site at its nearest point. Sough Dyke, a tributary of the River Dearne, flows across the site and is designated by the EA as a Main River. Sough Dyke is a culverted watercourse that flows in an easterly direction along Kendray Street then turns to the south east and passes underneath the railway line approximately 100m south of the level crossing. The stretch of the Sough Dyke culvert beneath the site is 1500mm in diameter and flows at a depth ranging from approximately 4.0m to 7.3m. The section of the culvert beneath the railway flows within a concrete box culvert approximately 1300mm x 1300mm.

11.19 The site is surrounded by a network of highways and paved pedestrian zones. Drainage record drawings indicate a number of foul, surface water and combined sewers beneath the roads.

Baseline Data Sources

11.20 Information contained within this chapter has been obtained from the following sources:

- Environment Agency Website and consultation;
- Yorkshire Water Sewer Records;
- Barnsley Level 1 Strategic Flood Risk Assessment, JBA Consulting, Sep 2010
- Report on Flood Risk Assessment at Barnsley Markets, Halloran Payne Associates Ltd, April 2007
- Barnsley Markets FRA Addendum – Sough Dyke Culvert, Scott Wilson, October 2007;
- Barnsley Markets Flood Risk Assessment, WYG, May 2011

Environment Agency Website and consultation

11.21 The Environment Agency's website flood risk map was consulted and the site is shown to lie entirely within flood risk zone 1 (low risk – likelihood of flooding less than 0.1% - 1 in 1000 year return period). The EA flood risk map indicates that the nearest area of higher flood risk is located approximately 0.8km to the north east and is associated with flooding from the River Dearne (see Figure 11.1).

11.22 WYG and Barnsley Metropolitan Borough Council (Wayne Atkins) met with Lesley Slaney and Gary Cliff of the Environment Agency on the 18th February 2011. The latest scheme proposals were discussed and in particular issues relating to the diversion of the Sough Dyke culvert (main watercourse), the requirements for attenuation of runoff from the new impermeable surfaces and the scope for the site specific flood risk assessment.

11.23 Sough Dyke is classified as 'Main River' and as such any work within 8m including foundations, surfacing and diversion works will require a Flood Defence Consent.

11.24 The Environment Agency advised that a 30% reduction in surface water discharge rate from the site would be sought. The provision of storm water attenuation storage will therefore be required as part of the drainage design.

Yorkshire Water Sewer Records

11.25 Yorkshire Water (YW) sewer record plans show two combined public sewer networks within the site vicinity (see Figure 11.2).

11.26 The combined sewer network to the north serves a catchment area covering the town centre to the north of the site and May Day Green to the west. Public combined sewers from Eldon Street and May Day Green converge within Kendray Street. A 600mm diameter public combined sewer flows in an easterly direction along Kendray Street then turns south east and increases to a 750mm diameter sewer immediately after the junction with Midland Street. The combined sewer passes beneath the railway line approximately 50m south of the level crossing and further combined flows from the north join the sewer as it flows across the former CEAG site.

11.27 The southern public combined sewer network within the site is shown to drain the northern and western parts of the town centre, and flows into the site via two sewers that combine within a single 1360mm diameter brick sewer in Cheapside. The brick sewer flows in a south easterly direction along Cheapside receiving connections from the west. The combined sewer then passes beneath the Alhambra Shopping centre and flows to the south east along Lambra Road.

11.28 YW record plans show the approximate location and alignment of the Sough Dyke (indicated as a continuous blue line on the plan). Sough Dyke is a culverted watercourse (designated Main River) that flows in an easterly direction along Kendray Street then turns to the south east and passes underneath the railway line approximately 100m south of the level crossing.

11.29 The record plans indicate the size of Sough Dyke culvert to be 1800mm diameter flowing beneath Kendray Street reducing to 1650mm diameter between Kendray Street and the railway and then increasing in size to 2500mm as it passes beneath the railway line. A CCTV survey of Sough Dyke culvert was carried out as part of the Tranche A Critical Ordinary Watercourse Hydraulic Assessment – Priority 4 report produced by JBA Consulting, February 2006. The size of the culvert identified within the JBA report differs from that shown on the sewer record plans and shows the length of culvert from the junction of Kendray Street and Eldon Street to where it passes beneath the railway line to be 1500mm diameter compared with 1800mm detailed above. The culvert construction is a combination of brick and concrete. The section of the culvert beneath the railway is indicated to be a pre-case concrete box culvert with approximate dimensions 1300 x 1300mm. The culvert then returns to a

1500mm brick construction downstream of the railway. It is believed that the culvert dimensions identified by JBA are correct since these are based on a physical survey.

11.30 A 1200mm public surface water sewer conveying flows from the south is shown to connect into the Sough Dyke near to the junction of Kendray Street and May Day Green.

Barnsley Level 1 Strategic Flood Risk Assessment (SFRA)

11.31 The level 1 SFRA includes a set of flood risk maps which show the predicted extents of the 1 in 100 year flood event (1% annual probability), the 1 in 1000 year flood event (0.1% annual probability) and the 1 in 100 year event with an additional allowance of 20% for climate change. All of these plans indicate that the site lies within flood risk zone 1 and that the nearest area of higher flood risk is located approximately 0.5 km away to the north east adjacent the River Dearne (for the 1 in 100 year event + 20%).

11.32 Map C-1 included within the SFRA provides an indication of the locations where pluvial (over land) flows are likely to occur and the estimated depth of any pooling that might result (see Figure 11.3). The analysis is based on a 1 in 100 year (1% probability) storm and assumes that existing sewers have capacity limited to the 10% (1 in 10 year) storm event.

11.33 Whilst Map C-1 provides a good initial overview of the areas likely to be prone to pluvial flooding, the flood zones are only considered to be indicative since the actual sewer capacities were not modelled. Map C-1 indicates a band of pluvial flooding across the western site area running between the two existing concrete buildings and then crossing the railway line into the eastern site area. The deepest predicted flood depth exceeds 2m within the eastern portion of the site. There is however no recorded history of flooding within these areas.

Report on Flood Risk Assessment at Barnsley Markets

11.34 The Halloran Payne Associates report (2007) had been commissioned to support the planning application for a previous development proposal within the site. The report concluded that the site was at low risk of flooding, however as a result of the

surrounding topography, it recommends that SUDS should be incorporated within the site drainage design to ensure that existing developments adjacent and at lower levels do not suffer flooding.

Barnsley Markets FRA Addendum – Sough Dyke Culvert

11.35 An Addendum to the Halloran Payne Associates Flood Risk Assessment was produced by Scott Wilson in October 2007 to address issues raised by the EA and to provide an assessment of the hydraulic capacity of Sough Dyke. The FRA Addendum report also considers the likely flow path and extent of flooding in the event of a collapse or partial blockage of the Sough Dyke.

11.36 The hydraulic modelling and report undertaken by Scott Wilson concluded that the Sough Dyke diversion proposed by HPA as part of the development would not have an adverse effect on the hydraulic performance of the watercourse. The report states that a significant partial blockage or total collapse of Sough Dyke where it passes the site is highly unlikely. Flood flow routes identified within the report suggest that the majority of flood flows generated in the event of a blockage or collapse of Sough Dyke would flow to a low area within the former CEAG site to the east of the railway line. The flood flow route identified follows Kendray Street to the east, over the level crossing before turning into the eastern site area. The flood flow route assumes that measures will be taken to prevent flooding from manhole access points on the line of the culvert located within the lower area of the new building.

Sensitivity of the site to flood risk and surface water receptors

Fluvial flooding from the River Dearne

11.37 Both the Environment Agency's website flood risk map and the flood risk map that accompanies the Barnsley Level 1 SFRA indicate that the site lies within Flood Risk Zone 1.

11.38 High water levels within the River Dearne as a result of flood flows can result in surcharging of the downstream lengths of Sough Dyke. Ground levels downstream of the site are significantly lower than those within the site (the cover level at the downstream end of the Scott Wilson model is 79.4m AOD). Flooding of Sough Dyke

as a result of high water levels within the River Dearne is therefore unlikely to affect the site.

11.39 Sough Dyke flooded during the summer of 1997 when high water levels within the River Dearne caused Sough Dyke to surcharge (Tranche A Critical Ordinary Watercourse Hydraulic Assessment – Priority 4, JBA Consulting, February 2006). The flooding incident occurred approximately 400m downstream of the site and it is reported that the pressure "blew off nearly 50m of the culvert crown near the football ground". It is considered that the level of risk posed to the site by the River Dearne is **slight**.

Fluvial Flooding from Sough Dyke (normal flow conditions)

11.40 Whilst Sough Dyke is designated as a Main River, the length of the watercourse through the urban centre of Barnsley to the River Dearne flows in a culvert.

11.41 The length of Sough Dyke from Kendray Street to a point approximately 380m downstream of the site was modelled by Scott Wilson as part of their Barnsley Markets FRA Addendum – Sough Dyke Culvert report (October 2007). The Scott Wilson hydraulic model was constructed using the WinDes Microdrainage software and uses rainfall data derived from the ReFH method. Results for the 1 in 150 year critical duration storm are provided within Appendix A of the Scott Wilson report and indicate that the stretch of Sough Dyke within the site vicinity has sufficient hydraulic capacity to discharge the flows from the design storm.

11.42 According to an inspection report on the Sough Dyke culvert carried out by JBA Consulting dated February 2006 (Tranche A Critical Ordinary Watercourse Hydraulic Assessment – Priority 4 (Culverted Watercourses) the diameter of Sough Dyke reduces downstream of the site to 600mm in diameter. The downstream stretch of Sough Dyke is therefore considered to be at higher risk of flooding. The flow constriction in the downstream watercourse is however unlikely to increase the risk of flooding within the site since ground levels downstream of the site are significantly lower than those within the site (the cover level at the downstream end of the Scott Wilson model is 79.4m AOD). Localised flooding in the vicinity of the constriction is therefore considered more likely.

11.43 Since the hydraulic capacity of the Sough Dyke in the vicinity of the site has been established to be adequate for the catchment it serves, the level of risk posed to the site by the Sough Dyke under normal flow conditions is considered **slight**.

Flooding from Sough Dyke as a result of a blockage or collapse

11.44 Although it is considered that under normal conditions the Sough Dyke does not pose a significant risk to the site, there remains a residual risk of flooding from the dyke in the event of blockage or collapse. The effects to the site from such flooding events were also considered as part of the Scott Wilson report. Partial and full blockages of the dyke at three separate locations were simulated for the 1 in 1, 1 in 30 and 1 in 100 year flood events. The location and volume of flooding that resulted in each of the hypothetical scenarios is tabulated within the report. The largest overall volume of flooding shown is generated by the 1 in 100 year storm event and occurs as a result of a total blockage of the culvert within the manhole immediately upstream of where the culvert passes beneath the railway. Whilst this is considered highly unlikely the total predicted volume of flooding for this event is given as 28,865cu.m.

11.45 The Scott Wilson report states that it is very unlikely that a full blockage or culvert collapse would occur at the very beginning of the storm event. It is far more likely that a blockage or collapse would occur at the peak of the storm and therefore result in a significantly lower volume of flooding. Furthermore the condition survey of the culvert, undertaken by JBA Consulting in May 2005, found that **"overall, the culvert is serviceable and in reasonably good condition"**.

11.46 Notwithstanding this, relatively large volumes of overland flooding would be generated as a consequence of Sough Dyke collapsing or becoming blocked so the sensitivity of the site is considered moderate. It is therefore necessary to ensure that sufficient mitigation measures are in place to ensure that any flood water generated can be routed to such places where it can be safely managed.

Flooding from overland flows (pluvial flooding)

11.47 Map C-1 that accompanies the Barnsley Level 1 SFRA (see Figure 11.3) indicates that the site lies within an area that is vulnerable to surface water flooding. A review of ground levels within the site and surrounding area indicates that there are two low

points within the site where pluvial flows from the surrounding area could potentially collect. The locations of the low points are adjacent the existing entrance to the markets off May Day Green and within the centre of the eastern site area. These two locations approximately match the areas of vulnerability shown on Map C-1.

11.48 Much of the town centre to the west of the site contains a high percentage of impermeable surfaces and falls toward the site. Any overland surface water runoff from the area to the west of the site, not intercepted by existing drainage systems, is therefore likely to enter Cheapside via New Street or Queen Street. In addition overland flows from the north could enter the site at the junction of Kendray site with Eldon Street. Surface water entering Cheapside will currently flow into May Day Green and congregate at the low point of approximately 95.9m A.O.D. adjacent the existing entrance to the markets. Although there is no historic record of the existing drainage system being exceeded or becoming blocked, in the event of this occurring overland flows could potentially pool to a depth of approximately 1.1m (approximately 97.0m A.O.D.) before an alternative flow path becomes available either down Kendray Street or through the open market. Flooding of this depth could potentially cause flooding to shops within May Day Green and Cheapside.

11.49 The second low point exists within the site to the east of the railway line, where pooling of surface water would potentially be contained by the retaining wall of Harborough Hill Road and the embankments and retaining walls of the railway line.

11.50 The indicative depth of flooding provided on Map C-1 is considered to be a worst case assessment, since it is based on the conservative assumption within the SFRA that existing drainage networks would only have sufficient capacity to deal with a 1 in 10 year storm event. It is likely that the more recently constructed drains within the vicinity will have greater capacity than this (at least up to 1 in 30 year design storms in accordance with Sewers for Adoption). Furthermore a recent hydraulic modelling study of Sough Dyke (the principal watercourse in the area which flows in a culvert beneath the site) has established that the local stretch of this culverted watercourse has sufficient capacity to discharge flows from a 1 in 150 year storm event. There is no record of surface water flooding within the site areas indicated on Map C-1 or at any other locations within the site.

11.51 The recorded history of flooding in the Barnsley area (documented within the previous reports) suggests that the most notable record of flooding locally occurred as a result of prolonged and widespread rainfall during the summer of 1997. The rainstorm resulted in the flooding of an area near to the football ground due to structural failure of the Sough Dyke downstream of the site.

11.52 Jason Kilner, Site Manager for the Barnsley Markets site, has confirmed that to his knowledge, going back over a period of 24 years, the existing markets building and the streets immediately adjacent the site have never flooded.

11.53 The existing site sensitivity to overland flooding is therefore considered to be **moderate**.

Groundwater Flooding

11.54 The site does not lie within an area defined within the Barnsley Level 1 SFRA as being at risk of groundwater flooding. There is no known history of groundwater flooding at the Barnsley Markets site including the existing basement area. The lower level / basement of the proposed markets building is to be constructed at a similar level to that of the existing building.

11.55 The site sensitivity to groundwater flooding is considered to be **slight**.

Sewer Flooding

11.56 There are a number of public sewers within the proximity of the site boundaries. Flooding from sewers can occur as a result of sewer blockages, or collapses, or as a result of the sewers not having sufficient capacity to convey high flows, particularly during severe rainfall events.

11.57 Some of the public surface water and combined sewers within the site vicinity are of relatively large diameter and could therefore potentially give rise to significant levels of flooding in the event of failure. These sewers are, however, owned and maintained by YW and a collapse is not therefore considered likely. In the unlikely event of a sewer blockage it is anticipated that YW would attend the site as a matter of urgency and take appropriate actions to reduce the risk to public health and property. There is no known history of sewer flooding within the site vicinity.

11.58 The volume and rate of flooding from public sewers would be considerably lower than could potentially be generated by a collapse or blockage of the Sough Dyke.

11.59 The site sensitivity to flood risk from overloaded, blocked or collapsed sewers is considered moderate and mitigation measures should be considered.

Table 11.3 Summary of the sensitivity of flood risk and surface water receptors

Feature	**Sensitivity**
Floodplain attributes: The site is located within Flood Risk Zone 1. Flood risk from watercourses: River Dearne Sough Dyke (normal flow conditions) Sough Dyke (as a result of blockage or collapse)	 Slight Slight Slight Moderate
Pluvial flooding / overland flow	Moderate
Groundwater	Slight
Sewerage network in site vicinity	Moderate

Impact of Development

Effects of site clearance, demolition and construction

11.60 The development proposals involve the diversion of public combined sewers, a public surface water sewer and the diversion of the Sough Dyke culvert, all of which currently lie within the footprint of the proposed building. The existing sections of sewer / watercourse will remain operational on their existing routes while the new diverted sections are constructed. If suitable measures are not put in place there is a risk of construction debris entering Sough Dyke or the public combined sewer as a result of the connection works increasing the likelihood of blockages occurring downstream. In addition the construction works within the site generally may pose a risk of pollutants entering the watercourse as a result of accidental spillage. It is

considered that the construction works will have a slight adverse effect on the downstream sewers and surrounding area if mitigation measures are not undertaken.

11.61 The temporary risk of flooding to the construction site posed by Sough Dyke and the existing public sewer networks is considered to be **negligible**.

11.62 The construction work will include the excavation of relatively deep excavations and trenches. Unless surface water is managed within the construction site runoff from pluvial and over land sources could inundate open excavations. Furthermore site runoff could impact on the surrounding areas. The impact of pluvial and overland flows on the construction site and the effect of uncontrolled runoff from the site onto the surrounding areas are considered to be **slight adverse**.

11.63 Other potential sources of flood risk such as the River Dearne and groundwater are considered **slight** and as such their effect on construction activities is considered **negligible**.

Effects of the Completed Barnsley Markets Development

11.64 The effect of the proposed development on the following receptors has been considered.

River Dearne

11.65 The development of the Barnsley Markets site will not result in an increase in impermeable area and no increase in site runoff is therefore anticipated. In line with the EA's requirements and local planning guidance the new surface water drainage system serving the development will provide a 30% reduction in the rate of runoff from site (when compared with the existing situation). Runoff from vehicle parking areas will be passed through oil interceptors prior to discharge. The impact of the proposed development on the River Dearne is therefore considered **negligible**.

Sough Dyke

11.66 As described above the rate of runoff from the site will be attenuated to 30% less than the existing discharge rate; excess surface water will be stored within tanks / oversized sewers within the site. It is therefore considered that the proposed development will have a **moderate beneficial** effect on Sough Dyke.

11.67 Drawing A066979-1317 (see Figure 11.4) showing the indicative drainage layout for the proposed Barnsley Markets building shows the proposed location of manholes that provide access to Sough Dyke culvert within the service yard access ramp. If these manholes were to surcharge, due to a blockage, collapse or inadequate capacity within the downstream pipe network, the resulting flood water would flow down the ramp inundating the service yard basement. It is therefore considered that Sough Dyke poses a **moderate adverse** effect on the proposed development.

Pluvial Flooding / Overland Flow

11.68 The design of the new markets includes two areas where external ground levels fall towards the building; the area of Market Square which falls toward the entrance of the Indoor Market, and the top of the service yard access ramp. It is therefore considered that overland flows from the surrounding area are likely to have a **moderate adverse** effect on the proposed development.

11.69 The existing site consists of impermeable surfacing throughout. Under the proposed development this will not change. It is likely that existing overland flow routes across the site will remain relatively unchanged by the development proposals. New surface water drainage features are to be provided throughout the site to intercept overland flows. It is therefore considered that the development of the site would have a **neutral** effect on the risk of overland flooding within the surrounding area.

Groundwater

11.70 The proposed development involves the construction of new roofs and paved surfaces across the entire surface of the site (as per the existing situation). Rain falling on the developed site will not therefore contribute to local groundwater levels. The effect of the development on local groundwater conditions is therefore considered **neutral**.

Sewerage network in site vicinity

11.71 The diversion of existing public combined and surface water sewers is proposed as part of the development. It is intended that the design of the diversions will be agreed in collaboration with Yorkshire Water and will have approximately the same hydraulic capacity as the existing sewers. The work will be carried out under a

section 185 agreement and the diverted section of the sewers will be adopted and maintained by Yorkshire Water. It is considered that the effect of the development on the local sewerage network is **neutral**.

11.72 In the event of flooding from the public combined sewer the basement level of the new Barnsley Markets building could be at risk of flooding. Flooding of the basement level could occur either as a result of flows surcharging from the proposed access manhole on the service yard access ramp or by the surcharging of the new drainage system within the building that is connected to the public sewer. It is considered that the existing public sewer network has a **moderate adverse** impact on the developed site.

Mitigation Measures

Construction Phase

11.73 The Principal Contractor will need to make provision for keeping the works, and in particular excavations, dry. Discharge consents will be required for temporary discharges from the construction site under the Water Resources Act 1991. It is assumed that any required water related consents will be in place before works commence and it is the responsibility of the client and contractor to ensure that this is the case. The residual risk of surface water flooding during construction is considered **negligible** since the inundation of excavations via overland flow would occur gradually and during times of heavy rainfall when it is unlikely that any work will be undertaken.

11.74 The proposed surface water and foul sewer connections will be undertaken via an agreement with Yorkshire Water under Section 106 of the Water Industry Act. A further surface water connection is proposed directly into Sough Dyke, and this will form part of a Flood Defence Consent to be agreed with the EA. The final connections will be made during a period of dry weather, and over-pumping will be undertaken to facilitate the continuation of any base flows. Measures will be put in place to ensure that construction debris does not enter the existing sewers / culvert during the course of the connection works. Furthermore a CCTV survey of the new (diverted) pipework will be undertaken prior to any connections being made.

11.75 The works will be carried out in accordance with current best practice and Environment Agency Pollution Prevention Guidance such as:

- PPG2 Above ground oil storage tanks
- PPG6 Working at demolition and construction sites
- PPG7 Fuelling stations: construction and operation
- PPG13 High pressure water and steam cleaners
- PPG18 Managing fire water and major spillages
- PPG21 Pollution incident response planning
- PPG26 Pollution Prevention Storage and Handling of Drums & Intermediate Bulk Containers

11.76 A CCTV survey of all new drains and connections will be required prior to hand over of the site to confirm the integrity of the new drainage system.

Completed Operational Development

11.77 The existing site runoff will be reduced by 30% as part of the new development. This will be achieved using hydro-brake flow control devices to limit the discharge rate of surface water flows from the site to the public surface water sewers and Sough Dyke. Excess surface water will be stored within below ground tanks and oversized sewers / culverts located within the site. Storage volume provided within the attenuation tanks will be sufficient to accommodate rainfall up to the 1 in 100 year event and including a 20% increase in runoff for climate change. The likelihood of flooding in downstream areas will therefore be reduced following the development of the site. Additional storage will be provided to accommodate the likely increase in rainfall over the lifetime of the new Barnsley Markets complex (due to climate change). This additional storage will ensure that the level of flood risk posed by the site to areas downstream remains low.

11.78 Drawing A066979-1317 (see Figure 11.4) showing the indicative drainage layout for the proposed Barnsley Markets building shows the proposed location of manholes that provide access to the Sough Dyke culvert and the public combined sewer. Some of these access points are located within the service yard access ramp. If these manholes were to surcharge, due to a blockage, collapse or inadequate capacity within the downstream pipe network, the resulting flood water would flow down the

ramp inundating the service yard basement. In order that potential flooding is routed to a more suitable location; manholes within the access ramp should be fitted with heavy duty double sealed covers and should be bolted down into the frames. The frames will also need to be securely anchored into the manhole construction. Flood flows within the public combined sewer / Sough Dyke would therefore back up and surcharge at one of the manholes in Kendray Street from where flood routes can be better managed.

11.79 It is recommended that all drainage connections from the new building basement areas to public sewers or Sough Dyke should be protected by means of a suitable non-return flow mechanism. This will protect the lower level of the new building in the event of either Sough Dyke or the public combined sewer flooding or surcharging.

11.80 The design of finished levels within Kendray Street should be considered carefully as part of the detailed design to ensure that any overland flows within Kendray Street are channelled away from entrances to the lower level of the new building. The design of the new markets includes two areas where external ground levels fall towards the building; the area of Market Square which falls toward the entrance of the Indoor Market, and the top of the service yard access ramp. It is recommended that slightly raised levels be provided along a line adjacent to the northern elevation of the new Barnsley Markets building (see Figure 11.5). This will facilitate the channelling of overland flood flows along Kendray Street toward the level crossing and away from the more vulnerable areas of the building. From Kendray Street it is anticipated that some flood water may enter the railway at the level crossing, however it is likely that the majority will continue over the level crossing and into the area of the site to the east of the railway. This area of the site is intended to be used as surface level parking and is considered a suitable location for the storage of storm water during extreme conditions.

11.81 Finished floor levels within the proposed new buildings should be set a minimum of 150 mm above surrounding ground levels in accordance with the Building Regulations so the future risk of flooding from surface water run-off or overland flow will be minimal. External paved areas should be designed to fall away from the new building and in particular to channel flows away from entrances into the building.

Residual Impacts

11.82 The residual risk of flooding to the site and surrounding area is not considered significant provided that suitable mitigation measures outlined above are addressed.

11.83 Table 11.4 below provides an assessment summary of the potential flood risk and surface water impacts and the anticipated residual effects, following the implementation of the proposed mitigation measures.

Table 11.4 – Summary of Flood Risk and Surface Water Effects

Issue/Source	**Potential Effect**	**Mitigation**	**Residual Effect**
Demolition and Construction			
Sough Dyke / Sewer Network	Slight adverse	Prevent construction debris entering the watercourse during connection. Connection to be made during dry weather. Temporary site discharge to be consented and suitable steps taken to prevent pollution of watercourse.	Neutral
Pluvial flooding / overland flow	Slight adverse	Pumping equipment to be provided to keep excavations free from standing water.	Neutral
Completed Development			
Sough Dyke	Moderate adverse	Non-return valve fitted on connection of new site drainage to Sough Dyke. Manhole covers on service yard access ramp to be double sealed and bolted down.	Neutral
Public sewer network	Moderate adverse	Non-return valve fitted on connection of new site drainage to public combined sewer.	Neutral

		Manhole covers on service yard access ramp to be double sealed and bolted down.	
Pluvial flooding / overland flow	Moderate adverse	Finished levels within Kendray Street to be set to direct flows away from access points to basement level of new building.	Neutral

Monitoring Programme

Construction Phase

11.84 The Contractor should regularly inspect the works to ensure that excavations are kept free from standing water and that adequate procedures are in place to minimise the risk of pollution (see paragraph 11.70).

11.85 Surface water discharge from the construction site will need to be monitored for compliance with any limitations stated within the discharge consent such as suspended solids etc.

11.86 A CCTV survey of all new drainage shall be undertaken prior to the handover of the site.

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11.87 Regular monitoring, inspections and maintenance of the new site drainage system is necessary to ensure that the system continues to provide the intended level of flood protection to the site and surrounding areas.

11.88 CIRIA report C697 'The SUDS Manual' provides general guidance on drainage issues to be monitored the frequency of monitoring and suitable maintenance regimes.

11.89 The type of system proposed (below ground tanks and oversized sewers) is robust and should require only minimal maintenance. 'The SUDS Manual' recommends that inspections of SUDS systems be carried out on a monthly basis, although for the Barnsley Markets site this inspection would be limited to the above ground aspects of

the system. Inlets to the system such as gulleys and drainage channels should be checked for silt and debris, and litter removed from drained surfaces. Catchpits and oil interceptors will also need to be inspected. The inspections will identify when de-silting of gulleys, catchpits and drainage channels is necessary and will help to detect areas of damage that may occur during operation of the site. From time to time a vacuum tanker will be required to empty catch pits, gulleys, drainage channels and oil interceptors.

11.90 The SUDS Manual also advises that the maintenance regime of the site needs to consider the response to extreme pollution events. Furthermore a response action plan should be developed so that if a spillage occurs it can be prevented from causing pollution to the receiving watercourse.

Alternative Scenarios

11.91 PPS25 recommends that a risk-based approach and sequential test are used in order to determine whether a site is suitable for a particular development. The assessment of risk and sequential test are considered as follows:

"The proposed development site is shown to be located within Flood Zone 1, therefore, in accordance with PPS25, the site is considered suitable for the proposed development".

Robustness of Analysis

11.92 The assessment of site sensitivity to flood risk and the impact of the proposed development set out within this chapter is based on publicly available information. The information referred to is from reliable sources and is regarded to be sufficient to justify the conclusions reached.

Summary and Conclusions

11.93 The site is shown on the EA flood risk map of the area to be located in flood risk zone 1. It is therefore concluded that the site is at low risk of fluvial flooding and in accordance with the requirements of the sequential test in PPS25: Development and Flood Risk, the site is suitable for the proposed development.

11.94 The site sensitivity to other sources of flooding including overland flow, sewers and groundwater has been considered. The site sensitivity to flooding from combined sewers and Sough Dyke is considered significant and the sensitivity to overland flooding is considered moderate.

11.95 Mitigation measures have been identified to address these residual risks and include the following:

- Surface water runoff from impermeable areas of the site will be discharged to public surface water sewers and the Sough Dyke at attenuated rates (30% lower than current site discharge rates). Attenuation storage below ground will be provided to prevent flooding of vulnerable areas within the site and of land adjacent to the site.
- All new drainage connections should be provided with non-return valves to protect the lower level of the proposed building in the event of either Sough Dyke or the public combined sewer surcharging.
- Manhole access to Sough Dyke and the public combined sewer are proposed within the new service yard access road which slopes into the basement. These manholes should be provided with double sealed covers that can be securely bolted down.
- Finished levels within Kendray Street should be designed to direct flows away from vulnerable access points into the new building basement.
- Finished floor levels within the proposed new buildings should be set a minimum of 150 mm above surrounding ground levels.

11.96 The impact of the proposed development on the level of flood risk in the surrounding area has been assessed to be **neutral** in respect to over land flooding, flooding from sewers and groundwater flooding. Furthermore it is considered that the proposed development will have a **moderate beneficial** impact on the receiving watercourse (Sough Dyke) as a consequence of the proposed 30% reduction in offsite flow rates.

11.97 The residual flood risk to the site, during both construction and operation of the new building, is considered neutral when the proposed mitigation measures are taken into account. The impact of the development on flood risk within the surrounding area is

neutral. It is considered that the proposed development will result in a **moderate beneficial** impact on Sough Dyke.