FLOOD RISK ASSESSMENT

ON

DEVELOPMENT OF RAILWAY CUTTING

HORTON STREET, HECKMONDWIKE

ON BEHALF OF

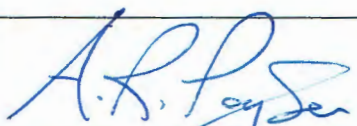
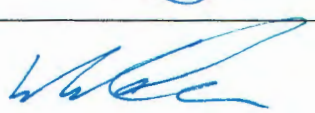
YORKDALES 2 LTD

ARP ASSOCIATES

CHARTERED CONSULTING ENGINEERS

Northwest House 5/6 Northwest Business Park Servia Hill Leeds LS6 2QH

0113 245 8498 0113 244 3864 leeds@arpassociates.co.uk www.arpassociates.co.uk

Flood Risk Assessment on Development of Railway Cutting, Horton Street, Heckmondwike 1471/01r1				
Revision/Date	**Initial Issue 10th November 2017**	**Revision A**	**Revision B**	**Revision C**
Prepared By:	A R Poyser BSc (Hons) CEng MICE FCIHT			
Signature				
Checked By:	W M Walker BSc (Hons)			
Signature				
Reviewed By:	A Radcliffe BEng (Hons) CEng MIStructE			
Signature				

CONTENTS

1.0 INTRODUCTION

1.1 Yorkdales 2 Ltd is proposing to redevelop the site of the former railway cutting at Heckmondwike for new residential dwellings. As part of the development appraisal and due to the evidence of water flow along the dismantled railway cutting, it was decided that a Flood Risk Assessment Report should be undertaken.

1.2 It is within the general development strategy of the country for development in areas where there is a risk of flooding to be assessed to avoid unnecessary increase in the requirement for flood defence. Under the National Planning Policy Framework (NPPF) and the Planning Practice Guidance (PPG), consultation is required with the Environment Agency, Land Drainage Authority and Water Authority and a Flood Risk Assessment Report should be prepared considering the development proposals and make recommendations for any flood mitigation measures.

1.3 ARP Associates have been appointed to carry out an assessment of the site, implement appropriate consultations and prepare a Flood Risk Assessment Report, in accordance with NPPF, to satisfy the requirements of the Planning Authority.

1.4 The consultations and walkover survey have been undertaken in September and October 2017.

1.5 The report has been initially prepared for the use and reliance of the Client only. The report shall not be relied upon or transferred to any other parties without the written agreement of ARP Associates. For the avoidance of any doubt, where ARP Associates enters into a letter of reliance for the benefit of a third party, that third party will be permitted to rely on the report. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party without ARP Associates consent.

2.0 WALKOVER SURVEY

General

2.1 The former dismantled railway cutting in Heckmondwike is a long narrow, approximately rectangular shaped, piece of land equating to an area of 2.58ha. The Ordnance Survey Grid Reference is 421950 423200.

2.2 A site location plan is presented in Appendix A.

Current Use

2.3 The site is currently derelict with no current use and is overgrown. The deep cutting of the former railway can be seen and there is a flat base at the bottom of the cutting where an informal walkway has been created. This is used for dog walkers and, apparently, during times of heavy storm, water flows along the rail track in a north to south direction. Access to the base of the cutting is from beyond Walkley Lane and then under the bridge.

2.4 It is also noted there is a worn trackway along the northern boundary used to link Walkley Terrace and Horton Lane, which is to the northeastern corner.

Boundaries

2.5 The site is situated in the residential and industrial area of Heckmondwike, and extends between bridges on Brunswick Street and Walkley Lane. The northwestern boundary is formed by the single arched stone bridge under Brunswick Street, whilst the southeast is formed by a double spanned steel beam construction under Walkley Lane. At this latter location, there is a large pipe conduit passing adjacent to the bridge and over the cutting.

2.6 The long northeastern boundary is formed by a post and wire fence, generally with woodland beyond, although residential development behind walls, fences and hedges is

present to the far northeastern and southeastern corners. Horton Street provides access from Brunswick Street to the new development and creates a step in the boundary of the development site. On the long southwestern boundary, this is formed by fences, walls and hedges of residential and industrial development.

Topography

2.7 The former cutting is very deep extending to around 18m below the northeastern boundary and around 10m below the southwestern boundary. There is a general fall from northwest to southeast, although the northeastern boundary rises up to a high point at around mid-point along the elevation and falls in both directions towards Brunswick Street and Walkley Terrace. A topographical survey is presented in Appendix B.

2.8 It should be noted that the earth level under and adjacent to Walkley Lane Bridge is higher than the general channel level to the former railway cutting and will act as a "dam" to any surface water flow through the site.

Vegetation

2.9 The site is overgrown with bushes, small trees, brambles and other similar plant growth. Some mature trees are located at isolated points along the southwestern boundary and there is woodland beyond the northeastern boundary.

2.10 Overhead electricity cables start from a timber pole towards the northeastern corner at Horton Lane and these pass over the woodland to the northeast. It is presumed that an underground cable extends to this point from Horton Lane.

Drainage

2.11 There is no obvious signs of a positive drainage system within the site and it is unlikely that land drainage will be present. Due to the steeply sliding slopes on the cutting, it is anticipated that a drainage system would have been present when the system was used for

the railway line. This could have been an open ditch, watercourse or pipeline extending towards the southwest.

2.12 The nearest watercourse is the River Spen approximately 500m to the south.

3.0 ENVIRONMENT AGENCY CONSULTATION

3.1 A consultation was requested from the Environment Agency (EA) and a copy of their response, under reference RFI/2017/61406, dated 23rd October 2017, is presented in Appendix C for reference purposes. The flood map for planning shows areas of land that may flood from rivers or sea. These areas do not take into account defences, as these can overtop or fail in extreme conditions.

3.2 The Flood Map for planning shows that the site falls within land assessed as having less than a 1 in 1000 annual probability of river or sea flooding in any year (less than 0.1%).

3.3 There is no flood history available and any records held by the Environment Agency are from watercourses which were surveyed after flood occurs. Therefore, other flooding may have occurred which is not shown on the plan.

3.4 Asset defences are located on the River Spen to the south and southwest of the site and those defences nearest to the site have a condition rating of 3 and 4. It is unlikely, however, for the site to benefit from these defences as no flooding from this source is likely to occur.

3.5 Extracts from the River Spen Flood Warning Improvement Study dated March 2009 was included and the two nodes closest to the site show the 1% plus climate change flood level as 51.384m and 50.002m A.O.D. The topographical survey for the development site shows levels well above the flood levels and, it is unlikely that flooding would affect the development area.

3.6 Reference if made to the new guidance on Climate Change Allowances for Flood Risk Assessments published in February 2016.

3.7 The risk of flooding from overland surface water was also provided and the map shows a 1 in 30 chance of flood extent on the base of the former cutting along the full length of the development. It is considered that this is the most suitable outlet for surface water from Heckmondwike to the north running mainly off Market Street, along the embankment and outfalling to the River Spen to the south of the scheme.

4.0 WATER AUTHORITY CONSULTATION

4.1 A consultation was requested from Yorkshire Water, who are the Water Authority for this area and a copy of their correspondence, under reference T016220 dated 1st October 2017, is presented in Appendix D for reference purposes.

4.2 Foul water can discharge to the 375mm diameter public combined sewer recorded in Walkley Terrace adjacent to the southeastern corner of the site.

4.3 In respect of surface water, attenuation is drawn to requirement H3 of the Building Regulations 2000. This establishes a preferred hierarchy for surface water disposal with consideration firstly be given to discharge to soakaway, infiltration system and watercourse in that priority order before consideration of discharge to sewers. Reference is also made to Sustainable Drainage Systems.

4.4 As the proposal site is currently undeveloped, no surface water is known to discharge to the public sewer network. As such, the local public sewer network does not have capacity to accept any surface water from the proposal site.

4.5 Yorkshire Water understand that culverted watercourses are located through the northern and southern parts of the site, and this appears to be the obvious place for surface water disposal.

4.6 Consultations are recommended from then Environment Agency, Land Drainage Authority/Internal Drainage Board with regard to surface water disposal from the development site with regard to surface water disposal from the development site.

4.7 Land and highway drainage have no right of connection to the public sewer network and no land drainage is to be connected or discharged to the public sewer. Yorkshire Water may accept highway drainage under certain circumstances if it can be demonstrated through satisfactory evidence that Sustainable Drainage Systems are not a viable option and there are no suitable watercourses to receive highway drainage. This may require a formal agreement with Yorkshire Water services under Section 114 of the Water Industry Act 1991.

5.0 LAND DRAINAGE AUTHORITY CONSULTATION

5.1 A consultation was requested from Kirklees Council, who are the Land Drainage Authority for this area, and a copy of their e-mail response, dated 26th September 2017, is presented in Appendix E for reference purposes.

5.2 It is confirmed that the site falls within Flood Zone 1 - low risk.

5.3 However, the site is subject to surface water flood risk for the 1 in 100 year event with significant flooding in the cutting as all surface water in the district falls to this low spot. There is ponding shown upstream of Brunswick Street and adjacent to Artillery Street to around 1.2m in flat areas before the flow splits and flows through the site. Depths for the 1 in 30 year event are also just as significant and only get worse for the 1 in 1000 year event.

5.4 Properties will have to be significantly raised for safety and an estimation on depths given against current topography is required to see if the same volumes can be accommodated in a clear through route. It will be necessary to assess levels along the slope on the site to avoid low spots where ponding may occur and affect property curtilage. It is important that the road and footpaths only become the conduits, and curtilage is safe.

5.5 A full assessment of the catchment is recommended remembering that it is assumed that sewers have some capacity before surcharging.

5.6 In respect of surface water disposal, the BGS data suggests infiltration will be problematic. A connection to watercourse should be explored but the nearest is the River Spen and 500m to the south. There is a possibility of tributaries and open ditches that are not recorded or part-recorded closer to the site and the Authority is aware of a surcharging system across the greenway, but are unsure of its status. An investigation from the River Spen for outfalls that could be traced to be located nearer to the site will be required. If this research comes up with no viable opportunities, then a combined sewer can be considered.

5.7 Reference is made to a large combined trunk sewer located under the Spen valley greenway but Yorkshire Water will have to be consulted on possibilities for connection. Greenfield discharge rates of 5l/s/ha would be the maximum permitted to any system and the figure could be much lower resulting in increased demands on attenuation. Any attenuation structure of 1500mm or greater in span under the highway will result in problems in forming a Section 38 Agreement with Kirklees Council. It is recommended that exploration of locating attenuation under landscaped areas is required. It will be necessary show that the drainage infrastructure is maintained and managed for the lifetime of the development. Even if the systems are offered for adoption under a Section 104 Agreement, this may not happen for a number of years and, therefore, an undertaking to form a Management Company with appropriate maintenance and management plans is to be provided, but this can cease at the point of adoption by the Statutory Undertaker.

5.8 A scheme to prevent pollution and flooding during the construction phase will be required as part of any Planning Condition.

6.0 MATERIAL CONSIDERATION IN RESPECT OF NPPF AND PPG

Flood Classification

6.1 The consultation with the Environment Agency and Land Drainage Authority has identified that the site falls within land assessed as having greater than a 1 in 1000 (0.1%) or greater annual probability of river or sea flooding. In accordance with Table 1 of the PPG, the site falls within Flood Zone 1 "low probability".

6.2 All forms of development are satisfactory within this Flood Zone, but consideration of surface water affects should be considered within any Flood Risk Assessment.

End Use

6.3 The development proposal is for the construction of residential development on the site, and a copy of the proposed masterplan layout is presented in Appendix F for reference.

6.4 When applying Table 2 of the PPG, the flood risk vulnerability classification shows that the proposed end use will fall into a "more vulnerable" classification.

Sequential Test

6.5 As set out in the NPPF, the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding (Zone 1).

6.6 When the site is evaluated in accordance with Table 3 of the PPG, the development shows that the Sequential Test is satisfied.

Flood Sources

6.7 Flooding from Rivers - The River Spen is around 500m to the south of the site and flooding from this source is considered to be unlikely.

6.8 Flooding from Local Watercourses - There are no known watercourses within or adjacent to the proposed development site although there may be informal tributaries providing routes for surface water to the River Spen and, if any of these are identified within or adjacent to the site, then flooding from this source will need to be considered.

6.9 Flooding from the Sea - The site is not located near enough to the sea to cause a problem of flooding from this source.

6.10 Flooding from Land - The land is situated within the residential and industrial areas on the site and these areas will have positive drainage systems. However, surface water overflow occurs from the northwest where surface water flows into the cutting and continues along through the site to the southeast. Therefore, flooding from this source will need to be considered.

6.11 Flooding from Groundwater - Whilst there is no ground investigation report, the Geological Survey Map of Great Britain for the area shows that the site is located on undifferentiated strata (siltstones, mudstones and sandstones) of the Lower Coal Measures with the upper stratum likely to be weathered to a cohesive material (Clay). These soils are likely to have poor infiltration properties and the presence of the surface water overflows over the land would confirm that these soils will be impermeable. Therefore, flooding from this source is considered to be low risk.

6.12 Flooding from Sewer - A new drainage system will need to be introduced onto the site and it is possible that any blockage will result in flooding from the lowest cover level of manholes or gullies. This will need to be considered as part of any proposed development.

6.13 Flooding from Reservoirs, Canals or Artificial Sources - There are no other reservoirs, canals or artificial sources which will result in flooding on the site.

Climate Change

6.14 The NPPF and PPG has indicated that the Global sea level will continue to rise, depending on greenhouse gas emissions, and the sensitivity of the climate system and there will be an increase in rainfall across the country. The PPG makes reference to the Environment Agency guidance for Climate Change and Table 2 makes an assessment of the increase in peak rainfall intensity. The guidance was changed in February 2016, and increases in rainfall of up to 40% should be considered in certain areas of the country.

6.15 Whilst no surface water is likely to extend into the site from the developed areas, water flow from the northwest along the base of the former railway cutting will need to be considered and some form of culvert to provide a route through for the water without causing upstream or downstream flooding will need to be considered. This being the case, only rainfall falling within the site boundaries will need to be considered in respect of climate change.

6.16 In accordance with the revised climate change figures, for an expected life of greater than 50 years for any new development, the anticipated increase in rainfall will be 30% at this location, and the drainage system should be designed in accordance with this requirement.

Flood Mitigation

6.17 The site falls within Flood Zone 1, and the Sequential Test is satisfied. Therefore, it is only necessary to take account of precautionary mitigation measures in relation to a catastrophic storm blockage of the proposed drainage system on the site, although details need to be prepared to accommodate the overland surface water flows during times of heavy storm. Therefore, the mitigation measures proposed are as follows:-

6.17.1 It is reported that water flows upstream of the site and adjacent to Artillery Street where the channel is flat, are in the order of 1.2m deep during times of storm and a calculation showing the section of culvert required to accommodate this flow through the bottom of the cutting is presented in Appendix G. This shows that a 1.65m diameter culvert will need to be placed along a straight grade from Brunswick Street to Walkley Lane to enable the capacity of the flow of water to continue as present. Due to the size of the culvert, it will also be necessary to prevent unauthorised access and appropriate grills/steel fencing will need to be installed on both ends of the culvert. It will also have to be located outside any highway boundary.

6.17.2 Floor levels to the properties shall be lifted above the top of the soffit of the culvert with no development located over the line of the pipe. On this basis, it is recommended that the finished floor level will be 600mm above the soffit of the culvert as a minimum.

6.17.3 Properties shall be designed without any basements and ground floors shall comprise solid concrete slabs or beam and block with screed construction.

6.17.4 Incoming electricity supplies shall be raised above ground floor level and ground floor electric sockets shall be served by loops from first floor level.

6.17.5 In the event of surface water run-off over the site, it would be necessary to design external levels to allow the flow to run to the southwestern corner following the natural fall of the land or to non-sensitive areas such as Public Open Space.

Sustainable Drainage

6.18 In order to comply with the requirements of NPPF, it is necessary to consider aspects of Sustainable Drainage techniques for the new development. No intrusive investigation of the ground conditions has been undertaken, but the Geological Survey Map of Great Britain

shows that the site is located on undifferentiated strata (siltstones, mudstones and sandstones) of the Lower Coal Measures with the upper stratum likely to be weathered to a cohesive material (Clay). These soils are likely to have poor infiltration characteristics and the known flow of water over the land during times of flood would suggest that the soils will not allow infiltration. Furthermore, it is known that the site will be infilled to a significant depth and any soakaways used on the site are likely to filter through the backfill and create potential problems around the culvert in relation to settlement of fill above. Therefore, it is assumed, for the purposes of this report, that a positive drainage system will be required.

Drainage

6.19 It is a requirement to ensure that surface water run-off from any proposed development has negligible consequence on downstream areas either in sewer capacity or discharge to watercourse.

Surface Water Discharge

6.20 In consultation with the Land Drainage Authority, the greenfield discharge rate shall be limited to 5l/s/ha. Based on the site area of 2.58ha, the proposed surface water discharge rate is 12.9l/s.

Proposed Surface Water Drainage

6.21 Whilst it will be necessary to undertake infiltration testing on the site to determine if the natural soils are suitable for soakaways, the known overflow of water during times of flood would suggest that the soils are impermeable. Furthermore, the site will be infilled to make the development construction practical, and it would be inappropriate to allow water to percolate through the fill over impermeable strata creating a "Well effect" below the development. Therefore, soakaways are considered to be an impractical solution for surface water discharge at this site. Furthermore, the nearest watercourse is 500m to the south and there is no obvious tributary to the River from the development on viewing the immediate

area. Therefore, consultations have commenced with Yorkshire Water to consider the possibility of a discharge to the public combined sewers in the vicinity around Walkley Lane. This correspondence is presented in Appendix D for reference purposes.

6.22 On the basis that an agreed surface water discharge rate of 12.9l/s can be negotiated, indicative calculations have been undertaken to determine the likely attenuation requirements for the new development site. The proposed development plan, which is presented in Appendix F, is insufficient to undertake detailed calculations of the proposed impermeable area and, therefore, it is assumed that 50% of the total site area (1.29ha) will become impermeable on completion of the development. On this basis, the indicative calculations have been carried out using the WinDES Source Control Computer Program and this shows that a volume of 324.7m^3 will be required to be attenuated for the 1 in 30 year storm. This can be achieved by several methods, including oversize pipes, underground tanks or balance ponds. One such option would be to provide 113m of 2.4m x 1.2m box culvert or equivalent. It will also be necessary to show that the 1 in 100 year event plus 30% allowance for climate change can be retained on site without causing flooding of buildings or third party land. In a worst case scenario, the attenuation volume would need to increase to 649.9m^3. The indicative surface water drainage calculations are presented in Appendix H, but detailed calculations and proposals will need to be prepared and submitted to the Planning Authority for approval prior to construction on site.

Foul Drainage

6.23 Foul drainage can discharge to the 375mm diameter public combined sewer recorded in Walkley Terrace adjacent to the southeast corner of the site.

Emergency Egress During Times of Flood

6.24 It is a requirement under the PPG that occupants should be able to egress any building during times of flood, without being trapped by flood conditions.

6.25 As the site falls within Flood Zone 1, no special mitigation measures are required in respect of emergency egress.

7.0 COMMENTS

7.1 The site falls within Flood Zone 1 and the Sequential Test is satisfied.

7.2 Flood mitigation measures are recommended in relation to the surface water overflow from the railway cutting, a catastrophic storm or blockage of the proposed drainage system. In these circumstances, the following mitigation measures are recommended.

7.2.1 The calculations show that a 1650mm diameter surface water culvert is required to be laid at a constant grade between the levels under Brunswick Street bridge and Walkley Lane bridge to accommodate overland surface water during times of storm.

7.2.2 Properties shall be raised a minimum of 600mm above the soffit of the new culvert.

7.2.3 Properties shall be designed without any basements and ground floors shall comprise solid concrete slabs or beam and block with screed construction.

7.2.4 Incoming electricity supplies shall be raised above ground floor level and ground floor electric sockets shall be served by loops from first floor level.

7.2.5 In the event of flooding of the site, it will be necessary to ensure that there is a route for flood water through to the southeastern corner or to non-sensitive areas such as Public Open Space without causing flooding to buildings.

7.3 A 30% increase in rainfall shall be incorporated into any new positive drainage system to satisfy the requirements of climate change.

7.4 Sustainable Drainage Systems of infiltration techniques are considered to be unsuitable on this particular site and there are no suitable watercourse outlets in the vicinity of the site. Therefore, the proposed surface water drainage system shall be restricted to the existing 5l/s/ha greenfield run-off rate and shall be attenuated for a minimum 1 in 30 year storm.

The 1 in 100 year storm plus climate change event shall also be accommodated within the system without causing flooding of buildings or third party land. Outfall into the combined sewers to the south of the site is being negotiated with Yorkshire Water at this time. The design, details and calculations shall be submitted to the Planning Authority for approval prior to construction on site.

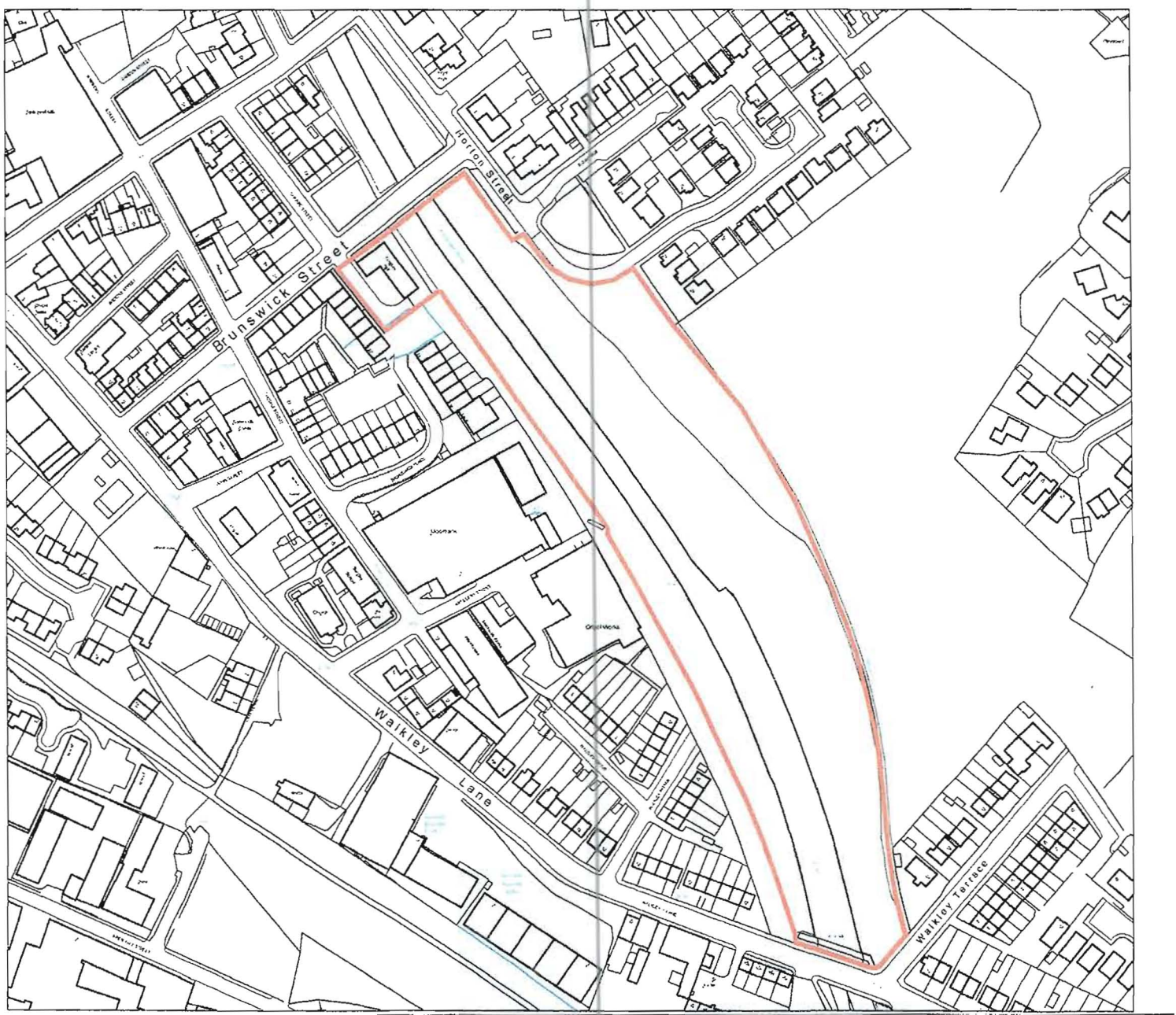
7.5 Foul water can discharge to the existing 375mm diameter public combined sewer in Walkley Terrace.

7.6 There are no special requirements for emergency egress.

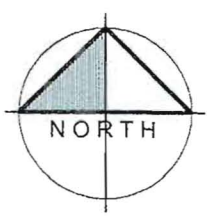
7.7 Subject to compliance with the above, the proposed development can satisfy the requirements of the National Planning Policy Framework and the Planning Practice Guidance in relation to flood risk.

A P P E N D I X A

SITE LOCATION PLAN



Location Plan 1:2500 @ A4



APPENDIX B

TOPOGRAPHICAL SURVEY

423100 N
423050 N
423000 N
421950 E
421900 E
423150 N
423100 N
423050 N
423000 N
423200 N
421850 E
421800 E

APPENDIX C

ENVIRONMENT AGENCY CONSULTATION

Allan Poyser

From: Andrew Radcliffe
Sent: Monday 23 October, 2017 1:09 pm
To: Allan Poyser; Wayne Walker
Subject: FW: Your Enquiry: RFI/2017/61406
Attachments: flood risk & flood consequence assessments.pdf; Asset Defence Map - 61406.pdf; Asset Information - 61406.pdf; Flood Map for Planning - 61406.pdf; Modelled Measurements - 61406.pdf; Node Point Map - 61406.pdf; Surface Water - 61406.pdf

fyi

Kind Regards

Andrew
0113 245 8498
andrewradcliffe@arpassociates.co.uk

ARP ASSOCIATES &
ARP GEOTECHNICAL LTD

www.arpassociates.co.uk

5 & 6 Northwest Business Park, Servia Hill, Leeds LS6 2QH
Pre-planning Geotechnical Civil Engineering Structural Engineering

---

From: Reilly, Hilary [mailto:Hilary.Reilly@environment-agency.gov.uk]
Sent: Monday 23 October, 2017 11:47am
To: Leeds Assoc
Subject: Your Enquiry: RFI/2017/61406

Our Ref: RFI/2017/61406

Your Ref:

Dear Mr. Poyser

Provision of Product 4 (Ernest Gordon Ltd - Disused Railway Cutting, Heckmondwike)

Thank you for your request of 22nd September to use Environment Agency data, in the development of the above site. The information is attached.

If you have requested this information to help inform a development proposal, then you should note the detail in the attached advisory text on the use of Environment Agency Information for Flood Risk Assessments.

Supporting Information

The Flood Map for Planning

The Environment Agency provides the Flood Map (see enclosed extract).

What is the Flood Map for Planning?

The Flood Map for Planning provides information on flooding from rivers and the sea for England and Wales. The Flood Map also has information on flood defences and the areas benefiting from those flood defences.

The Flood Map for Planning shows the following:

1. Flood Zone 3 (dark blue area on the enclosed map): natural flood plain area that could be affected by flooding from rivers and/or the sea – not taking into account the presence of any flood defences
   - For flooding from rivers the map indicates the extent of a flood with a 1% (1 in 100) chance of happening each year;
   - For flooding from the sea the map shows the extent of a flood with a 0.5% (1 in 200) chance of happening each year.

2. Flood Zone 2 (light blue area): natural flood plain area that could be affected by flooding from rivers and/or the sea – not taking into account the presence of any flood defences. Flood Zone 2:
   - indicates the extent of a flood with a 0.1% (1 in 1000) chance of happening each year.
   - and/or indicates the greatest recorded historic flood, whichever is greater.

3. Flood defences built in the last five years to protect against river floods with a 1% (1 in 100) chance of happening each year, together with some natural or constructed entities which retain, store or channel water and which may protect against smaller floods.

4. Areas benefiting from flood defences - areas that benefit from the flood defences shown, in the event of a river flood with a 1% (1 in 100) chance of happening each year, or a flood from the sea with a 0.5% (1 in 200) chance of happening each year. If the defences were not there, these areas would flood.

Flood History

Flood History – None available

To the best of our knowledge there is no known flood history for this site. The extent of flooding, and/or flood level information is only shown for those watercourses surveyed after the flood. Other flooding may have occurred which is not shown. This is the best information currently available. For local drainage information please contact your water utility company and your local council.

Water causing flooding can come from different places, for example from rivers or the sea; surface water (i.e. rainwater flowing over or accumulating on the ground before it is able to enter rivers or the drainage system); overflowing or backing up of sewers or drainage systems which have been overwhelmed or from groundwater rising up from underground aquifers.

Currently the Environment Agency can only supply flood risk data relating to the risk of flooding from rivers or the sea. However you should be aware that in recent years, there has been an increase in flood damage caused by surface water flooding or drainage systems that have been overwhelmed. Local Authorities and/or Water Companies may be able to provide some knowledge on the risk of flooding from sources other than rivers and the sea and we are working with these organisations to improve knowledge and understanding of surface water flooding.

Assets

If no formal flood defences use:
We have no record of flood defences helping to reduce flood risk in your area of interest. However please find attached a map and asset information of the closest defences.

Asset Location Map
Please find attached asset map(s) showing location of all (Agency and non-Agency maintained) flood defences and channels.

Description of Works
See attached table with description of the defences and structures shown on the above drawing, including condition ratings, upstream and downstream crest levels, where available.

Risk of Flooding – Environment Agency Defences
The risk of flooding in this area is now reduced by the presence of flood defences that we maintain, but there still is a residual risk of flooding if these were to breach or be overtopped by a flood greater than that for which they were designed.

Risk of Flooding – Privately Maintained Defences
You will see that the Environment Agency does not maintain any of those defences. However we undertake regular risk based visual inspections. We do not hold design levels and have no height information on these defences or structures.

Asset Condition Ratings
The performance of a flood defence asset is recorded as the condition of the asset. Our asset inspectors subjectively assess the conditions of assets (during visual inspection site visits) with reference to a national standard template. Each asset is given a rating between one and five with one being very good condition and five being very poor. A condition rating of 3, or 'fair' is the minimal acceptable standard for a critical asset, such as a defence wall that protects properties. We are striving to improve all assets below 'fair' to an acceptable standard.

Asset inspections are done on average every six months, although some critical assets are assessed on a more regular basis. It is possible that adjacent assets are inspected on different dates, which may result in two assets of a similar state of repair having different condition ratings.

Condition ratings of assets may also be affected by the time of year the surveys are conducted, as vegetation may obscure the asset in the summer months, or accessibility may be an issue during winter months. These factors would not usually affect the recorded condition rating of an asset unless the asset is on a borderline between two ratings.

Asset Standard of Protection
Please note that the provided Design Standard of Protection is an estimate and should not be relied on. Please note that where available the defended flood extents provide more reliable information relating to the protection offered by the defence (i.e. at which return period the water levels are likely to overtop the defence). If available and required the defended flood extents can be provided on request.

Modelling

Modelling: Detailed Flood Plain Mapping Report
See enclosed extracts from River Spen Flood Warning Improvement Study produced by JBA in March 2009. Extracts include 20%, 10%, 4%, 2% 1.33%, 1%, 1% +climate change and 0.1% annual probabilities.

Climate Change
Please note that new guidance on climate change allowances for Flood Risk Assessments has been published in February 2016.
The new guidelines are available from:
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Other

Surface Water Map

Risk of flooding from surface water information for Heckmondwike WF16 0LW

Thank you for your enquiry dated 28/09/17 regarding the above location.

Enclosed is a map of showing the risk of flooding from surface water for this area, produced in partnership with Local Authorities.

Surface water flood risk is widely distributed and can happen far from rivers and the sea. It's sometimes hard to say whether you're in an area at risk of flooding from surface water because surface water flooding can follow many more paths and can be affected by very small features such as kerb height and even speed bumps. We recommend you consider not only whether your property is shown in or near an area at risk, but also the broader scale and pattern of surface water flooding shown in your area. You may also wish to view this and other flood risk maps on our website.

Whether your property is at risk will depend on the accuracy of the mapping in this area, and on the details of your property – for example, how waterproof the structure is, the levels of doors and airbricks, and whether you have installed any flood resilience measures such as airbrick covers and flood boards.

If you require information on what is being done to manage surface water flood risk in your local area, please contact Kirklees Council.

Information Warning

Please note:

It is not possible to say for certain what the flood risk is but we use the best information available to provide an indication so that people can make informed choices about living with or managing the risks. The information we supply does not provide an indicator of flood risk at an individual property / site level.

The flood risk information provided on the attached map does not cover other sources of flooding such as from rivers and sea.

Risk of Flooding from Reservoirs Map
Outlines and simplified depth and velocity maps can be viewed on our website:
http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=reservoir&scale=1&textonly=off&ep=map&layerGroups=default&lang=_e&y=355134&x=357683#x=438988&y=406600&scale=2

Please, zoom into the location of interest, and then click on the inundated location for details. As a result a list of reservoirs will be provided with supporting information and a links to other data, such as estimated depths and speed of flooding, at the bottom of the result page.

A map of showing the outlines can also be provided on request.

Flood Warning
The site is covered by a Flood Warning. To register to receive this service, you can call Floodline 24 hours a day on 0845 988 1188.

LIDAR Data
Please note that our LiDAR data is now available free of charge (Open Data) from http://environment.data.gov.uk/ds/survey/index.jsp#/survey (once zoomed to the relevant location the available LiDAR products will be listed below the map).

Two LIDAR products are available:

1. Tiled LIDAR data - The full tiled dataset consists of historic LIDAR data which has been gathered since 1998. For some areas we have carried out repeat surveys and data is available in a range of resolutions.
2. Composite LIDAR data - The composite dataset is derived from a combination of our full tiled dataset which has been merged and re-sampled to give the best possible spatial coverage.

Light Detection and Ranging (LIDAR) is an airborne mapping technique, which uses a laser to measure the distance between the aircraft and the ground. This technique results in the production of an accurate, cost-effective terrain model suitable for assessing flood risk and other environmental applications.

The Environment Agency owns two LIDAR systems, which are installed in a survey aircraft along with its other operational remote sensing instruments.

The aircraft is positioned and navigated using Global Positioning System (GPS) corrected to known ground reference points. The aircraft typically flies at a height of about 800 metres above ground level and a scanning mirror allows a swath width of about 600 metres to be surveyed during a flight.

The Rights & Responsibilities of a Riverside Owner
The owner of property adjacent to a watercourse is usually deemed to be the riparian owner and, as such, has both riparian rights and responsibilities with regard to the watercourse within their ownership.

The responsibility for general maintenance and repair of the watercourse and its banks rests with the riparian owner. For more information on Rights and Responsibilities of a riverside owner, you can visit our website at: https://www.gov.uk/government/organisations/environment-agency go to the Flooding and coastal change section and click on 'Riverside ownership: rights and responsibilities ('living on the edge') under the River maintenance section and download the 'Living on the Edge' booklet.

Alternatively type the following address into your web browser:
https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities

Ordnance Survey Data
Under the terms of our licence agreement with the Ordnance Survey, we are unable to supply the OS data. Under this agreement we can only supply OS data to consultants/contractors carrying out work on our behalf.

Flood Portal
It's a new 'one-stop shop' web portal providing guidance and information on flood risk management in the UK. Arup have written and designed the site, in conjunction with CIRIA, the Local Government Association, the EA and Defra, primarily as a resource for local authority officers, flood risk management professionals, and others with an interest in flood risk. It's a part of the Capacity Building Strategy.
http://www.local.gov.uk/floodportal

If you have any queries or would like to discuss the content of this letter further please contact us on the telephone number below.

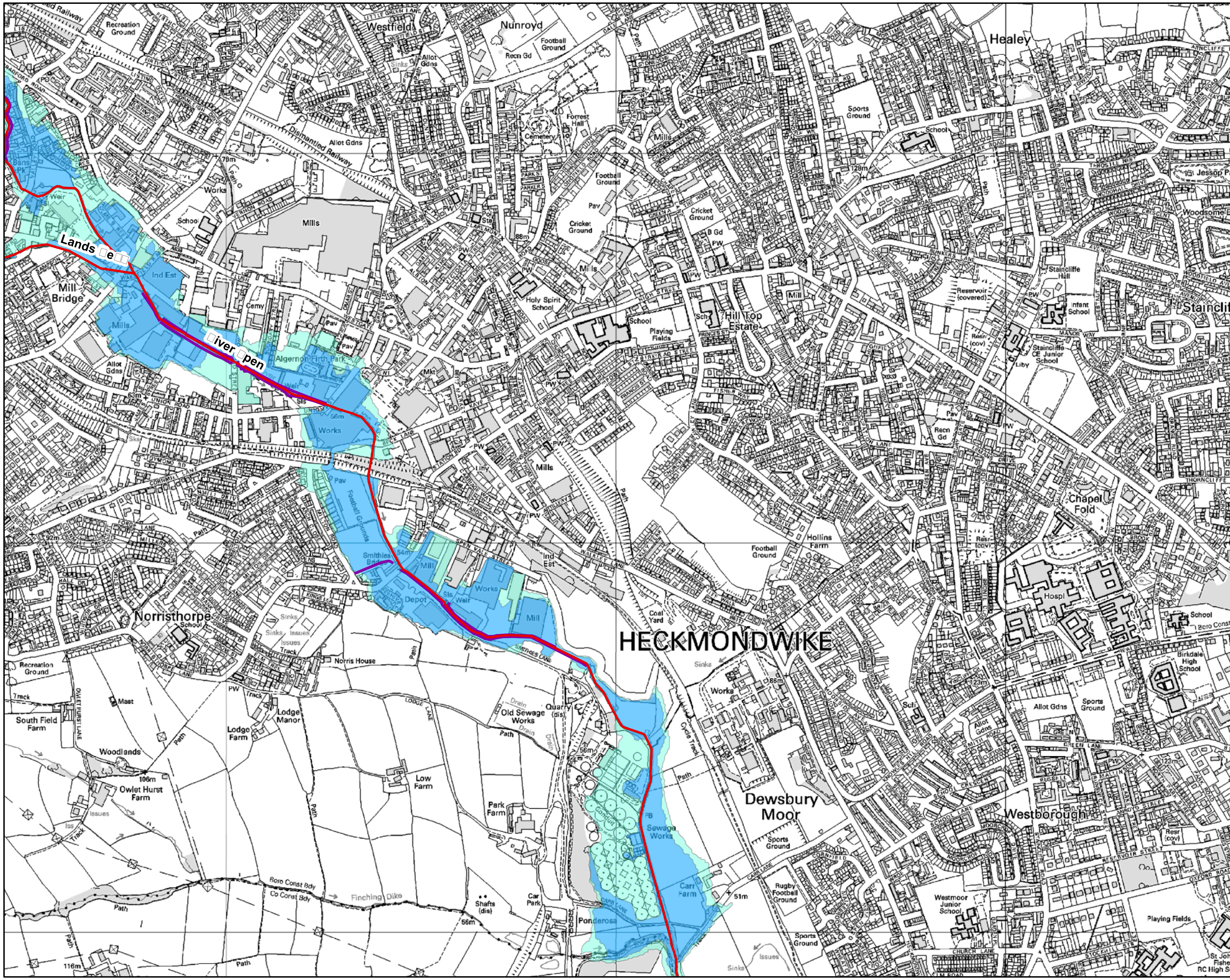
We would be really grateful if you could spare five minutes to help us improve our service. Please click on the link below and fill in our survey – we use every piece of feedback we receive:

http://www.smartsurvey.co.uk/s/EnvironmentAgencyCustomerSurvey/?a=Y

Yours sincerely,

Hilary Reilly/Customer Engagement Team
Environment Agency | Lateral, 8 City Walk, Leeds, LS11 9AT
Enquiries Team Tel: 0208 4748174 / Email: neyorkshire@environment-agency.gov.uk
Direct Tel: 0208 4747695 / Email: hilary.reilly@environment-agency.gov.uk

□□l□□□□□□ □lood Map □or □lannin□ □or □e□□mond□i□e □ □□□ □L□ Date □reated□□□□□□□□



Environment Agency

www.environment-agency.gov.uk

Scale: 1:10,000

when reproduced @ A3

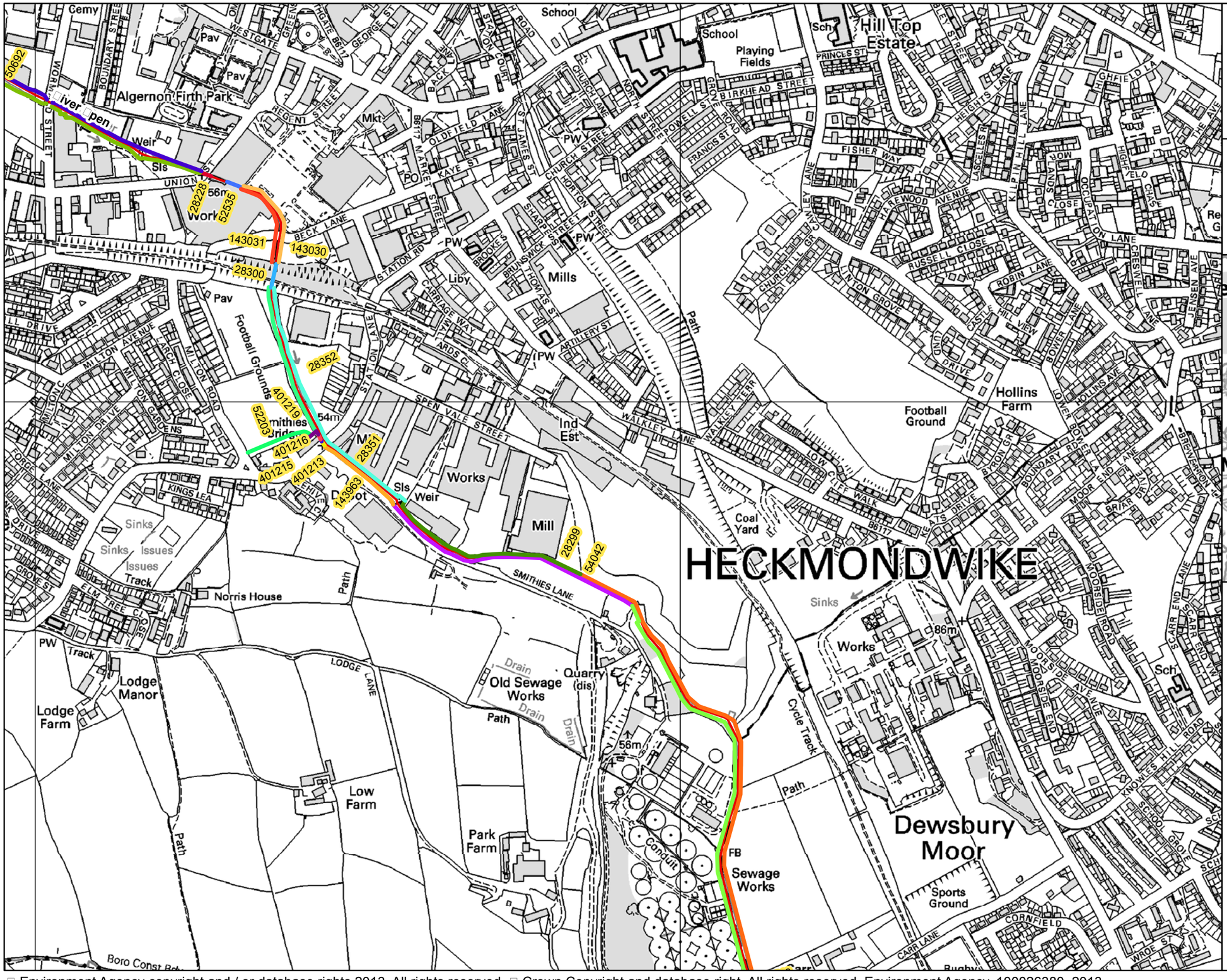
N S E W

L□□□□D

- Main River
- Flood Map Flood Defences
- Areas Benefitting From Flood Defences
- Flood Storage Areas
- Flood □one 3 (F□3)
- Flood □one 2 (F□2)

Contact Us: National Customer Contact Centre, PO Bo□544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: en□uiries@environment-agency.gov.uk

□□l□□□□□ □sset De□en□e Map □or □e□□mond□i□e □ □□□ □L□ Date □reated□□□□□□□□



Environment Agency

www.environment-agency.gov.uk

Scale: 1:6,000

N W E S

when reproduced @ A3

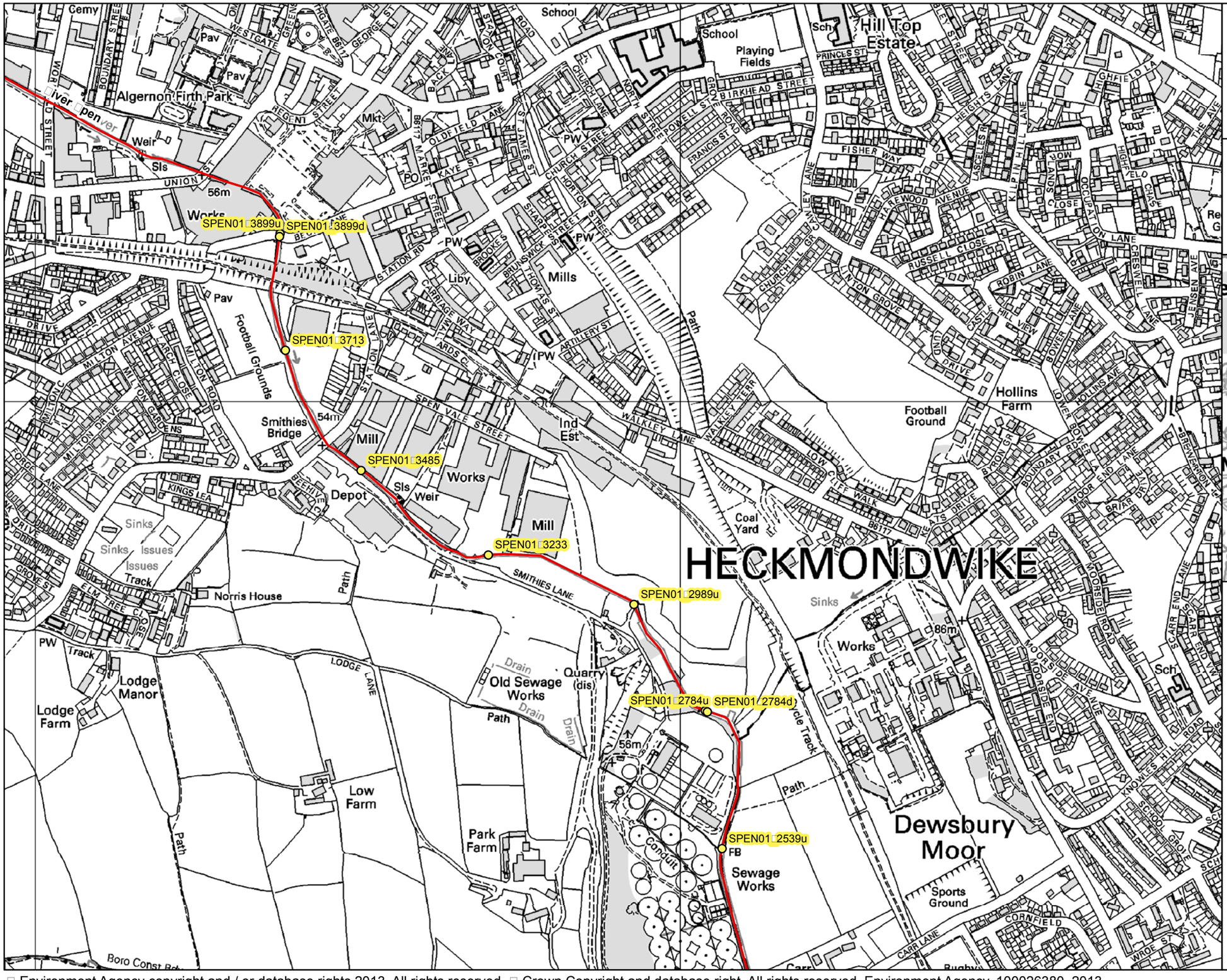
L□□□D

Main River	143963	50691
De□en□es	143031	28352
□□□□□□ID	143030	28351
401219	54042	28300
401216	52535	28299
401215	52204	28228
401213	52203	
174748	50692	

Contact Us: National Customer Contact Centre, PO Bo□544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: en□uiries@environment-agency.gov.uk

□□l □o□□□□□□ □sset In□ormation									
□sset ID	□sset □□pe	□sset □□□t□pe	Maintainer	Des□ription	□an□	Desi□n □tandard o□ □rote□tion □□rs□	□□t□al Do□nstream □rest Level □m□□D□	□□t□al □pstream □rest Level □m□□D□	□□t□al □ondition □atin□
50691	Defence	High□Ground	Private	Natural Channel With Gabions D/S	Left	50	No data	No data	4
54042	Defence	Wall	Private	Open Channel With Flood Wall	Right	No data	No data	No data	4
28299	Defence	Wall	Environment□Agency	Walled Channel	Left	50	53.150	53.150	4
28351	Defence	Wall	Environment□Agency	Sheet Piles And Masonry Wall	Right	50	53.300	54.260	3
52203	Defence	Embankment	Environment□Agency	Floodbank. Raised Floodbank Boundary To The Playing Field □ Washland, Protects Housing Adjacent To Smithies Bridge.	Right	50	54.502	55.230	2
28352	Defence	High□Ground	Private	Open And Natural Channel	Right	50	No data	No data	3
28300	Channel	Simple□Culvert	Private	Culvert	n/a	50	No data	No data	3
52535	Channel	Simple□Culvert	Private	Bo□Culvert.	n/a	50	No data	No data	4
28228	Channel	Simple□Culvert	Local□Authority	Road Bridge	n/a	50	No data	No data	4
174748	Defence	High□Ground	Private	Natural Channel	Right	50	No data	No data	4
143963	Defence	High□Ground	Private	Maintained Channel With Walls	Left	50	53.150	54.760	4
401213	Defence	Bridge□Abutment	Private	Bridge Abutment	Right	No data	No data	No data	2
401215	Defence	Wall	Environment□Agency	Wall. (Between Bridge And House)	Right	No data	54.595	54.595	2
401216	Defence	Wall	Private	Terrace House End Wall Acting As Flood Defence.	Right	No data	No data	No data	1
401219	Defence	Wall	Environment□Agency	Wall (Tie In Between House And Embankment)	Right	No data	54.575	54.575	2
143030	Defence	High□Ground	Private	Walled Channel Side	Left	50	No data	No data	4
143031	Defence	High□Ground	Private	Walled Channel Side	Right	50	No data	No data	3
52204	Defence	Wall	Private	Walled Channel With Culvert	Right	50	57.080	58.560	3
50692	Defence	Wall	Private	Walled Channel - Includes Culvert And Road Bridges	Left	50	57.070	57.600	3

□□l□□□□□ □ode □oint Map □or □e□□mond□i□e □ □□□ □L□ Date □reated□□□□□□□□



Environment Agency

www.environment-agency.gov.uk

Scale: 1:6,000

N W E S

when reproduced @ A3

L□□□D

- Node Reference
- Main River

Contact Us: National Customer Contact Centre, PO Bo□544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: en□uiries@environment-agency.gov.uk

Modelled Meas□rements □□□□□□

2009 River Spen Model Results

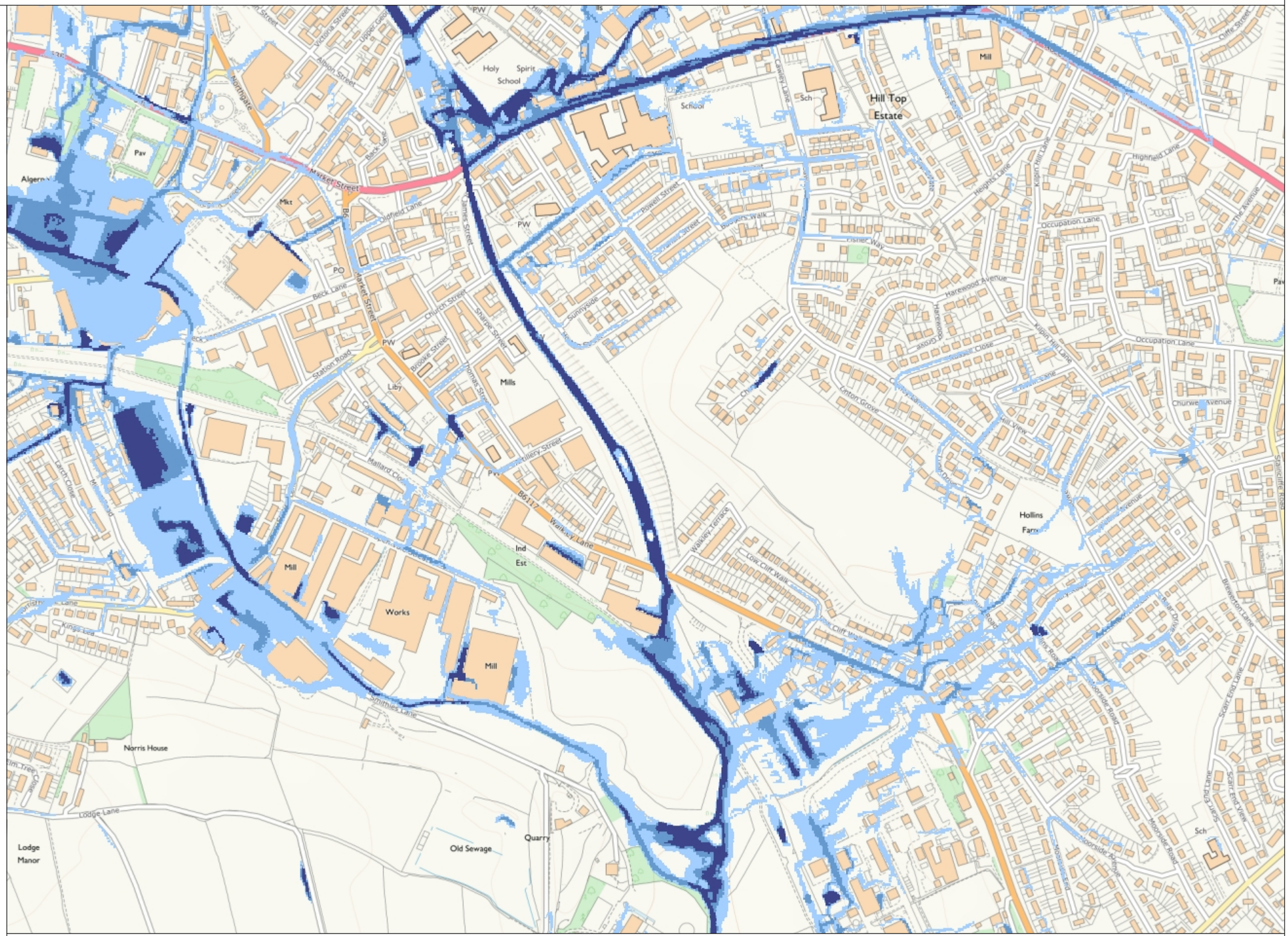
	□□□ ann□al pro□a□ilit□		□□□ ann□al pro□a□ilit□		□□ ann□al pro□a□ilit□		□□ ann□al pro□a□ilit□		□□□□□ ann□al		□□ ann□al pro□a□ilit□		□□ □□□ ann□al		□□□□ ann□al pro□a□ilit□	
Label	Ma□ □ta□e	Ma□ □lo□	Ma□ □ta□e	Ma□ □lo□	Ma□ □ta□e	Ma□ □lo□	Ma□ □ta□e	Ma□ □lo□	Ma□ □ta□e	Ma□ □lo□	Ma□ □ta□e	Ma□ □lo□	Ma□ □ta□e	Ma□ □lo□	Ma□ □ta□e	Ma□ □lo□
SPEN01□3899u	55.15	18.66	55.307	20.361	55.509	22.907	55.632	24.258	55.717	24.575	55.776	24.857	56.041	26.096	56.889	26.511
SPEN01□3899d	55.15	18.66	55.307	20.361	55.508	22.907	55.625	24.258	55.676	24.575	55.72	24.857	55.988	26.096	56.843	26.511
SPEN01□3713	54.081	12.785	54.165	13.421	54.25	15.256	54.296	16.665	54.319	17.364	54.333	17.918	54.402	21.233	54.63	34.413
SPEN01□3485	53.169	20.257	53.214	21.71	53.331	23.261	53.387	24.417	53.419	25.121	53.441	25.426	53.56	28.231	54.065	32.574
SPEN01□3233	51.925	20.252	52.018	21.638	52.369	26.679	52.525	28.918	52.622	29.074	52.672	29.297	52.934	30.185	53.827	31.348
SPEN01□2989u	49.97	20.233	50.092	21.612	50.563	26.948	50.767	28.634	50.926	29.354	51.014	29.414	51.384	29.638	52.042	30.629
SPEN01□2784u	49.115	18.383	49.198	18.773	49.436	20.086	49.551	20.719	49.648	20.731	49.718	20.706	50.002	20.506	50.663	25.082
SPEN01□2784d	49.11	18.383	49.187	18.773	49.396	20.086	49.494	20.719	49.58	20.731	49.631	20.706	49.885	20.506	50.536	25.082
SPEN01□2539u	48.021	21.856	48.124	22.641	48.33	23.747	48.458	24.202	48.536	24.433	48.586	24.52	48.824	25.076	49.465	26.698
LAND01□0335	64.691	2.14	64.772	2.53	64.868	3.05	64.934	3.45	64.972	3.69	64.998	3.86	65.115	4.632	65.474	8.08
LAND01□0297	64.065	2.137	64.12	2.53	64.185	3.05	64.23	3.449	64.257	3.689	64.271	3.859	64.482	4.63	64.74	7.906
LAND01□0249	62.258	2.138	62.355	2.53	62.626	3.049	63.25	3.43	63.612	3.67	63.815	3.834	64.373	4.259	64.626	4.333
LAND01□0189	60.741	2.138	60.881	2.53	61.229	3.048	61.611	3.43	61.733	3.67	61.766	3.834	61.869	4.259	62.084	4.333
LAND01□0162	60.135	2.138	60.256	2.53	60.878	3.044	61.397	3.418	61.549	3.541	61.59	3.562	61.71	3.573	61.907	3.503

Surface Water Flood Map for Heckmondwike WF16 0LW. RFI 61406 Date 03/10/17

Environment Agency

Legend

- Flood Extent 1 in 30
- Flood Extent 1 in 100
- Flood Extent 1 in 1000



0 50 100 150

Metres

N W E S

□se o□ □nvironment □□en□□ In□ormation □or □lood □is□ □ □lood □onse□□en□e □ssessments

Important
If you have re□uested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application en□uiry using the form available from our website:-

http://www.environment-agency.gov.uk/research/planning/33580.asp□

Depending on the en□uiry, we may also provide advice on other issues related to our responsibilities including flooding, waste, land contamination, water □uality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

In □**n□land**, you should refer to the Environment Agency□s Flood Risk Standing Advice, the technical guidance to the National Planning Policy Framework and the e□isting PPS25 Practice Guide for information about what flood risk assessment is needed for new development in the different Flood □ones. These documents can be accessed via:

http://www.environment-agency.gov.uk/research/planning/82587.asp□

http://www.communities.gov.uk/publications/planningandbuilding/nppftechnicalguidance

http://www.communities.gov.uk/publications/planningandbuilding/pps25guideupdate

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

In □ **ales**□ you should refer to TAN15 for information about what flood conse□uence assessment is needed for new development in the different flood □ones
http://new.wales.gov.uk/splash□jsessionid□8ylGTfG□thmB0t2vhp6hS1GcB1L□v□□B3Yl□f20□n7LK3□K0nMk□981825250□orig□/topics/planning/policy/tans/tan15/

You should also consult the Strategic Flood Conse□uence Assessment if one has been produced by your local planning authority.

In both □n□land and □ ales you should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk / Conse□uence Assessment (FRA / FCA) where one is re□uired, but does not constitute such an assessment on its own.

2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.

3. Where a planning application re□uires a FRA / FCA and this is not submitted or deficient, the Environment Agency may well raise an objection.

4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.

APPENDIX D

WATER AUTHORITY CONSULTATION

YorkshireWater

Mr A □o□ser
□rp □sso□iates
□nit 5□6 □ort□□est □□siness Pk
1ST F LR □ervia □ill
□ ood□o□se
Leeds
L□6 2QH

□or□s□ire □ ater □ervi□es
Developer □ervi□es
□e□era□e □e□□ni□al □eam
PO BOX 52
□rad□ord
□D3 7AY

□el: 0345 120 8482
Fax: (01274) 372 834

□o□r □e□: □RP 1471 □01
Our Ref: T016220

□mail:
□e□□ni□al. □e□era□e@ □or□s□ire□ater. □o. □□

□or telep□one en□□iries rin□:
□□ris □o□erts on 0345 120 8482

□st □□to□er 2017

Dear Mr Poyser,

Dis□sed □ail□a□ □□ttin□ Off □ **al□le□ Lane □e□□mond□i□e** - **□re □lannin□ □e□era□e □n□□ir□ □n**
R713401

Thank you for your recent en□uiry. Our charge of £153.00 (plus VAT) will be added to your account with us, reference ARP013. You will receive an invoice for your account in due course.

Please find enclosed a complimentary e□tract from the Statutory Sewer Map which indicates the recorded position of the public sewers. Please note that as of October 2011 and the private to public sewer transfer, there are many uncharted Yorkshire Water assets currently not shown on our records. The following comments reflect our view, with regard to the public sewer network only, based on a 'desk top' study of the site and are valid for a ma□imum period of twelve months.

Development of the site should take place with separate systems for foul and surface water drainage. The separate systems should e□tend to the points of discharge to be agreed.

□o□l □ ater

Foul water domestic waste should discharge to the 375 mm diameter public combined sewer recorded in Walkley Terrace, at a point to the south east the site.

□□r□a□e □ ater

The developer's attention is drawn to Re□uirement H3 of the Building Regulations 2000. This establishes a preferred hierarchy for surface water disposal. Consideration should firstly be given to discharge to soakaway, infiltration system and watercourse in that priority order.

Sustainable Drainage Systems (SuDS), for e□ample the use of soakaways and/or permeable hardstanding etc, may be a suitable solution for surface water disposal appropriate in this situation. You are advised to seek comments on the suitability of SuDS in this instance from the appropriate authorities.

As the proposal site is currently undeveloped no surface water is known to discharged to the public sewer network

YorkshireWater

As such, the local public sewer network does not have capacity to accept any surface water from the proposed site. If SuDS are not viable, the developer is advised to contact the Environment Agency/local Land Drainage Authority/Internal Drainage Board with a view to establishing a suitable watercourse for discharge.

It is understood that a culverted watercourse is located through the northern and southern parts of the site This appears to be the obvious place for surface water disposal (if SuDS are not viable).

Please note further restrictions on surface water disposal from the site may be imposed by other parties. You are strongly advised to seek advice/comments from the Environment Agency/Land Drainage Authority/Internal Drainage Board, with regard to surface water disposal from the site.

□t□er □□servations

Any new connection to an e□isting public sewer will re□uire the prior approval of Yorkshire Water. You may obtain an application form from our website (www.yorkshirewater.com) or by telephoning 0345 120 84 82.

An off-site foul and surface water sewer may be re□uired which may be provided by the developer and considered for adoption under Section 104 of the Water Industry Act 1991. Please telephone 0345 120 84 82 for advice on sewer adoptions. Alternatively, the developer may in certain circumstances be able to re□uisition off-site sewers under Section 98 of the Water Industry Act 1991 for which an application must be made in writing. For further information, please telephone 0345 120 84 82.

Prospectively adoptable sewers and pumping stations must be designed and constructed in accordance with the WRc publication "Sewers for Adoption - a design and construction guide for developers" 6th Edition as supplemented by Yorkshire Water's re□uirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site. Please contact our Developer Services Team (telephone 0345 120 84 82) for further information.

The public sewer network is for domestic sewage purposes. This generally means foul water for domestic purposes and, where a suitable surface water or combined sewer is available, surface water from the roofs of buildings together with surface water from paved areas of land appurtenant to those buildings. Land and highway drainage have no right of connection to the public sewer network. No land drainage to be connected/discharged to public sewer.

As a last resort, highway drainage may be accepted under certain circumstances. If it can be demonstrated, through satisfactory evidence, that SUDS are not a viable option, there are no watercourses or highway drains available and if capacity is available within the public sewer network, highway drainage discharges to the public sewer network may be permitted. In this event, the developer may be re□uired to enter into a formal agreement with Yorkshire Water Services under Section 115 Water Industry Act 1991 to discharge non-domestic flows into the public sewer network.

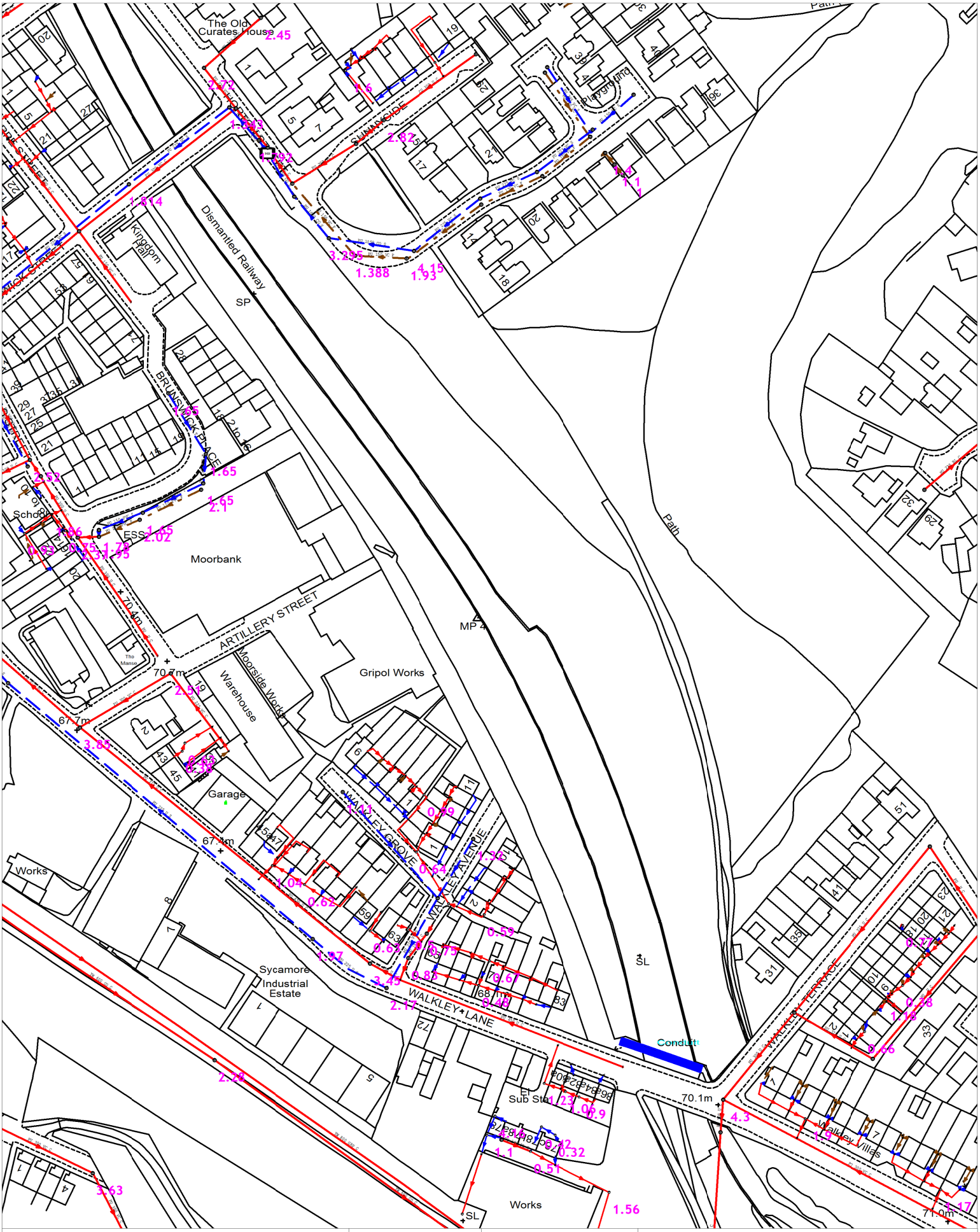
All the above comments are based upon the information and records available at the present time. The information contained in this letter together with that shown on any e□tract from the Statutory Sewer Map that may be enclosed is believed to be correct and is supplied in good faith.

YorkshireWater

Please note that capacity in the public sewer network is not reserved for specific future development. It is used up on a 'first come, first served' basis. You should visit the site and establish the line and level of any public sewers affecting your proposals before the commencement of any design work.

Yours sincerely

□□ris □o□erts
□e□era□e □e□□ni□ian
Developer □ervi□es



421800 : 422924	Map Name : SE2122NE	Title
YorkshireWater	Yorkshire Water, PO Box 500, Halifax Road, Bradford BD6 2LZ Contact Name : YorMap Advisor C ROBERTS Contact Tel : 87 2582	Notes
	Partial Key Foul Sewer = F Combined Sewer = C Surface Water Sewer = SW Trade Sewer = TD Partially Separate = PS	This plan is furnished as a general guide only and no warranty as to its correctness is given or implied. This plan must not be relied upon in the event of excavations or other works made in the vicinity of public sewers. No house or property connections are shown.
	Date Req : 01/10/2017, 12:31:59	Date Gen : 01/10/2017, 12:32:50
	Source : Sewer Network Enquiry	

UPN: Undefined Originator: C ROBERTS, YorMap, 87 2582

Chartered Consulting Engineers

ARP Associates 5 & 6 Northwest Business Park, Servia Hill, Leeds, LS6 2QH
c 0113 245 8498 a 0113 244 3864 m leeds@arpassociates.co.uk w www.arpassociates.co.uk

Mr C Roberts
Yorkshire Water Services Ltd
Developer Services
PO Box 52
Bradford
BD3 7AY

BY E-MAIL

Your Ref: T016220

Our Ref: 1471/01/ARPjc

9th November 2017

Dear Chris

Yorkdales 2 Ltd
Disused Railway Cutting off Walkley Lane, Heckmondwike
Pre-Planning Sewerage Enquiry on R713401

We refer to your pre-planning consultation of the 1st October 2017, regarding the development of the above site.

We note your comments regarding Requirement H3 of Building Regulations 2000 and the standard hierarchy of surface water disposal from the new development. Whilst no intrusive soils investigation or infiltration testing has been undertaken, it is known that the general geology of the site is undifferentiated strata (siltstones, mudstones and sandstones) of the Lower Coal Measures with the upper stratum likely to be weathered to a cohesive material (clay). These soils are likely to have poor infiltration properties and the presence of surface water overflow over the bottom of the railway cutting, during times of storm, suggests that the natural soils are impermeable. Furthermore, there are no suitable watercourses in the immediate vicinity of the site with the River Spen in the order of 500m to the south. You refer to a culverted watercourse through the northern and southern parts of the site, but this has not been identified by Kirklees Council, as Land Drainage Authority.

Therefore, we accept that the site is currently undeveloped and no surface water is known to discharge to the public sewer network, but would request that consideration is given to a connection to the combined sewers in either Walkley Lane or Walkley Terrace at an appropriate discharge rate.

Based on a rate of 5l/s/ha, the 2.58ha site would realise a discharge rate of 12.9l/s. This would be an ideal discharge rate for the development, but appreciate that this is dependent upon the capacity of the existing drainage system within the vicinity of the development to receive surface water discharge.

We thank you for your consideration of the above proposal and look forward to your early response. However, if you wish to discuss the matter over the telephone, please do not hesitate to contact us.

Yours sincerely
for ARP ASSOCIATES

A R Poyser

l1

APPENDIX E

LAND DRAINAGE AUTHORITY CONSULTATION

Allan Poyser

From: Paul Farndale <Paul.Farndale@kirklees.gov.uk>
Sent: Tuesday 26 September, 2017 4:17 pm
To: Allan Poyser
Subject: RE: 800/582 Disused Railway cutting, Heckmondwike

Hello Allan,

Hope you are well.

Main River Flood Zone 1 – Low Risk

Surface Water Flood Risk Mapping 3rd generation 1 in 100 year event shows significant flooding in the cutting as all surface water in the district falls to the low spot. There is ponding prior to the site with depths shown upstream of Brunswick Street upto 1.2m deep. Depths along the central valley thereafter vary but show over 1.2 metres deep adjacent to Artillery Street before flows split, depths continue to be significant as flows converge thereafter.

Depths for the 1 in 30 year event are also just as significant and only get worse for the 1 in 1000.

If this site is to be promoted properties will have to be significantly raised for safety. Looking at the layout, an estimation on depths given against current topography is required and to see if the same volumes can be accommodated in a clear through route.

It is noted that there is generally a slope toward the footpath and a slope along the site. However there are some low spots that will cause ponding and affect property curtilage. Such area should be adjusted so that the road and footpath only become the conduits and curtilage is safe. E.g. Lateral Street C to become the low spot and not across plots 70-75 putting them at risk.

A full assessment of the catchment is recommended remembering that it is assumed that sewers have some capacity but are surcharging.

Surface Water Disposal

BGS Data suggests infiltration will be problematic.

A connection to watercourse can be explored. However the enmained watercourse River Spen is 500m to the south. There is a possibility of tributaries and open ditches that are not recorded or part recorded closer to the site. We are aware of a surcharging system across the Greenway but are unsure of its status, it is currently not fit for purpose to accept discharges from a large development. We expect an investigation from the Spen for outfalls that could be traced to be located closer to the site.

If this research comes up with no viable opportunities then combined sewer can be considered. Please note there is a large combined trunk sewer located under the Spen Valley Greenway. Yorkshire Water will have to be consulted on the possibilities for connection. This is a recently laid trunk sewer diverting flows from a defunct treatment works to an alternative.

It is likely therefore that greenfield discharge rates of 5l/s/ha will be the maximum permitted to any system and the figure could be much lower resulting in increased demands on attenuation. Any attenuation 1500mm or greater in span under the highway will result in problems in forming a section 38 agreement with Kirklees Council. An exploration of locating attenuation under land scaped areas is required. Liaison with Landscape Management as well as drainage is advised so this area can perform two roles, storage and public amenity.

Section 106 Undertaking/Agreement

The LPA is obligated to ensure that the drainage infrastructure is maintained and managed for the lifetime of the development. Even if it is proposed that surface water systems will be offered for adoption, this may not happen for a number of years or agreements are not arrived at or the statutory undertaker is unhappy with aspects of construction. It is expected therefore that an undertaking to form a management company with an appropriate maintenance and management plan is provided which can cease at the point of adoption by the statutory undertaker.

Temporary Drainage

A scheme to prevent pollution and flooding during the construction phase will be required but can be conditioned.

Regards,

Paul Farndale
Principal Engineer
Flood Management & Drainage
Investment & Regeneration Service
Kirklees Council
01484 221000

From: Allan Poyser [mailto:AllanPoyser@arpassociates.co.uk]
Sent: 21 September 2017 08:25
To: Paul Farndale
Cc: Wayne Walker; Paul Carter
Subject: 800/582 Disused Railway cutting, Heckmondwike

Dear Paul

Please see the attached request for a pre-planning consultation for the above site. We are aware a surface water flow through the site and would appreciate your cvomment on the situation.

Kind Regards

Allan Poyser
0113 245 8498
allanpoyser@arpassociates.co.uk

ARP ASSOCIATES &
ARP GEOTECHNICAL LTD

www.arpassociates.co.uk

5/6 Northwest Business Park, Servia Hill, Leeds LS6 2QH
Pre-planning Geotechnical Civil Engineering Structural Engineering

Ltd accept no liability for loss or damage arising from their presence. ARP Associates is a trading division of ARP Geotechnical Ltd, a company registered in England and Wales with company number 3771811, whose registered office is at 5/6 Northwest Business Park, Servia Hill, Leeds LS6 2QH.

Website | News | Email Updates | Facebook | Twitter

APPENDIX F

MASTERPLAN LAYOUT

NORTH

3 Bedroom 4P Dwelling - 41

3 Bedroom 6P Dwelling - 24

4 Bedroom 7P Dwelling - 25

5 Bedroom 8P Dwelling - 6

Each dwelling has 2 off road parking spaces.

Site Plan 1:500 @ A1

Rev.	Description	Date	By	App'd
A.	General Layout Redesign and reduction in dwellings to suit turning heads and Urban Greenway layout.	23.01.17	AR	AJS

VIDA DEVELOPMENT

Results Driven, Results Delivered

Vida Development & Investment Ltd
Round Foundry Media Centre, Foundry Street, Leeds, LS11 5QP
t: 0113 8272267 e:mail@vida-development.uk www.vida-development.uk

Client: Ernest Gordon Ltd

Project: Residential Development
Disused Railway Cutting,Heckmondwike

Drawing Title: SITE PLAN - OPTION 4 AS PROPOSED

Project No.	Dwg No.	Rev.	Scale @ A1	Date	By	App'd
2014.034	010	A	1:500	29.11.16	AR	AJS

Issue Status: PLANNING

A P P E N D I X G

OVERFLOW CULVERT CALCULATIONS

ARP ASSOCIATES
&
ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS

Head Office:
5/6 Northwest Business Park
Servia Hill
Leeds LS6 2QH

☎ 0113 2458498
0113 2443864
leeds@arpassociates.co.uk
www.arpassociates.co.uk

Client: YORKDALES 2.		Project No. 1471/01	Sheet 1 of 2
Project: RAILWAY CUTTING, HECKMONDWIKE		Calc By: ARP	Date: 9/11/17
Element: FLOOD WATER OVERFLOW.		Chkd By:	Date:

EXISTING FLOW (Q_{EX})

Reports of flood water at 1·2m deep to the North of Brunswick Street and within the site adjacent to Artillery Street are due to flat or very shallow slopes along the channel. Therefore, to assess Q_{EX} use Mannings formula.

$$Q_{EX} = \frac{w \times d}{n} \left(\frac{w \times d}{w + 2d} \right)^{2/3} (i)^{1/2}$$

where w = width of base = 10m approx.

d = depth of flood water = 1·2m

n = Mannings number = 0·035 for rough rock

i = grade of channel = 1/1000

Inserting figures:

$$Q_{EX} = \frac{10 \times 1.2}{0.035} \times \left(\frac{10 \times 1.2}{10 + 2.4} \right)^{2/3} \times \left(\frac{1}{1000} \right)^{1/2}$$

$$= 342.86 \times 0.978 \times 0.032.$$

$$Q_{EX} = \underline{\underline{10.73 \text{ l/s}}}$$

ARP ASSOCIATES
&
ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS

Head Office:
5/6 Northwest Business Park
Servia Hill
Leeds LS6 2QH

0113 2458498
0113 2443864
leeds@arpassociates.co.uk
www.arpassociates.co.uk

Client: YORKDALES 2		Project No. 1471/01	Sheet 2 of 2
Project: RAILWAY CUTTING, HECKMONDWIKE		Calc By: ARP	Date: 9/11/17.
Element: FLOOD WATER OVERFLOW.		Chkd By:	Date:

PROPOSED CULVERT

Ground level at Brunswick Street ≈ 68.0 m

Ground level at Walkley Street ≈ 64.0 m.

fall ≈ 4.0 m

Length from topographical survey ≈ 260 m

Grade of new pipe = $\frac{260}{4}$ = 1/65

Using the Wallingford and Barr Hydraulic Tables

Table A41 K_s = 0.6 mm

1500 mm ϕ at 1/65 has Q_{PROP} = 9.4 m³/s

1650 mm ϕ at 1/65 has Q_{PROP} = 12.1 m³/s

∴ a 1650 mm ϕ culvert can accommodate the overland surface water flow with a 12.8% spare capacity.

APPENDIX H

INDICATIVE SURFACE WATER CALCULATIONS

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	100.685	0.685	12.7	0.0	12.7	155.8	O K
30 min Summer	100.857	0.857	12.7	0.0	12.7	202.6	O K
60 min Summer	101.012	1.012	12.7	0.0	12.7	244.9	O K
120 min Summer	101.119	1.119	12.7	0.0	12.7	273.9	O K
180 min Summer	101.137	1.137	12.7	0.0	12.7	278.8	O K
240 min Summer	101.125	1.125	12.7	0.0	12.7	275.6	O K
360 min Summer	101.093	1.093	12.7	0.0	12.7	267.0	O K
480 min Summer	101.060	1.060	12.7	0.0	12.7	258.0	O K
600 min Summer	101.026	1.026	12.7	0.0	12.7	248.6	O K
720 min Summer	100.990	0.990	12.7	0.0	12.7	238.8	O K
960 min Summer	100.915	0.915	12.7	0.0	12.7	218.4	O K
1440 min Summer	100.736	0.736	12.7	0.0	12.7	169.6	O K
2160 min Summer	100.498	0.498	12.7	0.0	12.7	105.0	O K
2880 min Summer	100.343	0.343	12.7	0.0	12.7	62.6	O K
4320 min Summer	100.200	0.200	12.2	0.0	12.2	24.1	O K
5760 min Summer	100.159	0.159	10.4	0.0	10.4	15.3	O K
7200 min Summer	100.136	0.136	8.8	0.0	8.8	11.2	O K
8640 min Summer	100.121	0.121	7.7	0.0	7.7	8.8	O K
10080 min Summer	100.111	0.111	6.9	0.0	6.9	7.5	O K
15 min Winter	100.759	0.759	12.7	0.0	12.7	176.0	O K
30 min Winter	100.954	0.954	12.7	0.0	12.7	229.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	68.836	0.0	166.5	0.0	22
30 min Summer	45.828	0.0	221.7	0.0	37
60 min Summer	29.238	0.0	282.9	0.0	66
120 min Summer	18.112	0.0	350.5	0.0	126
180 min Summer	13.534	0.0	392.8	0.0	184
240 min Summer	10.952	0.0	423.8	0.0	214
360 min Summer	8.106	0.0	470.5	0.0	278
480 min Summer	6.544	0.0	506.5	0.0	346
600 min Summer	5.539	0.0	535.9	0.0	414
720 min Summer	4.832	0.0	561.0	0.0	486
960 min Summer	3.892	0.0	602.5	0.0	624
1440 min Summer	2.866	0.0	665.5	0.0	886
2160 min Summer	2.108	0.0	734.0	0.0	1236
2880 min Summer	1.693	0.0	786.2	0.0	1564
4320 min Summer	1.242	0.0	865.1	0.0	2212
5760 min Summer	0.996	0.0	925.1	0.0	2936
7200 min Summer	0.839	0.0	974.0	0.0	3672
8640 min Summer	0.730	0.0	1016.5	0.0	4400
10080 min Summer	0.648	0.0	1053.9	0.0	5104
15 min Winter	68.836	0.0	186.5	0.0	22
30 min Winter	45.828	0.0	248.3	0.0	36

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	101.136	1.136	12.7	0.0	12.7	278.6	O K
120 min Winter	101.290	1.290	12.7	0.0	12.7	315.7	O K
180 min Winter	101.367	1.367	12.7	0.0	12.7	324.7	O K
240 min Winter	101.345	1.345	12.7	0.0	12.7	322.8	O K
360 min Winter	101.263	1.263	12.7	0.0	12.7	310.9	O K
480 min Winter	101.209	1.209	12.7	0.0	12.7	298.3	O K
600 min Winter	101.156	1.156	12.7	0.0	12.7	284.0	O K
720 min Winter	101.100	1.100	12.7	0.0	12.7	268.9	O K
960 min Winter	100.984	0.984	12.7	0.0	12.7	237.1	O K
1440 min Winter	100.692	0.692	12.7	0.0	12.7	157.7	O K
2160 min Winter	100.355	0.355	12.7	0.0	12.7	66.1	O K
2880 min Winter	100.206	0.206	12.3	0.0	12.3	25.6	O K
4320 min Winter	100.144	0.144	9.4	0.0	9.4	12.6	O K
5760 min Winter	100.120	0.120	7.6	0.0	7.6	8.7	O K
7200 min Winter	100.106	0.106	6.4	0.0	6.4	6.8	O K
8640 min Winter	100.097	0.097	5.6	0.0	5.6	5.7	O K
10080 min Winter	100.090	0.090	5.0	0.0	5.0	5.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	29.238	0.0	316.8	0.0	66
120 min Winter	18.112	0.0	392.5	0.0	122
180 min Winter	13.534	0.0	440.0	0.0	178
240 min Winter	10.952	0.0	474.7	0.0	232
360 min Winter	8.106	0.0	527.0	0.0	292
480 min Winter	6.544	0.0	567.3	0.0	368
600 min Winter	5.539	0.0	600.2	0.0	448
720 min Winter	4.832	0.0	628.3	0.0	524
960 min Winter	3.892	0.0	674.9	0.0	678
1440 min Winter	2.866	0.0	745.4	0.0	954
2160 min Winter	2.108	0.0	822.1	0.0	1260
2880 min Winter	1.693	0.0	880.6	0.0	1532
4320 min Winter	1.242	0.0	968.9	0.0	2208
5760 min Winter	0.996	0.0	1036.1	0.0	2936
7200 min Winter	0.839	0.0	1090.9	0.0	3672
8640 min Winter	0.730	0.0	1138.4	0.0	4400
10080 min Winter	0.648	0.0	1180.4	0.0	5128

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.290

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000	4	8	1.290

Model Details

Storage is Online Cover Level (m) 102.500

Box Culvert Structure

Height (m) 1.200 Slope (1:X) 500.000 Downstream Invert (m) 100.000
Width (m) 2.400 Length (m) 113.000

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SCL-0147-1290-1426-1290
Design Head (m)	1.426
Design Flow (l/s)	12.9
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Diameter (mm)	147
Invert Level (m)	100.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.426	12.8
Flush-Flo™	0.322	12.7
Kick-Flo®	0.791	9.7
Mean Flow over Head Range	-	10.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.8	1.200	11.8	3.000	18.2	7.000	27.2
0.200	12.2	1.400	12.7	3.500	19.5	7.500	28.2
0.300	12.7	1.600	13.5	4.000	20.8	8.000	29.0
0.400	12.6	1.800	14.3	4.500	22.0	8.500	29.9
0.500	12.3	2.000	15.0	5.000	23.2	9.000	30.7
0.600	11.8	2.200	15.7	5.500	24.3	9.500	31.5
0.800	9.8	2.400	16.3	6.000	25.3		
1.000	10.8	2.600	17.0	6.500	26.3		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 2.400 Invert Level (m) 101.424

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	100.694	0.694	12.8	0.0	12.8	268.1	O K
30 min Summer	100.854	0.854	12.8	0.0	12.8	355.1	O K
60 min Summer	101.016	1.016	12.8	0.0	12.8	443.2	O K
120 min Summer	101.156	1.156	12.8	0.0	12.8	519.6	O K
180 min Summer	101.212	1.212	12.8	0.0	12.8	549.8	O K
240 min Summer	101.231	1.231	12.8	0.0	12.8	559.8	O K
360 min Summer	101.225	1.225	12.8	0.0	12.8	556.7	O K
480 min Summer	101.200	1.200	12.8	0.0	12.8	543.2	O K
600 min Summer	101.176	1.176	12.8	0.0	12.8	530.0	O K
720 min Summer	101.152	1.152	12.8	0.0	12.8	517.4	O K
960 min Summer	101.108	1.108	12.8	0.0	12.8	493.2	O K
1440 min Summer	101.018	1.018	12.8	0.0	12.8	444.4	O K
2160 min Summer	100.862	0.862	12.8	0.0	12.8	359.3	O K
2880 min Summer	100.714	0.714	12.8	0.0	12.8	279.1	O K
4320 min Summer	100.492	0.492	12.8	0.0	12.8	158.3	O K
5760 min Summer	100.351	0.351	12.8	0.0	12.8	83.5	O K
7200 min Summer	100.255	0.255	12.4	0.0	12.4	44.0	O K
8640 min Summer	100.193	0.193	11.7	0.0	11.7	25.4	O K
10080 min Summer	100.166	0.166	10.6	0.0	10.6	18.8	O K
15 min Winter	100.756	0.756	12.8	0.0	12.8	301.9	O K
30 min Winter	100.939	0.939	12.8	0.0	12.8	401.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	115.731	0.0	279.9	0.0	23
30 min Summer	77.804	0.0	376.4	0.0	37
60 min Summer	49.937	0.0	483.1	0.0	68
120 min Summer	30.956	0.0	599.0	0.0	126
180 min Summer	23.058	0.0	669.3	0.0	186
240 min Summer	18.577	0.0	718.9	0.0	246
360 min Summer	13.656	0.0	792.7	0.0	364
480 min Summer	10.974	0.0	849.4	0.0	426
600 min Summer	9.254	0.0	895.3	0.0	492
720 min Summer	8.046	0.0	934.2	0.0	558
960 min Summer	6.447	0.0	998.0	0.0	688
1440 min Summer	4.709	0.0	1093.5	0.0	970
2160 min Summer	3.432	0.0	1195.4	0.0	1368
2880 min Summer	2.739	0.0	1271.8	0.0	1732
4320 min Summer	1.989	0.0	1385.3	0.0	2424
5760 min Summer	1.583	0.0	1470.1	0.0	3064
7200 min Summer	1.325	0.0	1538.3	0.0	3744
8640 min Summer	1.147	0.0	1597.8	0.0	4408
10080 min Summer	1.015	0.0	1650.2	0.0	5136
15 min Winter	115.731	0.0	313.5	0.0	22
30 min Winter	77.804	0.0	421.5	0.0	37

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	101.123	1.123	12.8	0.0	12.8	501.7	O K
120 min Winter	101.302	1.302	12.8	0.0	12.8	591.9	O K
180 min Winter	101.421	1.421	12.8	0.0	12.8	630.3	O K
240 min Winter	101.501	1.501	12.8	0.0	12.8	645.7	O K
360 min Winter	101.538	1.538	12.8	0.0	12.8	649.9	O K
480 min Winter	101.459	1.459	12.8	0.0	12.8	638.9	O K
600 min Winter	101.385	1.385	12.8	0.0	12.8	620.8	O K
720 min Winter	101.334	1.334	12.8	0.0	12.8	604.1	O K
960 min Winter	101.256	1.256	12.8	0.0	12.8	571.6	O K
1440 min Winter	101.121	1.121	12.8	0.0	12.8	500.4	O K
2160 min Winter	100.887	0.887	12.8	0.0	12.8	373.1	O K
2880 min Winter	100.652	0.652	12.8	0.0	12.8	245.4	O K
4320 min Winter	100.355	0.355	12.8	0.0	12.8	85.6	O K
5760 min Winter	100.197	0.197	11.8	0.0	11.8	26.3	O K
7200 min Winter	100.157	0.157	10.1	0.0	10.1	16.7	O K
8640 min Winter	100.137	0.137	8.7	0.0	8.7	12.7	O K
10080 min Winter	100.123	0.123	7.7	0.0	7.7	10.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	49.937	0.0	541.1	0.0	66
120 min Winter	30.956	0.0	670.9	0.0	124
180 min Winter	23.058	0.0	749.6	0.0	182
240 min Winter	18.577	0.0	805.2	0.0	240
360 min Winter	13.656	0.0	887.9	0.0	350
480 min Winter	10.974	0.0	951.3	0.0	458
600 min Winter	9.254	0.0	1002.8	0.0	554
720 min Winter	8.046	0.0	1046.3	0.0	580
960 min Winter	6.447	0.0	1117.8	0.0	736
1440 min Winter	4.709	0.0	1224.7	0.0	1044
2160 min Winter	3.432	0.0	1338.9	0.0	1492
2880 min Winter	2.739	0.0	1424.4	0.0	1824
4320 min Winter	1.989	0.0	1551.6	0.0	2468
5760 min Winter	1.583	0.0	1646.5	0.0	3000
7200 min Winter	1.325	0.0	1722.9	0.0	3672
8640 min Winter	1.147	0.0	1789.5	0.0	4392
10080 min Winter	1.015	0.0	1848.2	0.0	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.290

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000	4	8	1.290

Model Details

Storage is Online Cover Level (m) 102.500

Box Culvert Structure

Height (m) 1.200 Slope (1:X) 500.000 Downstream Invert (m) 100.000
Width (m) 2.700 Length (m) 201.000

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SFP-0150-1290-1602-1290
Design Head (m)	1.602
Design Flow (l/s)	12.9
Flush-Flo™	Calculated
Objective	Future Proof
Diameter (mm)	150
Invert Level (m)	100.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.602	12.9
Flush-Flo™	0.404	12.8
Kick-Flo®	0.925	9.9
Mean Flow over Head Range	-	11.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.7	1.200	11.2	3.000	17.3	7.000	26.0
0.200	11.8	1.400	12.1	3.500	18.6	7.500	26.8
0.300	12.6	1.600	12.8	4.000	19.8	8.000	27.7
0.400	12.8	1.800	13.6	4.500	21.0	8.500	28.5
0.500	12.7	2.000	14.3	5.000	22.1	9.000	29.3
0.600	12.5	2.200	14.9	5.500	23.1	9.500	30.1
0.800	11.4	2.400	15.6	6.000	24.1		
1.000	10.3	2.600	16.2	6.500	25.0		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 2.700 Invert Level (m) 101.602