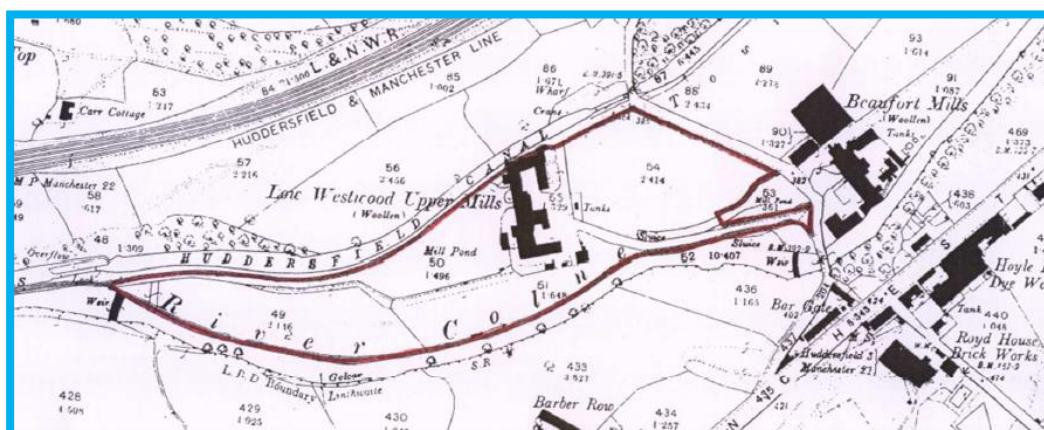


# Westwood Wilson Ltd

## Westwood Mill, Linthwaite, Kirklees, HD7 5RR

### Sustainable Drainage Report



Historic map supplied by Westwood Wilson Ltd showing an early map of the area

31<sup>st</sup> January 2020

V4

This report is based on the instructions given by our client. It is not intended for use by a third party, and no responsibility will be given to any third party.

The consultant has followed accepted procedure in providing the services, but given the residual risk associated with any prediction and the variability which can be experienced in flood conditions, the consultant takes no liability for and gives no warranty against actual flooding of any property (client's or third party) or the consequences of flooding in relation to the performance of the services.

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### Version history

Version	Date	Prepared by	Comment
D1	05.09.16	CO	Issued for approval
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### Issue history

Version	Date	Issued to	Method
D1	05.09.16	Westwood Wilson Ltd,	Email pdf
V2	20.12.19	Ditto	Ditto
V3	17.01.20	Ditto	Ditto
V4	31.01.20	Ditto	Ditto

## 1. Introduction

Westwood Wilson Ltd (WWL) is proposing the restoration of Westwood Mill, a Grade II\* Listed mill building with enabling residential development on adjacent land.

Consultations have been held with Historic England who have informally agreed the layout in connection with the Listed Building and its setting.

Flood Risk has been considered and a detailed topographic survey undertaken to inform a Flood Modelling Report, Addendum, Flood Risk Assessment and this Drainage Strategy (FRADS), which are issued as separate documents. They Modelling Reports has been issued previously to the Environment Agency (EA) as part of a pre-application consultation process and has since been revised and supplemented with an Addendum based on the EA's latest flood data.

The Lead Local Flood Authority, Kirklees Council, has been consulted, and they advised that the West Yorkshire SUDS Guidance Report gives guidance on the information required in support of a planning application. This report is to accompany a detailed application for the overall project, and it is anticipated that the detail drainage design will be prepared in response to a planning condition.

The information required schedule is copied in Appendix 1.

This report considers the existing circumstances and describes the proposed sustainable surface water drainage system which will manage surface water runoff from the site, reduce flood risk as a consequence, and improve runoff water quality. It will also enhance amenity and biodiversity.

This report should be read in conjunction with the Flood Modelling Report by Edenvale Young and the Flood Risk Assessment and Drainage Strategy by Clive Onions Ltd.

## 2. Site Location and Characteristics

The site is located at Westwood Mill, Linthwaite, Huddersfield, HD7 5RR (Grid Ref SE 095145) and is in Kirklees Council district. The Mill is currently derelict but had a large mill pond with other associated water features to manage the works and the artificial water flows through the site for industrial purposes.

The existing development comprises a derelict Grade II\* Listed Mill building with associated buildings, ponds and water infrastructure. The site incorporates a leat which leads along the northwest of the site to a former large mill pond. To the east of the Mill is a large open area up to Low Westwood Lane, which is slightly raised above general levels. The Mill pond has outlet sluices serving large culverts which pass under the Mill building, with an open channel which leads to a more modern settling pond system which in turn discharges into the River Colne.

The leat is dry and unused, and the Mill pond is dry with no signs of water – it is dry under foot. The settlement ponds do contain water.

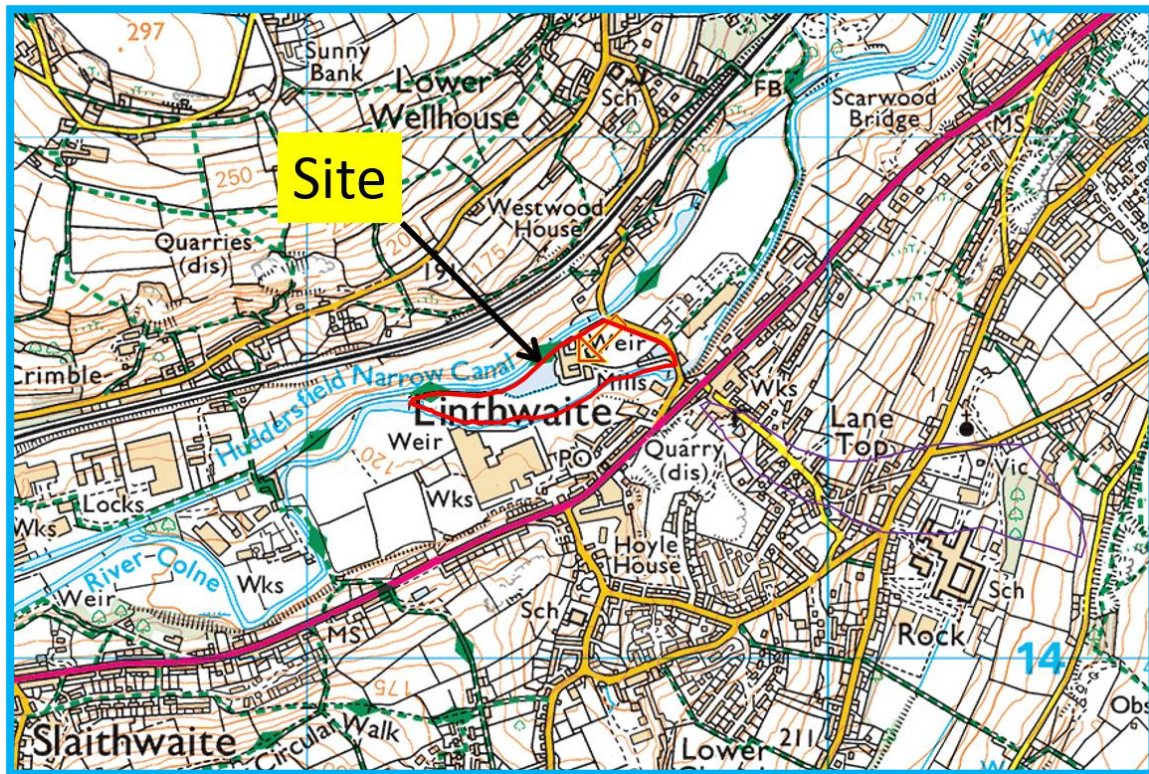


Fig 1 Site location and setting showing the River Colne forming the southern boundary of the site (Streetmap).

A detailed topographic survey has been undertaken and shows the site to be at 118.5m AOD in the west, with a gentle fall to 117m AOD in the centre of the site, south of the Mill Pond. The land falls to 115m AOD in the east, giving an average almost uniform fall across the site of 1 in 150. The overall site area is approx. 3.5 ha.

The British Geological Survey Viewer describes the soil as Alluvium, comprising clay, silt, sand and gravel. The ground is therefore likely to provide low permeability, but there might be localised areas suitable for infiltration. Groundwater level is likely to be related to the long term water level in the River Cole which forms the southern boundary.

Although manholes were recorded, including the public foul sewer which crosses the site, the survey did not undertake any excavation to locate buried drainage in the vicinity of the Listed Building – this will be done as part of the approved works, which need Historic England approval.



Fig 2 Satellite view of site, highlighted in red, showing derelict mill and hard paving in the east of the site (Google Earth image).

### 3. Proposed Development

The proposed development comprises the restoration of the key Westwood Mill buildings and the associated boundary walls and historic features to comply with the Listed Building Requirements. The development also comprises blocks of terraced housing, but with the general location agreed with the council and Historic England.

The proposal includes the refurbishment of the sluice into the leat, and a restricted entry flow of about 100 l/s, and the restoration of the Mill Pond.

The outlets serving the former hydropower generators under the building will be restored, and the outlet from the pond in the southeast corner utilised with a sluice to control the pond level and manage levels during extreme fluvial events.

Car parking will be formed in permeable paving/materials allowing infiltration, with a main entrance access and spine roads in conventional adoptable macadam construction.

Buildings will have conventional pitched roofs to harmonise with the Mill Building and its setting, which has dictated the locations of the dwellings through consultation with Historic England.

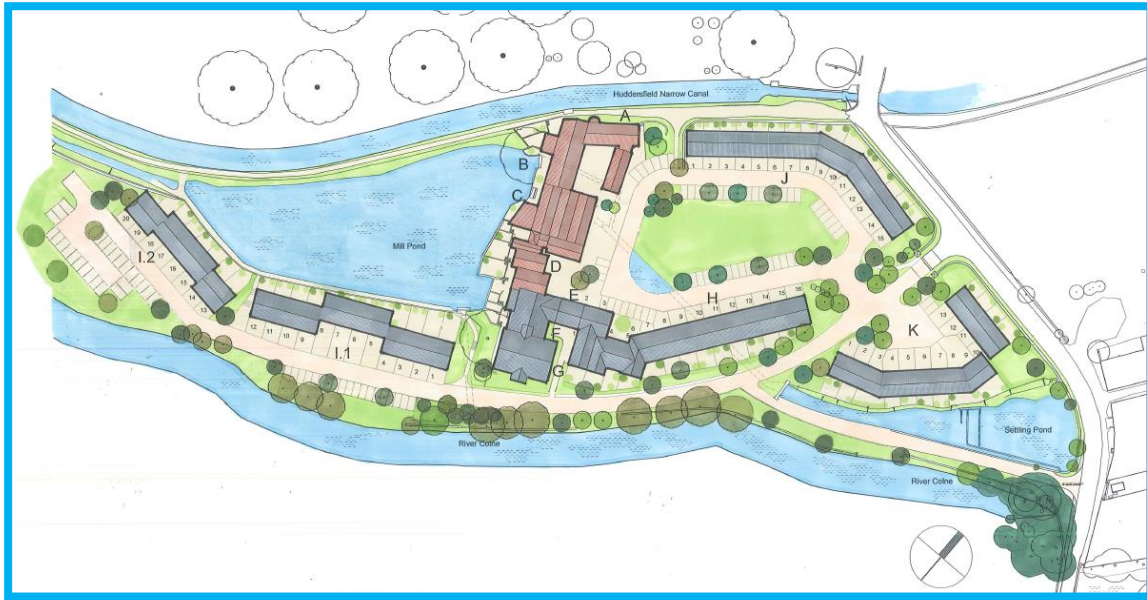


Fig 3 Proposed layout showing the reuse of the Mill building, and the new terraced houses to the east and west.

The development will involve treatment of the Himalayan Balsam and Japanese Knotweed which is present on parts of the site. The significant retained vegetated areas will be restored with native species to provide a high quality habitat and amenity for residents and visitors to the site.

#### 4. Existing Surface Water Drainage

The Mill use has created a leat running from the River Colne in the west, through a sluice system, into a Mill Pond. The main outlet is under the building through a hydropower generator, now disused, which discharges through a pipe and leat and into more modern settling ponds for water improvement from the textile processes. This flow returns to the River Colne, below the level of a weir, through a large culvert visible from Bargate Bridge.

The Mill Pond has a substantial historic drain point in the southeast corner, which is currently sealed off with masonry.

Surface water runoff from the former Mill building roofs is likely to have discharged into the former Mill Pond area, but intrusive investigations have not been undertaken to probe the routes, due to the precarious condition of the Mill building and the need for Listed Building Consent to undertake any such works. The routes will be established as part of the preparation works for restoration and when it is safe to do so.

There are no signs of formal drainage arrangements for the external yard areas, and the indications are that runoff leads into the surrounding landscaping and then into the river.

## 5. Proposed Surface Water Drainage

The sluice leading into the leat and Mill Pond will be refurbished, and the inlet flow limited to about 100 l/s for reasons of safety. This will remain closable for maintenance purposes. So, the flow will enter by gravity from the River Colne, flow through the Mill Pond and then return to the River Colne – a short diversion.

The leat is about 4m wide, and so will be formed into a more defined low-flow channel to suit the proposed flow, creating a planted corridor with sinuous channel for self-cleansing purposes and amenity. The Mill Pond will be cleared, inspected in detail, maintained and sealed prior to refilling and the bank slopes slackened for safety. The outlets under the building will be located, inspected and overhauled. The existing drain point to the southwest of the Mill Pond will be opened, investigated and modified as required to provide a durable culvert to drain the pond for maintenance reasons, and a sluice with overflow to maintain water levels and discharge to the River.

When safe to do so the roof drainage serving the Mill will be investigated in detail and the following strategy is proposed, consistent with complying with the Listed Building Requirements:

- Connections of surface water to the foul drainage will be removed where possible.
- Connections on the western side of the Mill which discharge into the Mill Pond will be retained, as it is likely this infrastructure is part of the historic characteristics of the Mill Building.
- Connections which are on the east side of the building will be gathered and directed into a new main drainage system serving the site.

**Runoff into Mill Pond;** It is not intended to add further water to the leat and Mill Pond. The western pitched roofs of the Mill which face the pond will continue to be drained into the Pond; these add up to 726m<sup>2</sup>. This creates a runoff of 4.62 l/s in the 1 in 2 year 15 minute event, and 24.4 l/s in the 1 in 100 year event + 40% climate change allowance (17.4 l/s + 40%). (See Appendix 4 for calculations)

**Runoff from existing site;** The eastern part of the existing Mill and the paved areas recorded on the topographic survey has been calculated as 3,925m<sup>2</sup>. The 1 in 2 year 15 minute runoff rate has been calculated as 25 l/s (see Appendix 5 for calculations).

### **Runoff from the proposed development area;**

The proposed impermeable area has been calculated as follows;

- Housing block i.1 = 702m<sup>2</sup>
- Housing block i.2 = 530m<sup>2</sup>
- Building G = 386m<sup>2</sup>
- Housing block H = 971m<sup>2</sup>
- Housing block K = 679m<sup>2</sup>
- Housing block J = 714m<sup>2</sup>
- Road (spine road and road around The Green) = 3773m<sup>2</sup>
- Total Impermeable area = 7,754m<sup>2</sup> (ie without the contribution from the Mill)

The greenfield runoff has been calculated and results in Qbar of 3.1 l/s (Appendix 3)

To compensate for climate change, it has been decided to reduce the permitted runoff from the existing eastern Mill impermeable area by 50%, to 12.5 l/s in the 1 in 2 year event. The total design peak outflow from the impermeable areas of the site (excluding the small western roof of the Mill) has therefore been taken as  $12.5 + 3.1 = 15.6$  l/s.

To set this in context, the Lead local Flood Authority has advised on a permitted outflow of 5 l/s ha, which based on the site area of 3.5ha would be 17.5 l/s.

Calculations have been prepared to determine the attenuation required to limit the runoff to 15.6 l/s for all events up to the 1 in 100 year event with 40% additional allowance for climate change, which results in a required attenuation volume of 490m<sup>3</sup> (see Appendix 6).

A conventional gravity drained system is proposed, with an open pond area to manage the storage and a discharge into the existing swale on the site, which leads to the River Colne.

The proposed development will be drained as follows:

- Housing blocks in the east and west will be drained into a main carrier drain flowing along the access roads and discharging into the Settling Pond which drains into the River Colne. This will be a conventional gravity drained system.
- The outlet to the Settling Pond will incorporate a vortex flow control device restricted to 15.6 l/s, to mobilise the storage.
- The runoff from the blocks and road in the vicinity of The Green will generally discharge into a perimeter swale around The Green.
- The swale will discharge into the gravity drainage system which leads to the flow control device.
- In extreme events, water will back up into The Green, which will be in the form of a lowered area to provide safe temporary attenuation with capacity for 490m<sup>3</sup> until the water can discharge through the control device.
- The Green and swale will be vegetated to provide the water cleaning virtues meeting the Sustainable Drainage virtues.

The main access road into the site will be formed in conventional macadam surface for durability for frequent service vehicles and to satisfy adoptable standards.

The car parks and subsidiary aisles will be formed in permeable construction which will incorporate a geotextile base to allow infiltration. Shallow swales will also be formed along the southern perimeter of the western access road to indicate that water is infiltrating and to provide further storage, cleaning and infiltration virtues, and a varied habitat. At 1 in 150, the gradient of the swales is very shallow and will encourage infiltration and evapotranspiration.

A pond created by The Green will have a plan area of 990m<sup>2</sup> and with a depth of average 500mm, will provide a volume of 495m<sup>3</sup> for available storage. The area could be flat, slightly domed or undulating, provided it provides the required storage and receives the overflow from the perimeter swales. Runoff will back up into the pond to provide storage for the extreme events in the system, thus reducing flood risk downstream.



The Green will be unlined, thus allowing natural infiltration in normal circumstances, but this will be a bonus, and is not measured or relied upon. Soakaway tests can be undertaken when the detail design is undertaken to quantify this opportunity.

The Green and its temporary use by water in extreme events will provide amenity, enhance biodiversity and improve runoff quality. The area can include trees which favour the type of environment.

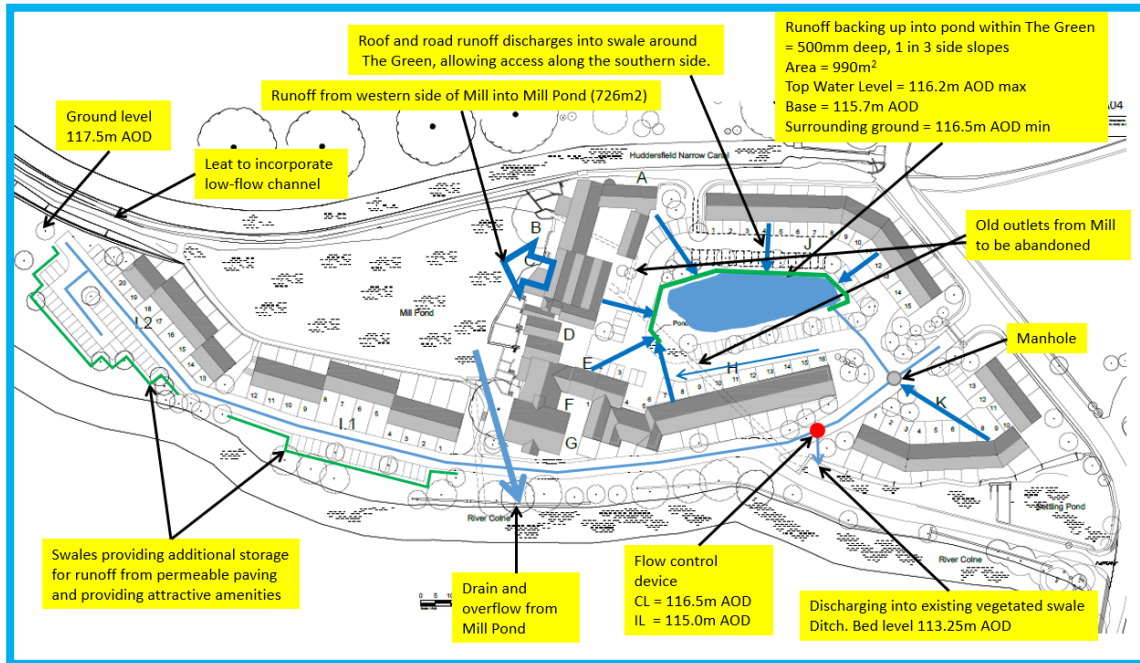


Fig 4 Proposed Surface Water Drainage Strategy. Levels are indicative, but show ample fall to the receiving swale, which in turn has ample fall into River Colne, downstream of weir.

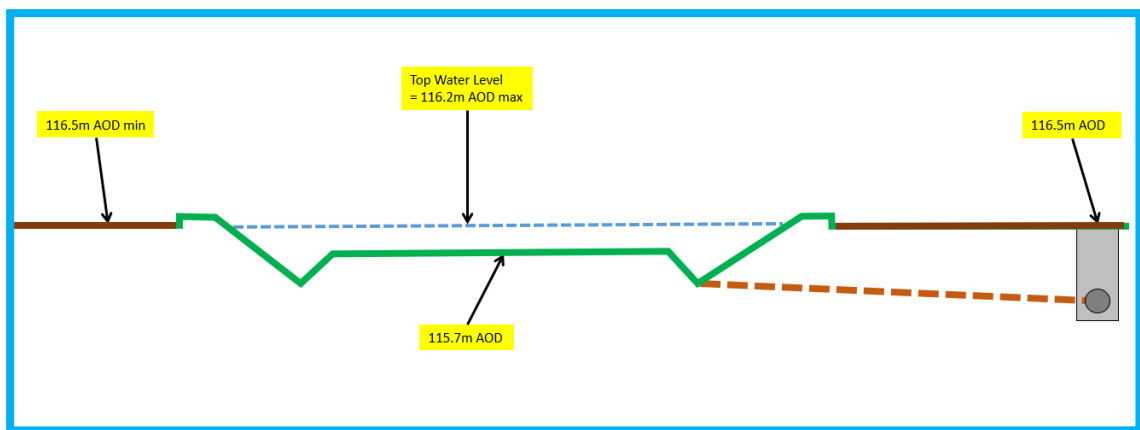


Fig 5 Proposed indicative section with levels associated with the pond within The Green and part-perimeter swale.

Analysis has shown that permeable paving is well suited to ground with low permeability – less than  $1 \times 10^{-6}$  m/s – and so the permeable paving both by observation of the site and by consideration of the ground conditions will function and provide a sustainable solution. However, infiltration tests will be undertaken in accordance with BRE 365 as part of the detailed design and the depth of granular material chosen not only to carry the imposed loads but also to manage the rainfall/infiltration balance, including allowance for the benefits of the perimeter swales.

The overall strategy can therefore safely manage the runoff rates and required attenuation whilst providing further benefits to the site and meeting sustainable drainage virtues.

The surface water drainage system will be offered for adoption and the agreed extent will be constructed to adoptable standards and offered for adoption. The remaining drainage will be built to comply with Building Regulations, and the SuDS features will be built to provide a durable system safe for the lifetime of the development with normal maintenance.

A simple, site-specific conventional gravity drained system is therefore proposed, which has ample fall, will incorporate SuDS features to contribute to amenity and wellbeing, will enhance biodiversity, reduce flood risk downstream and improve runoff quality.

## 6. Foul Drainage

A separate foul drainage system is proposed. The existing system will be investigated in detail and it is likely that all-new drains will be installed. Existing drains will be capped using a proprietary system to remove the potential for surface water entering the foul drainage system.

Low water use appliances will be installed in the development to reduce water demand and reduce flows in the drainage system.

An existing foul sewer runs through the site which will provide a connection for the domestic appliances installed at the site. The route will be surveyed in detail and will follow the designed spine road, and a connection made at a point agreed with the water company. An existing manhole can be seen in the image below which would provide a convenient connection point for the development.

The foul drainage system will be built to adoptable standards and offered for adoption by the water company.

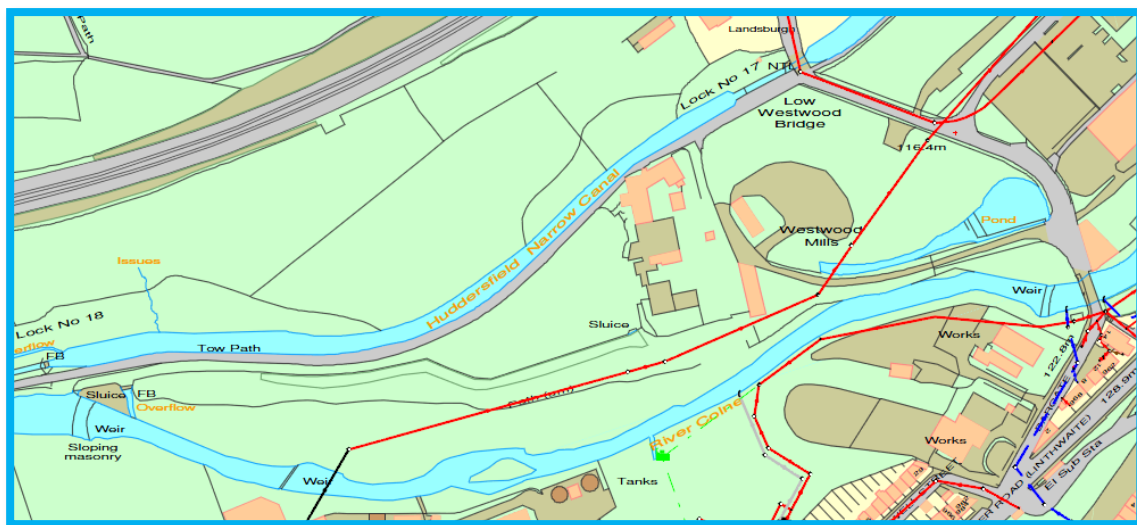


Fig 6 Sewer record plan showing foul sewer along spine road, with an existing manhole suitable for connection below the label 'Westwood Mill'.

## **7. Management and Maintenance**

The surface water drainage system will incorporate silt traps and catchpits for easy inspection and maintenance.

A maintenance regime will be established by the designer to ensure that the permeable paving and drainage, including the control device, are inspected routinely and maintained as necessary.

The Developer will offer the drainage and access roads for adoption.

A Management Company will be established with an obligation to maintain the unadopted and non-private common infrastructure. The Developer will prepare a brief and programme to be implemented by the Management Company.

Residents will be informed of their obligations to maintain their private drainage elements, with clear guidance on what to do.

## **8. Designing for Exceedance**

Exceedance runoff from the site will be directed along safe routes, generally along the access road, which naturally falls towards the River Colne to the south of the site. The exceedance routes will not pose a problem for access or for off-site areas given the site is adjacent to the river and the generous capacity below the Bargate bridge.

## **9. Conclusions and Recommendations**

The restoration of Grade II\* Listed Westwood Mill is proposed and requires enabling residential development to deliver the project.

The flood risk to the site has been considered and detailed modelling undertaken to produce a Modelling Report, Addendum and Flood Risk Assessment and Drainage Strategy which are issued separately and should be read in conjunction with this report. These have formed the basis of a pre-application consultation process with the Environment Agency. A detail drainage design will be developed based on these proposals, which show that there is adequate provision for a high quality SuDS design to manage runoff and improve runoff quality.

Consultations have also been held with the Planning Authority and with the Lead Local Flood Authority (LLFA) at Kirklees Council.

This report describes the existing drainage system and a new surface water drainage strategy to serve the proposed development.

The site will incorporate permeable paving, swales, and a pond to reduce the risk of flooding off-site up to the 1 in 100 year event with climate change allowance. The proposals will add to the amenity of the development and encourage biodiversity. The multiple use of The Green is in direct harmony with the guidance of Defra, to make multiple uses of spaces.

The proposals will reduce the risk of surface water entering the foul drainage system and combined with modern low water use appliances the proposal has the potential to significantly improve capacity in the adopted foul drainage system.

The system is designed to incorporate silt traps etc for easy inspection and maintenance, and the private, adopted and common parts are described, together with a maintenance description. A Management Company will be appointed to maintain the common parts.

The proposal therefore brings improved management of runoff rates, improved runoff quality and contributes to the amenity of the site and biodiversity and enables the restoration of the important Grade II\* Listed Mill. The drainage proposal satisfies the West Yorkshire Combined Authority SuDS Guidance, Defra's guidance, the SuDS Manual guidance, reduce flood risk and enhance biodiversity and amenity. They therefore deliver betterment over the existing conditions.

**Appendix 1** Information Requirements for Sustainable Drainage Report to accompany an outline and detailed planning application (from West Yorkshire Combined Authority SuDS Guidance). The planning application includes detailed drawings of the development proposals, which should be read in conjunction with this application.

**Outline planning**

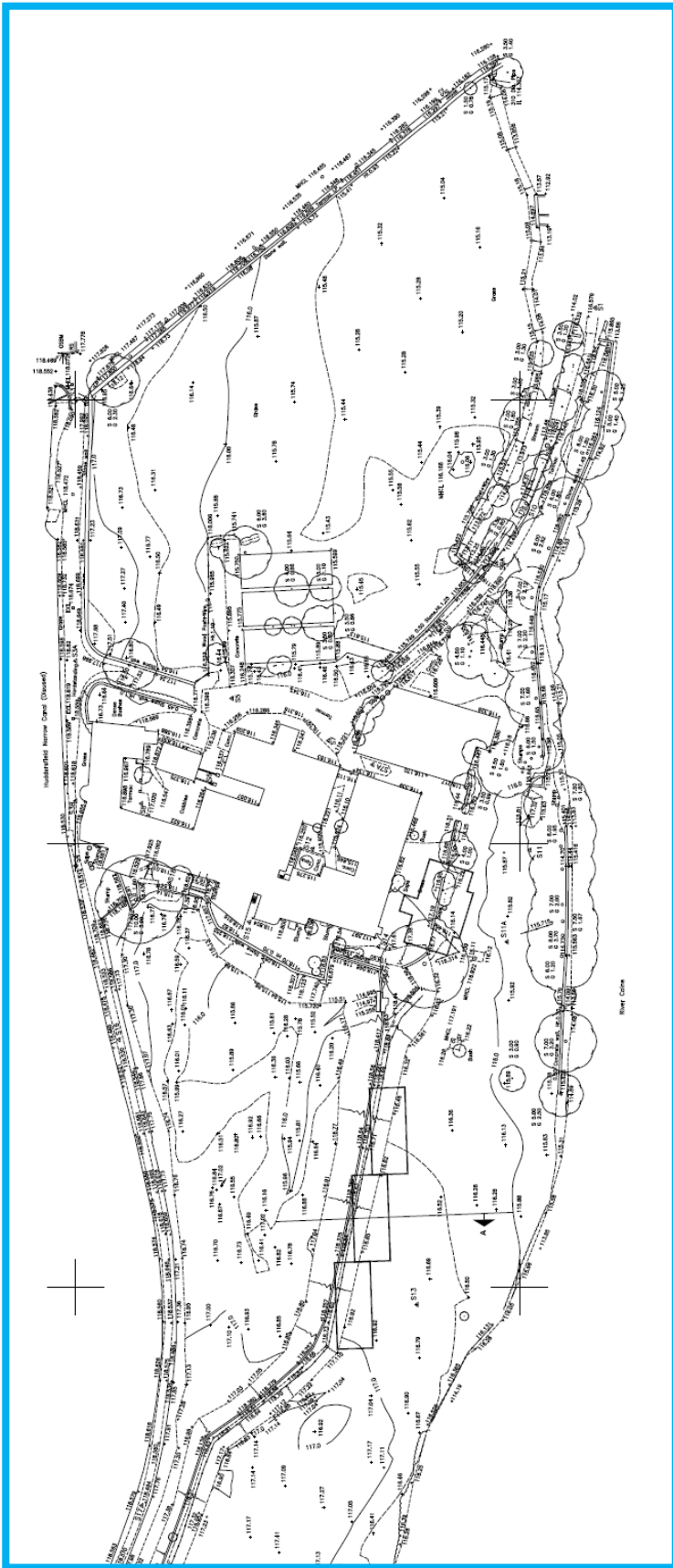
Statutory consultee information requirements		Information to be provided by developers for outline planning application (Requirements draw on readily available information)
Site location and LLFA(s) involved	Site location	Site location plan
	Grid reference and post code	For centre of site
	LLFA(s) involved	Identified through initial discussions with planning officers
Existing Site Characteristics	How the site currently drains	Marked up topographical survey plan showing existing impermeable areas and existing drainage infrastructure
	Location of nearest watercourse (open and culverted)	OS map or similar/contact LLFA to check drainage register
	Location of nearest public sewer (surface water and/or combined)	Water authority asset records
	Location of nearest highway drain	Contact LLFA to check drainage register
	Sources of flood risk already present on the site	Risk of flooding on site obtained from the EA's flood risk maps and LLFA's historical records
	Sources of flood risk already present near the site	Risk of flooding near the site obtained from the EA's flood risk maps and LLFA's historical records
	Existing topography	Topographical survey plan of existing site
	Underlying geology and infiltration rate	Description of underlying geology from Soils map. Measured as part of site investigation (where it has been undertaken)
	Groundwater level and aquifer protection	Information from British Geological Survey maps and Environment Agency Groundwater Source Protection Zone maps. Measured as part of site investigation (where it has been undertaken).
	Existing use of site (with regard to potential contaminants)	Description of current and previous site uses. Relevant soil and groundwater contamination testing as part of site investigation (where it has been undertaken)
Existing predevelopment runoff rate	Existing impermeable areas quantified on OS map or topographical survey. Estimate of existing runoff rate.	
Proposed Site Characteristics	Type of development	Master plan layout
	Area of development	Proposed impermeable area at Master planning stage
	Percentage increase or decrease in impermeable area from existing site	Indicative increase or decrease
	Proposed site layout and levels	Master plan layout with indicative finished levels
	How any particular requirements addressing flood risk have been considered	Discussion with LLFA about potential requirements for floor levels, flood storage compensation, flood resilient construction etc.
	How any particular requirements addressing amenity and biodiversity have been considered	Potential areas for combining open space with SuDS to improve amenity and biodiversity on the site shown on the master plan layout.

Statutory consultee information requirements (continued)		Information to be provided by developers for outline planning application (Requirements draw on readily available information)
Information about how the site will be drained after development.	Options discounted as unfeasible SuDS options and why	Assessment of options based on available information, identifying further information to be obtained.
	How the site will be drained	Concept drainage layout plan with indicative sizes of drainage infrastructure
	How the proposed drainage scheme will mimic natural drainage patterns	Discussion with LLFA about the selection of suitable SuDS methods to be included in the drainage scheme.
	Requirements requested by the LLFA, Environment Agency, Water Authority and other risk management authorities	Evidence of initial consultations. Concept layout plans/sketches addressing the requirements.
	Agreed discharge rate and receptor (including location)	Preliminary calculations showing that the proposed design will achieve the agreed requirements.
Climate adaptation and resilience considerations.	Identify maintenance requirements and responsible organisation	Initial discussion with LLFA regarding adoptability of various components, maintenance requirements of the various options and who will be responsible for the various maintenance activities.
	How climate change has been considered	Evidence of inclusion in preliminary calculations
	How will exceedance events be controlled	Plan showing exceedance flow paths or relevant discussion in the concept drainage design report
	If future interventions are needed	Discussion with LLFA to confirm the requirements

Statutory consultee information requirements		Information to be provided by developers for full planning and reserved matters applications (Requirements draw on information required to plan and design the development)
Site location and LLFA(s) involved	Site location	Site location plan
	Grid reference and post code	For centre of site
	LLFA(s) involved	Identified through initial discussions with planning officers
Existing Site Characteristics	How the site currently drains	Existing drainage layout plan, condition assessment of existing drainage assets to be retained
	Location of nearest watercourse (open and culverted)	Shown on proposed drainage layout plan if it will receive runoff from the site
	Location of nearest public sewer (surface water and/or combined)	Shown on proposed drainage layout plan if it will receive runoff from the site
	Location of nearest highway drain	Shown on proposed drainage layout plan if it will receive runoff from the site
	Sources of flood risk already present on the site	To be assessed in a Flood Risk Assessment
	Sources of flood risk already present near the site	To be assessed in a Flood Risk Assessment
	Existing topography	Topographical survey plan of existing site
	Underlying geology and infiltration rate	Results of a site geotechnical investigation. Infiltration rates to be tested in accordance with BRE 365 in areas of proposed soakaways or other infiltration SuDS methods.
	Groundwater level and aquifer protection	Information from Environment Agency Groundwater Source Protection Zone maps. At least three months of groundwater level monitoring as part of the site investigation.
	Existing use of site (with regard to potential contaminants)	Relevant soil and groundwater contamination testing as part of site investigation
Proposed Site Characteristics	Existing redevelopment runoff rate	Existing runoff rate calculations
	Type of development	Proposed site layout plans
	Area of development	Proposed impermeable area and allowance for potential future increases
	Percentage increase or decrease in impermeable area from existing site	Actual increase or decrease
	Proposed site layout and levels	Proposed layout and proposed finished surface levels
	How any particular requirements addressing flood risk have been considered	Proposed plans and details addressing relevant requirements
	How any particular requirements addressing amenity and biodiversity have been considered	Proposed plans and details of relevant SuDS features.


Statutory consultee information requirements		Information to be provided by developers for full planning and reserved matters applications (Requirements draw on information required to plan and design the development)
Information about how the site will be drained after development.	Options discounted as unfeasible SuDS options and why	Final assessment of options
	How the site will be drained	Design drainage layout plan with sizing and details of critical infrastructure
	How the proposed drainage scheme will mimic natural drainage patterns	Discussion about the selection of suitable SuDS methods included in the drainage scheme.
	Requirements imposed by the Environment Agency	Proposed layout plans, details and calculations addressing the particular requirements
	Requirements imposed by the Water Authority	Proposed layout plans and details addressing the particular requirements
	Agreed discharge rate and receptor (including location)	Detailed calculations showing that the proposed design will achieve the agreed requirements
	Identify maintenance requirements and responsible organisation	Detailed maintenance management plan including responsible parties for the various activities.
Climate adaptation and resilience considerations.	How climate change has been considered	Evidence of inclusion in detailed calculations
	How will exceedance events be controlled	Plan showing exceedance flow paths
	If future interventions are needed	Timing and nature if interventions to be detailed in maintenance management plan including responsible parties for the various activities.

Appendix 2 Topographic Survey



**Appendix 3** QBAR Calculation Sheet

<b>Project Title</b>	Westwood Mill, Linthwaite	<b>Site Address</b>	Linthwaite, Huddersfield
<b>Project Number</b>	14037	<b>Post Code</b>	HF7 5RR



**FEH Runoff Calculation**      using method in SUDS Manual 24.3.2

$$Q_{med.cds} = 8.3062 AREA^{0.8510} \times 0.1536^{(1000/SAAR)} \times FAARL^{3.4461} \times 0.0460 BFIHOST^2$$

AREA (ha)		0.7754			
BFIHOST		0.714			
FAARL		1			
SAAR		1149			

<b>QMED (l/s)</b>		<b>2.91</b>			Calculated for 50 hectares and scaled down
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**Hydrological Region**      10

**Site Location**




Figure 21.1 Hydrological areas

<b>FEH Point data</b>	<b>Eastings</b>	<b>Northings</b>
	409498	414575

**Rainfall depths**

	6 hour	12 hour
1 in 2 year	26.0	35.4
1 in 10 year	42.8	51.1
1 in 30 year	54.6	64.5
1 in 100 year	69.9	87.1

**Greenfield Runoff Rates**


Event	Growth Curve Factor	Flow (l/s)
1 year	0.87	2.7
2 year	0.93	2.9
QBAR	n/a	3.1
10 year	1.38	4.3
30 year	1.7	5.3
100 year	2.08	6.5

Version :	V1	Created :	HB
Comments :	-	Date :	13.12.2019

Checked :	CO	Unit 4b, Winford Business Park,	
Date :	13.12.2019	Winford, Bristol. BS40 8JH.	



**Appendix 4** Existing Runoff Calculation Sheet – West Roof of Mill

<b>Project Title</b>		Westwood Mill, Linthwaite					
<b>Project Number</b>		19088					
<b>Previous Site Runoff Rates</b>							
Impermeable Area Draining to System		726 m <sup>2</sup>					
Runoff Coefficient		0.9					
Duration (hrs)	100 year depth (mm)	100 year runoff (l/s)	30 year depth (mm)	30 year runoff (l/s)	2 year depth (mm)	2 year runoff (l/s)	
0.25	24.01	17.4	18.4	13.34	6.4	4.62	
0.5	33.31	12.09	25.1	10.13	8.6	3.11	
0.75	39.43	9.54	29.6	7.97	10.1	2.43	
1	44.06	8.0	33.0	6.66	11.2	2.08	
2	52.70	4.78	40.2	4.05	16.1	1.46	
3	58.47	3.54	45.2	3.04	19.5	1.18	
4	63.09	2.86	49.1	2.48	22.2	1.01	
6	70.76	2.1	55.3	1.86	26.5	0.80	
8	77.17	1.75	60.5	1.52	30.1	0.68	
10	82.74	1.50	65.0	1.31	33.1	0.60	
12	87.69	1.33	69.0	1.16	35.7	0.54	
16	96.22	1.09	76.0	0.96	40.3	0.46	
20	103.40	0.94	81.9	0.83	44.1	0.40	
24	109.66	0.83	87.1	0.73	47.5	0.36	
32	121.02	0.69	96.6	0.61	53.5	0.30	
40	130.62	0.59	104.7	0.53	58.7	0.27	
48	138.87	0.53	111.8	0.47	63.2	0.24	
96	171.37	0.32	140.4	0.29	82.2	0.16	
<b>FEH EXPORT DATA</b>							
"FEH Web Service(2.0.0.0) "							
FEH 2013	Parameters	FEH 2013					
Design rainfall	Rainfall model=	Design rainfall					
For a point	Calculation type=	For a point					
Point	Calculation mode=	Point					
	Calculation location=	GB		409498	414575		
Version :	V1	Created :	HB	Checked :	CO		
Comments :	-	Date :	18.12.2019	Date :	18.12.2019		

**Appendix 5** Existing Runoff Calculation Sheet – East Roof of Mill and Existing Impermeable Areas

Project Title Project Number		Westwood Mill, Linthwaite 19088		clive onions consulting civil engineer			
<b>Previous Site Runoff Rates</b>							
Impermeable Area Draining to System		3925 m <sup>2</sup>					
Runoff Coefficient		0.9					
Duration (hrs)	100 year depth (mm)	100 year runoff (l/s)	30 year depth (mm)	30 year runoff (l/s)	2 year depth (mm)	2 year runoff (l/s)	
0.25	24.01	94.2	18.4	72.14	6.4	25.00	
0.5	33.31	65.37	25.1	54.78	8.6	16.84	
0.75	39.43	51.59	29.6	43.07	10.1	13.15	
1	44.06	43.2	33.0	36.00	11.2	10.99	
2	52.70	25.86	40.2	21.91	16.1	7.90	
3	58.47	19.12	45.2	16.41	19.5	6.37	
4	63.09	15.48	49.1	13.38	22.2	5.43	
6	70.76	11.6	55.3	10.05	26.5	4.34	
8	77.17	9.47	60.5	8.24	30.1	3.69	
10	82.74	8.12	65.0	7.09	33.1	3.24	
12	87.69	7.17	69.0	6.27	35.7	2.92	
16	96.22	5.90	76.0	5.18	40.3	2.47	
20	103.40	5.07	81.9	4.47	44.1	2.17	
24	109.66	4.48	87.1	3.96	47.5	1.94	
32	121.02	3.71	96.6	3.29	53.5	1.64	
40	130.62	3.20	104.7	2.85	58.7	1.44	
48	138.87	2.84	111.8	2.54	63.2	1.29	
96	171.37	1.75	140.4	1.59	82.2	0.84	
<b>FEH EXPORT DATA</b>							
"FEH WebService (2.0.0.0) "							
FEH 2013	Parameters	FEH 2013					
Design rainfall	Rainfall mode=	Design rainfall					
For a point	Calculation type=	For a point					
Point	Calculation mode=	Point					
	Calculation location=	GB		409498	414575		
Version :	V1	Created :	HB	Checked :	CO		
Comments :	-	Date :	18.12.2019	Date :	18.12.2019		

**Appendix 6** Attenuation Calculation Sheet in accordance with SuDS Manual

Project Title		Westwood Mill, Linthwaite		clive onions consulting civil engineer			
Project Number		14037					
<b>Required Volume Calculation (South)</b>							
Assumed outflow		15.6 l/s					
Impermeable Area Draining to System		8480 m <sup>2</sup>					
Climate Change Factor		40 %					
Runoff Coefficient		0.95					
Duration (hrs)	100 year depth (mm)	100 year + 40% (mm)	Intensity (mm/h)	Inflow (l/s)	Outflow (l/s)	Balance	
						Flow (l/s)	Storage (m <sup>3</sup> )
0.25	24.01	33.6	134.5	300.9	15.6	285.3	256.75
0.5	33.31	46.6	99.3	208.7	15.6	193.1	347.60
0.75	39.43	55.2	73.6	164.7	15.6	149.1	402.59
1	44.06	61.7	61.7	138.0	15.6	122.4	440.77
2	52.70	73.8	36.9	82.6	15.6	67.0	482.05
3	58.47	81.9	27.3	61.1	15.6	45.5	490.97
4	63.09	88.3	22.1	49.4	15.6	33.8	496.91
6	70.76	99.1	16.5	36.9	15.6	21.3	461.10
8	77.17	108.0	13.5	30.2	15.6	14.6	421.07
10	82.74	115.8	11.6	25.9	15.6	10.3	371.57
12	87.69	122.8	10.2	22.9	15.6	7.3	315.08
16	96.22	134.7	8.4	18.8	15.6	3.2	186.65
20	103.40	144.8	7.2	16.2	15.6	0.6	42.99
24	109.66	153.5	6.4	14.3	15.6	-1.3	None
32	121.02	169.4	5.3	11.8	15.6	-3.8	None
40	130.62	182.9	4.6	10.2	15.6	-5.4	None
48	138.87	194.4	4.1	9.1	15.6	-6.5	None
96	171.37	239.9	2.5	5.6	15.6	-10.0	None
<b>FEH EXPORT DATA</b>							
FEH Web Service (2.0.0.0)	VERSION	Version	1.0.0				
FEH 2013	Parameters		FEH 2013				
Design rainfall	Rainfall model=		Design rainfall				
For a point	Calculation type=		For a point				
Point	Calculation mode=		Point				
	Calculation location=		GB	409498	414575		
Version :	V1	Created :	HB	Checked :	CO		
Comments :	-	Date :	18.12.2019	Date :	18.12.2019		