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Kirkby Mills
(Ryedale District Council)

Phase 1 Studies
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CONTRACT

This report describes work commissioned by The Environment Agency under Official Order 067005472 of 5 July 2002. The Agency's representatives for the contract were Bill Rodham and Robin Bailey at Region and Mark Saunders and Vicky Spencer at Area. Jeremy Benn, Richard Annable, Tony Hardwick, Ron Watson, Mike Storey, Charlotte Davison and Sarah Bratley of JBA carried out the work.

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ABBREVIATIONS

Agency/EA	The Environment Agency (prior to April 1996, the National Rivers Authority)
AMAX	Annual Maximum
BFIHOST	Baseflow Index estimated from soil type
CSO	Combined Sewer Overflow
DTM	Digital Terrain Model
FARL	Index of flood attenuation due to reservoirs
FDMS	Flood Defence Management System (Environment Agency database)
FEH	Flood Estimation Handbook
FY	Financial Year
IDB	Internal Drainage Board
2001 IFM	Indicative Floodplain Maps (2001 issue)
IH/CEH	Institute of Hydrology/Centre for Ecology & Hydrology (Since January 2000)
IH130	Institute of Hydrology Report 130 – Flood Risk Map of England & Wales
JBA	JBA Consulting – Engineers & Scientists
mAOD	Metres Above Ordnance Datum
NRA	National Rivers Authority (predecessor to the Environment Agency)
NTS	Northern Telemetry System
NWA	National Water Archive
NYCC	North Yorkshire County Council
OS	Ordnance Survey
OS NGR	Ordnance Survey National Grid Reference
POT	Peaks over a Threshold
QMED	Median annual maximum flood
RFDC	Regional Flood Defence Committee
SAAR	1961-90 Standard-period annual maximum rainfall (mm)
Section 24(5)	Section 24 of the Land Drainage Act 1976
Section 105	Section 105 of the Water Resources Act 1991 & 1995
SPR	Standard Percentage Runoff
SSSI	Site of Special Scientific Interest
SUDS	Sustainable Urban Drainage System
Tp	Time to Peak
URBEXT	FEH index of fractional urban extent
USBPR	United States Bureau of Public Roads

SUMMARY OF RELEVANT LEGISLATION

LDA, 1976	Land Drainage Act 1976
LDA, 1991	Land Drainage Act 1991
LDA, 1994	Land Drainage Act 1994
WRA, 1991	Water Resources Act 1991
WRA, 1995	Water Resources Act 1995 (update to 1991 Act to account for creation of the Environment Agency)

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1 EXECUTIVE SUMMARY

1.1 Flood History & Channel Capacity

1.1.1 It is believed that this watercourse was placed in the current schedule of Section 105 investigations by the Environment Agency and Ryedale District Council, because of flooding from the River Dove and Mill Race. There is evidence of a number of events dating back to 1986. The Study Reach of the River Dove (excluding the Mill Race) is designated Main River and is maintained by the Environment Agency.

1.1.2 There are three instances of property flooding in the last 20 years.

Date	Description	Comment
30 Oct 2000	Flooding of properties and roads. <i>Source: Residents</i>	Flooding in Keldholme and Kirkby Mills. Mill Chase submerged. 26-30 other properties flooded. Roads east and west of Keldholme Bridge affected and five adjacent properties flooded.
1 Nov 2000	Flooding of properties and road. <i>Source: Residents</i>	Flood water returned to Kirkby Mills and Station Cottages. 26-30 properties affected.
2 August 2002	Flooding of properties and road. <i>Source: Residents</i>	Flooding in Keldholme and Kirkby Mills. Mill Chase flooded again. Total 4-6 other properties at Kirkby Mills - exacerbated by storm sewer overflow and high levels in River Dove. Flooding at Keldholme similar to October 2000.

1.1.3 This study has revealed that at least 27 houses and 6 commercial properties at Keldholme and Kirkby Mills were affected by flooding in Autumn 2000. Much of the same property was affected again in August 2002. Keldholme and Kirkby Mills are geographically separate, but high levels in the River Dove are a common factor at both sites. At Keldholme, river flooding is combined with surface water flow from adjacent land and surcharge from road drainage. At Kirkby Mills there are problems of high levels in the River Dove and the Mill Race combined with surcharging surface water, foul and highway drainage systems.

1.1.4 High levels in the River Dove are made worse in Kirkby Mills by poor channel maintenance and one notable bridge constriction (to Riverside Farm). The Mill Race channel is severely impeded by a pipe crossing at the Corn Mill.

1.1.5 The outline of the communities at Keldholme and Kirkby Mills has existed for many years. There has been some in-fill development more recently. Based on information in the Ryedale Local Plan the potential for further expansion seems unlikely. Elsewhere in the River Dove catchment sustainable urban drainage techniques, as recommended by PPG25, should help to lessen the future impact of development on flood risk at Keldholme, Kirkby Mills and further downstream at Malton and Norton.

1.1.6 Emergency flood response is provided by Ryedale District Council. Flood warnings are generally provided by the Environment Agency although there are no specific warnings issued for Kirkby Mills or Keldholme. Warnings for these areas might be possible by development and use of a relationship between the gauge at Cherry Tree Farm (on the adjacent Hodge Beck catchment) and Kirkby Mills Gauging Station.

1.1.7 There are water quality issues associated with licensed Combined Sewer Overflow (CSO) discharges to the Mill Race and River Dove. These have become known during this Section 105 Study but are outside the scope of this (flood defence) investigation. Yorkshire Water is sympathetic to the problems, but advise that they would be unable to act before 2005 unless a variation were to be made to AMP3, under the authorisation of the Environment Agency.

1.2 2001 Indicative Floodplain Maps (2001 IFM)

- 1.2.1 The 2001 IFM maps (Figure 4) show flooding along the line of the River Dove and Mill Race. The flood outline is taken from the IH130 Report, supplemented by the recorded extents of historical flood events.
- 1.2.2 It has not been possible to improve on the 2001 IFM by walkover inspection alone. However, the IFM does include all property affected by flooding in Autumn 2000 and is believed to be robust. It is unlikely that any extra property at risk will be revealed by detailed survey and flood modelling and a Phase 2 study is therefore not recommended.
- 1.2.3 However, the residents are very anxious to make progress. If the possibility of capital works is to be explored in the future then detailed survey, hydraulic modelling and flood mapping would be an integral part of the investigation and might be justified under further Section 105 Studies.

1.3 Recommendations

- 1.3.1 Landowners adjacent to the River Dove and Mill Race should be made aware of their rights and responsibilities as riparian owners. They should be aware that there is a medium to high flood risk and need to be aware of the present information and warning systems provided by the Environment Agency. They are advised to make their own contingency plans, in case of flood alerts.
- 1.3.2 The Environment Agency should review the planned maintenance activities for the River Dove because of the flood problems. This especially applies to tree management and clearance of gravel shoals.
- 1.3.3 The Environment Agency should investigate the possibility of providing flood warnings to Keldholme and Kirkby Mills based on a relationship between the gauge at Cherry Tree Farm, (on Hodge Beck) and the River Dove at Kirkby Mills, or use of warnings triggered from the (downstream) Kirkby Mills Gauging Station.
- 1.3.4 The Environment Agency should consider inclusion of a capital flood defence scheme within the Long Term Plan at Keldholme and Kirkby Mills. Other partners in the scheme would probably include North Yorkshire County Council and Yorkshire Water. Discussions should be held with Yorkshire Water regarding possible modifications to the 600mm diameter pipe crossing on the Mill Race, which is currently causing a significant obstruction to flow.
- 1.3.5 The Environment Agency should continue to encourage appropriate use of SUDS to reduce the impact of development and climate change on flood risk. The Ryedale District Council Local Plan robustly addresses the problems of development and flood risk. This is endorsed.
- 1.3.6 Ryedale District Council emergency procedures and Major Incident Plans should include the possibility of flooding at Keldholme and Kirkby Mills. The residents should be informed of the services which the Council is able to offer in a flood emergency.
- 1.3.7 North Yorkshire County Council (Highways Division) should be encouraged to undertake interception and diversion works to prevent discharge into the Mill Race.
- 1.3.8 The detailed survey work and hydraulic modelling involved in further Section 105 survey and improved flood mapping could be used to underpin the maintenance regime and to help make progress towards an improved standard of service at Kirkby Mills and Keldholme. However, it is not recommended that a Phase 2 study be undertaken solely for the purposes of refining the floodplain outline.

2 WATERCOURSE & CATCHMENT DESCRIPTION

This section provides an overview of the watercourse system and its catchment. The description is based on the existing (i.e. Autumn 2002) situation. Details of the historical and possible future development are included in Sections 3 and 4.

2.1 Summary

Table 2.1: Details of Watercourse/Responsible Bodies
(see Figure 1 and Summary Report for watercourse location and relevant boundaries)

Relevant Statutory Bodies	
Environment Agency Region:	North East
Environment Agency Area:	Dales
Local Environment Agency Office:	York
Regional Flood Defence Committee:	Yorkshire RFDC
Other Drainage Bodies:	River Rye IDB
Planning Authority:	Ryedale District Council North York Moors National Park
Highway Authority:	North Yorkshire County Council
Emergency Planning Authority:	North Yorkshire County Council
Sewerage Undertaking:	Yorkshire Water (Direct control – no sewerage agency)
Watercourse Details	
Principal name:	River Dove including Mill Race
Other name(s):	None
Named tributaries:	None with Study Reach
Upstream limit of study:	OS NGR SE 708 863
Downstream limit of study:	OS NGR SE 704 853
Total watercourse length studied:	1.8km
Main River extent:	River Dove is Main River to Keldholme Bridge (upstream extent of Study Reach).
Main urban areas drained:	Kirkbymoorside, Keldholme and Kirkby Mills
FDMS Reach Reference(s):	Main River Reach 0165, Sub Reaches 03 and 04
Flood Warning Area(s):	None within Study Reach.
Sites of Special Scientific Interest:	North York Moors, Farndale SSSI, Hill House Nab SSSI
National or Local Nature Reserves:	None within the catchment.
Notes:	
1. FDMS – Flood Defence Management System	
2. Check made for any SSSIs or Nature Reserves in the entire catchment – not just adjacent to the watercourse.	

2.2 Catchment Description

- 2.2.1 This study includes the River Dove and Mill Race in the small communities of Keldholme and Kirkby Mills near Kirkbymoorside in North Yorkshire. The River Dove drains Farndale, an elongate valley amounting to 50.1km², falling in a south easterly direction over a distance of almost 20km. The river rises on Westerdale Moor in the Cleveland Hills at an altitude of 400m AOD, close to the water divide with the River Tees catchment. At Keldholme ground levels lie at approximately 50m AOD. It is here that the steep slopes of Farndale meet flatter land in the Vale of Pickering.
- 2.2.2 The River Dove flows over a full series of Jurassic Rocks from the Lias Clays at the highest points of the Cleveland Hills, through the Ravenscar and Corallian Limestones, and meeting the younger Kimmeridge Clays in the Vale of Pickering.

- 2.2.3 There are no significant tributaries of the River Dove above the Study Reach. Hodge Beck joins on the right bank of the River Dove 2km downstream of the lower extent of the Study Reach and the River Dove itself meets the River Rye a further 4km downstream. These watercourses are all major tributaries of the River Derwent, which flows south from the Vale of Pickering below Malton to meet the tidal River Ouse at Barmby Barrage 45km to the south. The River Dove is essentially a natural channel over most of its length, although, like most watercourses in the Vale of Pickering, it has been engineered through its flat regime, largely below the Study Reach.
- 2.2.4 For this study the catchment boundaries for the River Dove have been estimated from the FEH CD-ROM and checked against the OS 1:25,000 sheets together with OS profile data. Figure 1 shows the catchment boundary and also the following key catchment features:
- The coarse relief of the catchment as derived from OS 'Panorama' data¹.
 - The Study Reach and river network.
 - Hydrometric stations within and adjacent to the catchment area.
- 2.2.5 At Keldholme and Kirkby Mills, the standard FEH CD-ROM is adequate for this study, and there is a gauged record from the Gauging Station at Kirkby Mills (OS NGR SE 705855) from 1972 onwards. The flood hydrology should therefore be reliable.
- 2.2.6 Table 2.2 summarises the essential catchment descriptors derived from the FEH CD-ROM and the published OS sheets (1:50,000 and 1:25,000 scale) for key points along the Study Reach.

Table 2.2: Catchment Descriptors
(See also Figure 1)

Location:	Downstream Limit
OS NGR:	SE 7045 8530
DTM Area – Catchment Area (km ²):	60.43
BFIHOST – Baseflow index estimated from soil type	0.495
FARL – Index of Flood attenuation due to reservoirs and lakes	1
SAAR – 1961-90 Standard – period annual maximum rainfall (mm)	902
Index of fractional urban extent	0.005
Fraction of catchment draining to combined sewers (%):	N/A

2.3 Watercourse Description

- 2.3.1 The line of the watercourse and its key hydraulic/drainage features have been assessed from four sources – the published OS data (as shown on Figure 2), a walkover inspection, reference to historical OS plans and discussions with EA staff. Figure 2 shows the line and main features of the channel plotted against the OS Landline data and Table 2.3 (overleaf) summarises the key features. A set of record photographs from the site visit is also included in the Photographs section at the back of this report.
- 2.3.2 For ease of reference, a labelling system has been used in the figures, photographs, tables and text for the key features. These are labelled using a three-part code as follows:
- DOV-S-001
- where:
- DOV is the watercourse identifier
- S is the feature code (S for hydraulic structure (bridge/culvert), W for weir/sluiice, FD for flood defence, C for sub-catchment and P for photograph)
- 001 is a sequential number (increasing upstream)
- 2.3.3 The River Dove is Main River throughout the Study Reach. The head of Main River is the downstream face of Keldholme Bridge. The Mill Race is Non-Main River.

River Dove

- 2.3.4 The River Dove is the major watercourse along the Study Reach. The upstream limit consists of an attractive masonry arched bridge named Keldholme Bridge, shown in Photograph DOV-S-026. The span is 10m and rise 2.5m. The riverbed below is somewhat sluggish, but with gravel shoals on either bank downstream. At the time of the walkover survey, a property named Priory Lodge on the right bank had sandbags deployed along the bank top as a precaution (Photograph DOV-P-025).

¹ Ordnance Survey 'Panorama' data provides 5m vertical interval contours.

- 2.3.5 At Keldholme Priory there are fine walled gardens on the right bank and open pasture on the left. There is small check weir at OS NGR SE 70881 86222 (Photographs DOV-W-024) otherwise the channel is natural and tree-lined. The owner confirmed that no property, other than gardens at Keldholme Priory, was affected by flooding. There is a free span steel access bridge with vertical stone abutments at Manor Farm at OS NGR SE 70724 86143 (Photograph DOV-S-023). The span is approximately 10m and depth to water level 2m.
- 2.3.6 The tree-lined channel below Manor Farm continues in a natural state, running alongside the minor road below three detached properties, which all lie above flood level on the right bank. The land on the left bank was in stubble and appeared to be lower than the right bank. At River View (OS NGR SE 70507 86076) there is a major diversion weir (Photographs DOV-W-010 and DOV-P-022) with a sluice (Photograph DOV-W-021) on the right bank. The length of the crest is approximately 50m and there is a free fall of approximately 2m on the downstream face. Flooding of the road (but not property) on the right bank seems probable under extreme conditions. The sluice, an undershot vertical gate, was locked in the closed position at the time of inspection.
- 2.3.7 The channel below the weir is somewhat deeper (at 3m) than upstream and heavily overgrown by mature trees on both banks, which are steep. The bed width is approximately 8m. The A170 Kirkbymoorside by-pass crosses the River Dove on an embankment and over a rectangular concrete bridge opening 11m wide and 3m deep (Photographs DOV-S-006 and DOV-P-007). There is a gauge-board on the right bank, upstream abutment, as shown on Photograph DOV-S-006. There is also a 600mm diameter flapped storm sewer overflow on the right bank a few yards upstream of the bridge, which was discharging raw sewage vigorously during the inspection (Photograph DOV-S-009).
- 2.3.8 Below the road bridge the channel is very heavily overgrown with trees, as shown in Photograph DOV-P-005. The Mill Race joins some 80m downstream, with the gardens of properties in Kirkby Mills reaching down to the bank top on the right bank. There is an access bridge to the new Riverside Farm House on the left bank at OS NGR 70536 85752 which is only 6m in width with 2m high vertical abutments. This crossing is believed by residents to be causing an obstruction to flow. A new house and many of the older houses on the right bank had supplies of sandbags ready for deployment (Photograph DOV-P-004).
- 2.3.9 There is an access ford over the riverbed from Kirkby Mills Industrial Estate, to the agricultural land on the left bank at OS NGR 70478 85634. The channel is very heavily overgrown by mature trees. Kirkby Mills River Gauging Station is situated about 100m downstream and equipped with a flat vee weir (Photograph DOV-W-003). The gauging hut is sited on the left bank on an island of high ground, accessible by a clear span footbridge below, as shown in Photograph DOV-S-002. Downstream the river channel continues on a somewhat straighter course, but is still heavily overgrown by trees on both banks, as shown in Photograph DOV-P-001.

Mill Race

- 2.3.10 The Mill Race forks from the main channel at the large diversion weir near River View. The vertical, undershot sluice gate is approximately 900mm wide by 600mm deep and was closed at the time of inspection. The open channel forms the boundary of property on the right bank named Cruck and Mill Cottages. The access is difficult but the buildings on the right bank are believed to be above flood level, although gardens may be at risk. Land on the left bank is in rough pasture. It is understood that the owner of the Corn Mill has the right to operate the sluice gate.
- 2.3.11 The throat of the Mill Race through the Corn Mill is a stone arch approximately 1m rise by 1m span (Photograph DOV-S-020). The race was obviously intended to serve The Corn Mill but since the gate was closed there was very little flow observable at the time of the walkover survey. There are two timber access bridges below. The first is the rear access over the race into the Corn Mill. The second is a private access for Mill Chase (Photograph DOV-S-013).
- 2.3.12 Both houses at Station Cottages had stop board grooves fitted to the external doors, as shown in Photograph DOV-P-012. Owners of the bungalow named Mill Chase have constructed a complete flood wall with flood gates within the front and rear gardens (Photographs DOV-P-018 and 019). There is a 600mm diameter pipe crossing immediately below the Corn Mill Access Bridge. This is a very poor pipe crossing indeed. There is less than 150mm clearance to the bridge soffit and 300mm above the bed, as shown in Photograph DOV-P-017. The channel is almost totally obstructed. It is understood that this is the same pipe seen to be discharging raw sewage above the A170 River Dove Bridge (ref. paragraph 2.3.7 above). It is not known when this pipe was installed.
- 2.3.13 The private access bridge at Mill Chase had a similar width of opening, at approximately 3m, but the clearance above the bed was more satisfactory, at about 2m.
- 2.3.14 The A170 crosses the Mill Race about 25m downstream of Mill Chase on a rectangular concrete bridge with an opening 3m wide by 2m high (Photograph DOV-S-011). The open channel below the A170 forms the boundary of houses on the right bank in Kirkby Mills and is very inaccessible.

- 2.3.15 It is evident that most of the houses below the A170 are at flood risk. There were several stocks of sandbags ready for deployment and many of the houses were fitted with flood door grooves.

Table 2.3: Watercourse Hydraulic Details
(see also Figure 2)

	River Dove	Mill Race
Downstream control:	Channel	River Dove
N°. of bridges:	5	4
N°. of culverts:	Nil	1
Length of channel in culvert (m):	Nil	16
N°. of weirs/sluices:	4	1
Total length studied (km):	1.45	0.34
Other features:		600mm pipe crossing obstruction beneath Corn Mill access bridge
Notes: 1. A culvert is defined as any structure spanning the watercourse without an articulated deck. 2. Length of channel in culvert is defined as total length of culvert with a continuous length of greater than 10m.		

Environment Agency Archive Photographs

- 2.3.16 There are no EA archive photographs showing flooding at Keldholme and Kirkby Mills.

3 WATERCOURSE & CATCHMENT HISTORY

This section summarises the information collected from the various sources detailed in Appendix A & B in terms of a chronological sequence. The purpose of this is to provide a history of the watercourse and its flooding problems (if any) alongside development and other organisational changes in the catchment.

3.1 Drainage Responsibilities

- 3.1.1 The responsibility for drainage in the catchment has changed several times over the last 50 or so years. For this study it has been necessary to establish the various bodies involved in order to determine the location of information and Table 3.1 below summarises the findings.

Table 3.1: Land Drainage Legislation & Responsibilities

Date	Arterial Drainage (Main River) ¹	Arterial Drainage (Non-Main River) ²	Sewerage (surface water and foul) ³
Pre-1965	Not known	River Rye IDB	Not known
1965	Yorkshire Ouse and Hull River Authority (later titled Yorkshire River Authority)		
1 Apr 1974	Yorkshire Water Authority (Rivers Division)	River Rye IDB Ryedale District Council	Yorkshire Water Authority
1 Apr 1989	National Rivers Authority (Yorkshire Region)		Yorkshire Water Services Ltd
Sep 1993	National Rivers Authority (Northumbria & Yorkshire Region)		
1 Apr 1996	The Environment Agency (North East Region – Dales Area)		
<i>Notes:</i> 1. 'Main River' are the statutory defined watercourses under the Water Resources Act. 2. 'Arterial Drainage' covers Non-Main watercourses that are not part of the adopted sewer system. 3. 'Sewerage' includes foul, surface water and combined systems that have been adopted by the relevant sewerage authority. 4. Organisations in bold are the current (Sep 1999) responsible bodies.			

3.2 Previous Investigations/Capital Schemes/Maintenance

- 3.2.1 The Environment Agency includes the following activities within the annual maintenance schedule for the River Dove Reach 03, which includes the downstream 250m of the Study Reach (below Kirkby Mills Gauging Station) and Reach 04, from Kirkby Mills Gauging Station upstream to Keldholme Bridge:
- Clearance of obstructions including fallen debris and tree works as necessary.
- 3.2.2 North Yorkshire County Council (Highways Division) maintains the public road bridge openings as and when necessary.
- 3.2.3 There is some anecdotal evidence from old maps that the pipeline from the CSO overflow lies on the line of a former watercourse which is now piped beneath the sports fields. There is evidence of a "sinks" above Swineherd Lane at OS NGR SE 69987 86451. It is understood that this water is now intercepted by the local road drainage systems.
- 3.2.4 It appears that the 600mm diameter pipeline which discharges untreated sewage from the CSO to the River Dove upstream of the A170 was extended from the Mill Race to the River Dove by Yorkshire Water. This was probably to improve the dilution of the effluent since the flow in the Mill Race is now minimal.

3.3 Land-use Changes

- 3.3.1 The original settlement pattern at Kirkby Mills and Keldholme was established well before 1856, based on evidence from the 1:10,560 Ordnance Survey Plans. The Thirsk to Malton Railway Branch Line was built between 1856 and 1910 and is now replaced by the line of the A170 main road.
- 3.3.2 There has been a small amount of in-fill development with approximately eight houses and an ambulance station built on the north side of Kirkby Mills, and three houses west of Manor Farm. The bulk of recent development has taken place off Gray Lane, east of Keldholme, by construction of about 30 houses.
- 3.3.3 The bulk of development in the catchment has been concentrated in and around Kirkbymoorside. Approximately two thirds of the urban area drains to the River Dove catchment.
- 3.3.4 Development outside the defined settlement boundary is restricted to farming, forestry, rural economy, and recreation uses or other purposes, which should not affect the character of the surrounding area.

3.4 Flooding History

Information Sources

Information from Walkover Survey

- 3.4.1 The owner of Priory Lodge, Mrs Curtis, had suffered flooding in Autumn 2000 and had no recollection of other events at that address. However, she was of the opinion that the 1968 flood was not so severe as the 2000 event. She also remembered serious flooding of The Priory and other local property in the 1930's, when she lived outside the village. Other property at Keldholme affected in Autumn 2000 included Duna Cottage, Keldholme Cottages (technically above the Study Reach) and Clay Hill House below the bridge. Other properties on the left bank at Keldholme lie above flood level, although water may affect the gardens. Mrs Curtis also confirmed that Keldholme Cottages were flooded in Autumn 2000.
- 3.4.2 The doorways of the property named Duna Cottage (OS NGR SE 70887 86316) have been fitted with new flood doors.
- 3.4.3 The owners of the Corn Mill and three adjacent houses on the right bank of the Mill Race named Station Cottages and Mill Chase were all flooded in August 2002 and October 2000. Flooding from the Mill Race was made worse by surcharge from the 600mm surface water sewer and associated manholes which cross the Mill Race at OS NGR SE 70415 85983, the rear access to the Corn Mill. It is understood from residents that the manholes have since been provided with screw-down covers to prevent lifting during surcharge, when the River Dove is high. Floodwater in the recent events was heavily contaminated by sewage.
- 3.4.4 It is understood that many of the 25 houses in Kirkby Mills suffer quite frequent flooding. There is reliable anecdotal evidence that the Mill Race does back up from the River Dove and that flooding is augmented by surface water from the A170 highway. Floodwater accumulates in the road and around the houses. It affects the builder's yard west of the road junction. It is prevented from returning to the river south of Southacre Sewage Pumping Station (OS NGR SE 70430 85731) by a road hump and consequently floods the field north of Kirkby Mills Industrial Estate. When water levels rise sufficiently there are approximately six factory units within the industrial estate including Woods, Ashford's Barrington's, and a pine furniture business which are all potentially at risk.

Information from the EA

- 3.4.5 Some limited details of the Autumn 2000 flood events were provided for Kirkby Mills and Keldholme. No information on the number of properties or levels was recorded.
- 3.4.6 The 600mm CSO outfall to the River Dove above the A170 was known to the Agency. It is a licensed CSO.

Information from Ryedale District Council

- 3.4.7 Ryedale District Council provided a comprehensive schedule of flooded property in November 2000 with depths of water for the full District. This corresponded closely with information from the questionnaire survey. (include in Appendix B).
- 3.4.8 Ryedale District Council does not undertake routine maintenance at Keldholme and Kirkby Mills but does undertake enforcement action and can provide sandbags in emergencies.

3.4.9 Information from NYCC Highways Dept.

- 3.4.10 NYCC Highways Dept. are responsible for keeping the channel clear beneath the public road bridges, all of which were free at the time of inspection.
- 3.4.11 NYCC are also responsible for road drainage. There is evidence that the highway drainage intercepts surface water from the former open watercourse above a “sinks” at Swineherd Lane, north east of Kirbymoorside. The Council acknowledges that there are two highway drainage outfalls to the Mill Race², both of which are impeded during floods. They also expressed a hope that shortcomings could be overcome by provision of new pipe from Kirbymoorside to an outfall to the River Dove near the Industrial Estate.
- 3.4.12 Table 3.2 below summarises the data sources searched and any relevant information found. Appendix B and the Phase 1 Studies Summary Report provides further details on many of these sources.

3.5 Information from the Questionnaire Survey

- 3.5.1 The questionnaires returned by residents suggest that there are two fundamental flooding problems. In October 2000 some of the houses at Keldholme were flooded from the River Dove but there are complications including overland flow from Gray Road and nearby roads and fields. At Kirkby Mills it seems evident that flooding is caused by high levels in the River Dove backing up the Mill Race. The problems are exacerbated by flooding from a surcharging sewer and can be augmented by highway drainage.

Table 3.2: Sources Searched for Flooding Information
(copies of relevant data not already in Agency's records are included in Appendix B)

Source (see Appendix B & Summary Report for further details)	Relevant Information Found
Environment Agency Sources:	
Section 24 Land Drainage Survey (1998):	• No reports found specific to Keldholme or Kirkby Mills.
Section 105 Preliminary Survey (1998):	• No reports found.
Section 24(5) Schedules (updated 1994):	• No reports found specific to Keldholme or Kirkby Mills
Section 105 Studies:	• None previously undertaken.
2000 Indicative Floodplain Maps:	• Indicative Floodplain of the River Dove does include most of the urban area in Keldholme and Kirkby Mills.
Development Control Correspondence Files:	• No new developments identified.
Other Archives EA Flood Level Archive Flood Warning Manual:	• Not included.
Flood Warning Areas/Action Plans:	• No warnings are currently issued for Keldholme or Kirkby Mills
Capital Plan:	• None currently prepared.
Site-specific Flooding Reports:	• No proposals.
Flooding Photographs:	• None.
Local Flood Warning Plans:	• Photos provided by Mr & Mrs Young, Mr B Hughes, Mr B James, Mrs J Sinfield and Mrs M Lea (see Flooding Photographs section).
Other Sources (Detailed references to these are also provided in the Summary Report):	
BHS Chronology of Hydrological Events:	• None.
Land of Singing Waters by D R Archer:	• No entries found.
Library sources:	• None.
	• Gazette and Herald 16 November 2000
	• Gazette and Herald 14 December 2000
	• Gazette and Herald 25 January 2001
	• Gazette and Herald 20 March 2001
	• Gazette and Herald 3 May 2001
	• Gazette and Herald 8 August 2002
Highway Authority:	• Problems at Kirkby Mills are known to NYCC Highways and Transportation Department.
Local Authority:	• Provided details of property flooded in November 2000
Sewerage Undertaking:	• Problems at Kirkby Mills are known to Yorkshire Water.

² Letter from NYCC to a resident, dated 22 March 2001 (In Appendix A, attached to questionnaire response from Mr & Mrs Young.)

Table 3.2: Sources Searched for Flooding Information
(copies of relevant data not already in Agency's records are included in Appendix B)

Source (see Appendix B & Summary Report for further details)	Relevant Information Found	
S105 Flooding Questionnaires (see Appendix A for further details)	Address:	Returned?
	Mill Chase, 21A Kirkby Mills	Yes
	3 Keldholme Cottages	Yes
	21 Kirkby Mills	Yes
	Rosebay Cottage, Kirkby Mills,	Yes
	18 Kirkby Mills	Yes
	The Corn Mill, Kirkby Mills,	Yes
	Duna Cottage, Keldholme,	Yes
	Southacre, Kirkby Mills	Yes
	Ivy Cottage, Keldholme	Yes
	Keldholme Priory	Yes
	4 Kirkby Mills	Yes
	Lillem Cottage, 10 Kirkby Mills	Yes
Hydrometric Record:	River Dove Gauging Station, Kirkby Mills	
Consultations: (see Appendix B for further details)	Robin Bailey, Environment Agency	
	Mark Saunders, Environment Agency	
	Philip Edwards, Environment Agency	
	Ian Cooke, Environment Agency	
	Peter Yerrel, Environment Agency	
	John Bell, Environment Agency	
	Kim Andrew, Environment Agency	
	Geoff Holder, Ryedale District Council	
	Vicky Spencer Environment Agency	

3.5.2 Table 3.3 summarises the known flood history of the catchment.

Table 3.3: Chronology of Flood Events

Date	Description	Specific Details (Extent/Level/ Annual Probability)	Accuracy/ Confidence Level
16 Nov 1878	Widespread flooding in Ryedale.	"...the oldest man in [Helmsley] had never saw (sic) [the River Rye] so large" (The Northern Echo, Saturday 16 November 1878)	• Low
May 1986	Road and gardens flooded at 21 Kirkby Mills – affected total of two properties (from A170).		• Low
11 April 1998	Road and gardens flooded at Mill Chase, Mill House and 21 Station Cottages. Total of six properties affected.		• Medium
April 1999	Road and gardens flooded at Mill Chase, Mill House and 21 Station Cottages. Six properties in total.	Mill Chase flooded to DPC level	• Medium
30 Oct 2000	Flooding in Keldholme and Kirkby Mills. Mill Chase submerged. 26-30 other properties flooded. Roads east and west of Keldholme Bridge affected and five adjacent properties flooded.	Mill Chase flooded 1m deep. Flooding at Keldholme 0.5 to 1.0m deep. No flooding experienced at Keldholme in previous 25 years.	• Medium
1 Nov 2000	Flood water returned to Kirkby Mills and Station Cottages. 26-30 properties affected.		• Medium

Table 3.3: Chronology of Flood Events

Date	Description	Specific Details (Extent/Level/ Annual Probability)	Accuracy/ Confidence Level
2 August 2002	Flooding in Keldholme and Kirkby Mills. Mill Chase flooded again. Total 4-6 other properties at Kirkby Mills - exacerbated by storm sewer overflow and high levels in River Dove. Flooding at Keldholme similar to October 2000.		<ul style="list-style-type: none"> Medium
Notes: 1. In terms of usefulness for hydraulic model calibration/verification.			

3.6 Summary of Property Affected

- 3.6.1 Table 3.4 summarises the property flooded on 30 October 2000. This includes a total of 27 properties, 6 of which are at Keldholme, and the remainder at Kirkby Mills.

Table 3.4: Schedule of Property Flooded in Keldholme and Kirkby Mills Autumn 2000

Source	Address	Depth (r m)
Ryedale DC	Riverside Farm Cottage, Kirkby Mills	610
	20 Station Cottages Kirkby Mills	450
	Ash Brook, Keldholme	25
	Manor Cottage, Keldholme	330
	Clayhill House, Keldholme	175
	Priory Lodge, Keldholme	155
	Duna Cottage, Keldholme	52
	3 Keldholme Cottages, Keldholme	230
	Riverside Farm House, Kirkby Mills	610
	The Old Farmhouse, Kirkby Mills	60
	Rosebay Cottage, Kirkby Mills	15
	Southacre, Kirkby Mills	125
	Alderson House, Kirkby Mills	15
	The Mill Barn, Kirkby Mills	1,000
	The Corn Mill Guest House, Kirkby Mills	245
	10 Kirkby Mills	430
	11 Kirkby Mills	355
	12 Kirkby Mills	180
	17 Kirkby Mills	125
	18 Kirkby Mills	50
	19 Kirkby Mills	125
	21 Kirkby Mills	490
	29 Kirkby Mills	12
	Dovecot, 3 Kirkby Mills	150
	6 Kirkby Mills	110
	7 Kirkby Mills	110
	Dove Cottage, 9 Kirkby Mills	750

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4 PLANNING & DEVELOPMENT ISSUES

This section provides a summary of the current adopted or deposit draft Development Plan for the relevant Unitary, District or County Local Authorities.

The catchment of the River Dove lies entirely within Ryedale District Council. Part of the catchment above the Study Reach lies within the North Yorkshire Moors National Park.

- 4.1.1 The Ryedale District Council Local Plan Deposit Draft dated November 1997 was formally adopted by the Council in March 2002. This included significant changes to the policy on flooding in the light of PPG25³. The amended policy, ENV25 below, was redrafted following the recommendations of the Inspector and further significant changes. The final revisions were not available in time for inclusion in this report. An extract from the draft amendments is included in Appendix B.

"POLICY ENV25 - DEVELOPMENT AND FLOOD RISK

In order to minimise flood risk, proposals for development will be assessed against:

- the advice of the Environment Agency;
- the level of actual risk involved;
- the need for urban regeneration and the redevelopment of previously developed land; and
- the following criteria:-

- A In areas with a high risk of flooding*, new development, including proposals which involve the raising of land, will only be permitted where:-

(i) In the case of areas that are considered by the Environment Agency to act as functional flood plain, there would be no development except for essential transport and utilities infrastructure which could not be located in an area of lower risk. Where, exceptionally, such development is permitted this will be subject to satisfactory design and compensatory flood storage measures;

(ii) In the case of areas within development limits, new development will be permitted provided that flood defences to the appropriate standard for the proposed development are available or will be provided. In such cases, the proposed buildings and layout should be adequately designed to resist flooding. Development will only be permitted where it would not increase the risk of flooding elsewhere, and the proposal includes, where necessary, the provision of adequate compensation measures to prevent this occurring.

(iii) In all other high risk areas outside development limits, proposals which involve general purpose housing and residential or institutional accommodation will not be permitted. Job-related residential development and commercial and industrial proposals will only be permitted where that location is essential and there are no alternatives in areas of lower risk. Where, exceptionally, development is permitted this will be subject to the provision of satisfactory flood prevention measures and associated compensatory flood storage measures.

- B Developers will be required to fully fund the provision and future maintenance of flood mitigation and defence measures required as a result of their proposals, including any consequent works to prevent additional flood risk to other properties. Any flood protection or mitigation measure should not have any material adverse effect upon the nature conservation value of the area or detract from the character or setting of nearby settlements or Listed Buildings or sites of archaeological value.

- C A Flood Impact Assessment, prepared in consultation with the Environment Agency, will be required to be submitted with any planning application that is within an area considered to be at risk from flooding or that would materially increase the risk of flooding through run-off. *[NB this policy should now refer to a Flood Risk Assessment, in line with Appendix F of PPG25.]*

³ Planning Policy Guidance Note 25, DETR, 2001

- D Development that would increase the risk of flooding through altered surface water run-off must include adequate measures to prevent this. Wherever appropriate, new development should incorporate a sustainable drainage system in order to manage water run-off rates and so assist with the prevention of flooding.

* The 'approximate extent of the area liable to flood' in the Plan area is shown on the Proposals map and accompanying insets. This represents the area of high risk i.e. with an annual probability of flooding of 1% or greater. However, this information is indicative and is liable to change. For detailed information on areas at risk from flooding, including the location and extent of functional flood plains, consult the Environment Agency."

- 4.1.2 In the Local Plan Deposit Draft there is no land allocated for housing in Keldholme or Kirkby Mills. Elsewhere in the two communities, there are very few opportunities for development without adversely affecting the character of the settlement.
- 4.1.3 There is special identification on the inset map (Appendix B) that most of the community at Kirkby Mills alongside the River Dove and Mill Race are within an Area Liable to Flood, i.e. where policy ENV25 applies in the original draft Local Plan. There is no such area identified at Keldholme. The Inspector recommended that the inset plans, which give the detail, be updated in the Final Plan to show the Indicative Floodplain, based on information to be provided by the Environment Agency.

Table 4.1: Summary of Development Pressure

			(ha)	(m ² s)	(sqm)	(Y/N)	Is the site in a potential floodplain (Y/N)	Unimplemented permission (Outline/full)
None	N/A	N/A	N/A	N/A	N/A			
Windfall or other sites (where known)								
None	N/A	N/A	N/A	N/A	N/A			

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5 CATCHMENT FLOOD HYDROLOGY

This section summarises the methods used to provide indicative peak flood estimates for the River Dove catchment.

5.1 Introduction

- 5.1.1 An important input into a flood risk assessment is the analysis of historic floods (where data is available) and estimation of flood flows for a range of annual probabilities or 'design' events. The Agency's Policy⁴ is that flood estimates are undertaken using the Flood Estimation Handbook⁵ (FEH) and the Agency's FEH guidelines⁶. This Policy has been followed in this study.
- 5.1.2 The objectives of the hydrological study were to:
- (a) Identify and interpret all relevant hydrological data for the area;
 - (b) Identify any historic flood events which could be used for model calibration or for inclusion in the flood frequency analysis and estimate their annual probability;
 - (c) Produce catchment maps for the watercourse and estimate standard catchment characteristics;
 - (d) Use FEH methods to estimate T-year design flows for the watercourses at specified locations;
 - (e) Compare design flood estimates with regional values and check for internal consistency;
 - (f) Estimate likely level of confidence of annual probabilities associated with flow estimates.
- 5.1.3 Due to the nature of this study (a preliminary investigation) the hydrological analysis has concentrated on the production of peak flood estimates rather than hydrographs. These peak flood estimates can be used as the input to a further phase of work involving hydraulic modelling although an assessment of flood volume may also be required.

5.2 Description of the Catchment

- 5.2.1 The River Dove drains Farndale, an elongate valley amounting to an area of 50.1km² and falling in a south easterly direction over a distance of almost 20km. The river rises on Westerdale Moor in the Cleveland Hills at an altitude of 400mAOD, close to the water divide with the River Tees catchment. At Keldholme ground levels lie at approximately 50mAOD. It is here that the steep slopes of Farndale meet flatter land in the Vale of Pickering.
- 5.2.2 The River Dove flows over a full series of Jurassic Rocks from the Lias Clays at the highest points of the Cleveland Hills, through the Ravenscar and Corallian Limestones and meeting the younger Kimmeridge Clays in the Vale of Pickering. Figure 1 shows where the catchment is located relative to the wider region, and Figure 2 shows the sites of flow estimation points chosen for the study.
- 5.2.3 Table 5.1 summarises the key catchment descriptors derived from the FEH CD-ROM and the published OS sheets (1:50,000 and 1:25,000 scale) for key points along the Study Reach.
- 5.2.4 For the River Dove the standard FEH CD-ROM dataset was found to be adequate for this study and did not require any manual modification (see Section 5.3).

5.3 Urbanisation

- 5.3.1 In the Local Plan Deposit Draft there is no land allocated for housing in Keldholme or Kirkby Mills. Elsewhere in the two communities, there are very few opportunities for development without adversely affecting the character of the settlement. It should be noted that the representation of urbanisation in the FEH methods is

⁴ The Environment Agency. Memorandum from Flood Defence Manager, September 2000.

⁵ Reed D W, et.al. The Flood Estimation Handbook. 1999. NERC, Swindon.

⁶ The Environment Agency. Flood Estimation Handbook Guidelines. In two parts. Environment Agency Management System Document EAS/3301/5/1. Version 1, August 2000.

that URBEXT is used to estimate the net effect of urbanisation – i.e. it assumes that some level of discharge control is implemented.

Table 5.1: FEH Catchment Descriptors
(see Figure 1)

Location (also shown on Figure 2):	DOV_1	DOV_2
	D/S Model Limit	U/S Model Limit
OS NGR:	SE 7045 8530	SE 7085 8630
DTM Area-Catchment Area (km ²):	60.43	52.84
Catchment Area from OS 1:25,000 Sheet (km ²):	60.43	52.84
BFIHOST-Baseflow index estimated from soil type	0.495	0.460
FARL-Index of Flood attenuation due to reservoirs and lakes	1.000	1.000
URBEXT – Urban Extent (1990 value)	0.005	0.001
URBEXT – Urban Extent (assumed 2010 value)	0.005	0.001
SAAR-1961-90 Standard –period annual maximum rainfall (mm)	902	921
Approx. Fraction of catchment draining to combined sewers (%):	Insignificant	Insignificant
Approx. Fraction of catchment draining to separate surface water sewers (%):	Insignificant	Insignificant
Notes:		
1. All values in BOLD are derived from Version 1.0 of the FEH CD-ROM		

5.4 Hydrometric Data

- 5.4.1 There are good records of flood peak data for the River Dove, as summarised in Table 5.2. Flood peak data (in the form of river stage and the most recent rating equations) have been obtained from the Agency and loaded onto the HiFlow database at JBA.
- 5.4.2 More than 13 current meter gaugings have been performed at Kirkby Mills since the station was commissioned in 1973. The maximum stage gauged by current metering at Kirkby Mills is only approximately 0.33m, whilst the highest recorded stage at the station is approximately 2.25m. The flow gauging data was obtained from the Agency. Owing to the importance of the data at Kirkby Mills it was considered prudent to review its rating curve. Information on rating equations and flow gaugings were obtained from the Agency.

Table 5.2: Flow or River Level Data Available
(see Figure 1 for locations)

Watercourse	Station	Gauging Authority number	NW L ⁽¹⁾ Number (used in FEH)	OS National Grid reference	Rating Available?	Period of data to WINFAS ⁽²⁾ FEH	Period of Additional data
River Dove	Kirkby Mills	2560	027042	SE 705 855	Yes	1973-2000	None
Notes:							
1. National Surface Water Archive Number.							
2. Version 1.0 dated 1999.							

- 5.4.3 The gauging station on the River Dove at Kirkby Mills is located some 240m upstream of the Study Reach's downstream extent.
- 5.4.4 Peak flow and level data up to and including the end of Water Year 1999 (i.e. up to 30 September 2000) have been obtained for the gauging station listed in Table 5.2 in the form of annual maxima and peaks over a threshold. Data for the River Dove have been entered into JBA's HiFlow database to enable statistical verification and visualisation of the data. The rating curve has also been entered.
- 5.4.5 There are also rainfall records from an intensity (15 minute) rain gauge at Church Houses. Figure 1 shows the location of these sites where known.

5.5 Annual Maximum Flow Data

- 5.5.1 Annual maximum flows were abstracted from the Peaks over a Threshold (POT) data provided by the Agency. There are 29 annual maxima for water years (Oct - Sept). The data are plotted and tabulated on a sheet exported from HiFlow, shown in Appendix C.

5.6 Peak Flood Estimates

- 5.6.1 Flood estimates were derived for 2 locations in the River Dove catchment, as described in Table 5.1. Peak flows for a range of annual probabilities (return periods) were estimated using both the FEH Statistical method and the FEH Rainfall-Runoff method. The details of the calculations are provided in Appendix C. The locations of the flow estimation points are shown on Figure 2.

5.7 FEH Statistical Method

- 5.7.1 There are two parts to the FEH Statistical method: the estimation of an index flood (QMED) and the estimation of flood growth curves.
- 5.7.2 QMED was estimated from AMAX data at the downstream model limit and from catchment descriptors at the upstream model limit, and the value refined using information from a donor catchment, the River Dove at Kirkby Mills, which is located close to the downstream model limit. The catchment descriptor equation underestimates QMED for this donor catchment.
- 5.7.3 Flood growth curves were derived using the WINFAP-FEH software, using a single pooling group to estimate flows at the two locations in the Dove catchment. The details are given in Appendix C.
- 5.7.4 The resulting flow estimates are shown in Table 5.3.

Table 5.3: Flood Estimates from the FEH Statistical Method at each Subject Site

Site code	Flood peak (m ³ /s) for the following probabilities & return periods (in years)						
	50%	20%	10%	4%	2%	1.33%	1%
	2-year	5-year	10-year	25-year	50-year	75-year	100-year
DOV_01	30.01	40.32	47.09	56.08	63.24	67.62	70.83
DOV_02	29.44	39.60	46.28	55.16	62.23	66.57	69.75

5.8 FEH Rainfall-Runoff Method

- 5.8.1 The Rainfall-Runoff method involves constructing a simple model of the catchment, with three parameters. These can be best estimated when there are rainfall and river level or flow data for a number of flood events. This information was available for the River Dove, so the parameters were estimated using the available data. The parameters are given in Appendix C.
- 5.8.2 Design flows are estimated from design rainfall events, which are prescribed by the FEH. The design rainfall durations are given in Appendix C, Table 5.4 (NB. The table in the Appendix, not that below).
- 5.8.3 The ISIS-Hydrology⁷ software was used to generate hydrographs for a range of return periods. The resulting peak flows are given in Table 5.4.

Table 5.4: Flood Estimates from the FEH Rainfall-Runoff Method at each Subject Site

Site code	Flood peak (m ³ /s) for the following probabilities & return periods (in years)						
	50%	20%	10%	4%	2%	1.33%	1%
	2-year	5-year	10-year	25-year	50-year	75-year	100-year
DOV_01	11.93	17.28	20.80	25.99	30.42	32.82	34.78
DOV_02	11.65	16.88	20.34	25.45	29.81	32.17	34.10

5.9 Design Peak Flows

- 5.9.1 The FEH Statistical method gives higher flood estimates for all catchments in the study area. The difference ranges from up to 152% larger for the largest catchment, DOV_01, to up to 153% larger for the area draining to DOV_02.
- 5.9.2 Because this catchment is gauged with a relatively long period of record, the Statistical method is well suited. The size of the catchment gives rise to a large number of similar-sized catchments in the pooling group. The Statistical method utilises up-to-date information from a large dataset, whereas the Rainfall-Runoff method is

⁷ ISIS Hydrology & Flow Routing. Version 1.5, September 2000. Halcrow/ Wallingford Software.

based on information from before the early 1970's. In consideration of these factors, it is therefore suggested that flood estimates for this catchment be derived from the FEH Statistical method.

- 5.9.3 The peak flows adopted for the hydraulic assessment in Section 6 of this report can therefore be found in Table 5.3.

5.10 Design Hydrographs

- 5.10.1 Flood hydrographs can be derived (for example, for use in a flow routing model) directly from the FEH Rainfall-Runoff method but for the purposes of this study no consideration of hydrograph shape or volume has been made.

6 ASSESSMENT OF HYDRAULIC CAPACITY

This section provides a preliminary assessment of the hydraulic capacity of the watercourse compared to indicative estimates of flood flows. Comment is also made on the likelihood of other factors, such as blockage, leading to flooding.

6.1 Hydraulic Capacity

- 6.1.1 The hydraulic capacities of 'pinch points' in the channel have been calculated using the Manning equation and the approximate dimensions of the channel/culvert/bridge sections noted from the site visit. The results of this analysis are shown in Table 6.1.

Table 6.1: Hydraulic Capacity
(NB – assumes free discharge to downstream)

Location (OS NC R)	Channel Type	Ref. (Figure 3)	Photograph Ref.	Approx. Capacity (m ³ /s)	Indicative 1% (100 yr) Peak Flow Estimate (m ³ /s)	Comment
SE70488577	Bridge	Page 2 of 2	None available	15	72.4	Riverside Farm House Access Bridge
SE70418598	Bridge	Page 1 of 2	DOV-S-015	1.8	1.75	600mm diameter pipe crossing at Corn Mill
SE70488698	Sluice	Page 1 of 2	DVO-W-021	1.75	N/A	Control Sluice (assumed fully open)
SE70518607	Weir	Page 1 of 2	DOV-W-010	105	72.4	River Dove Diversion Weir
SE70848632	Bridge	Page 1 of 2	DOV-S-026	60	72.4	Keldholme Bridge

- 6.1.2 Note: Other less significant structures and footbridges have not been considered as 'pinch points' due to the open land and low level providing adequate flow routes for high flows.
- 6.1.3 The capacity of the Riverside Farmhouse access bridge is clearly limited. This has been estimated, from the cross sectional area and assumed velocity of 1.5m/s, to be 15m³/s.
- 6.1.4 The total flow area at the Corn Mill Access Bridge is approximately 2.7m² but there ought to be at least 600mm freeboard between the pipe invert and design water level, which certainly is not available. The effective flow area below the pipe crossing is estimated at 1.8m². Technically the capacity is likely to be at least 1.8m³/s but this in no way suggests that the structure is satisfactory, as the risk of blockage is very high.
- 6.1.5 For the purposes of capacity estimation, the control sluice has been assumed to be fully open with a head of 1.5m against the orifice. It is further assumed that the Mill Race has no natural catchment.
- 6.1.6 There is no precise level information on the diversion weir to the Mill Race. It is estimated that the head over the weir can reach 1.5m before road flooding occurs at Riverview. At this level, however, floodwater would probably pass harmlessly overland on the left bank.
- 6.1.7 The cross sectional area of Keldholme Bridge is approximately 20m². The 'arch-full' capacity is estimated to be 60m³/s which is slightly less than the 1% probability (100-year) flood estimate. Since it is a hump-backed bridge the road levels at either side are below the soffit level of the arch, hence overbank flow and flooding will occur before the theoretical capacity of 60m³/s can be attained.
- 6.1.8 The performance of the River Dove and Mill Race cannot be determined with any confidence without detailed survey and hydraulic modelling. The flood risks arising from the Mill Race are strongly influenced by high receiving levels in the River Dove.





6.2 Flood Outlines

6.2.1 Figure 4 shows the current status of knowledge on flood outlines, including:

- The flood outlines from the IH 130 model, which provides a crude estimate of floodplain based on a notional 1% probability (100-year) flood flow and assuming no defences and ignoring any backwater effect from structures.
- The published floodplain on the 2001 Indicative Floodplain maps (2001 IFM) already issued to the Local Planning Authority.

6.2.2 The 2001 IFM for the River Dove is based on IH 130 data but the outline has been modified based on recorded extents of historical floods.

Table 6.2: Main Hydraulic Structures on River Dove and Mill Race at Kirkby Mills
(see also Figures 2 and 3)

				Hydraulic Capacity (based on Manning's Eqn for open channel and USBPR method for culverts/bridges - assuming free discharge)		
No photo available, see Figure 2	Riverside Farm House Access Bridge	SE70488577	Free span access bridge, width 6m with vertical abutments approximately 2m high.	15	Unable to convey the estimated 1% probability (100-year return period) flow. Capacity is less than 50% probability (2-year) flow.	No photo available, see Figure 2
DOV-S-015	600mm diameter pipe crossing at Corn Mill	SE70418598	Access bridge, width 6m, depth to soffit 1m, with 0.6m diameter pipe crossing 0.15m below bridge soffit and 0.3m above bed.	1.8	Unable to convey the estimated 1% probability (100-year return period) flow. Capacity is less than 50% probability (2-year) flow. Crossing is a significant obstruction, and problems are exacerbated by high risk of blockage.	
DVO-W-021	Control Sluice (assumed fully open)	SE70488698	Vertical-lifting gate (normally closed), width 0.9m, depth 0.6m. Controls inflow to Mill Race.	1.75	The capacity of the sluice closely matches that of the pipe crossing downstream. The sluice may be opened during a flood event, but could also overtop if kept closed. Any resulting flooding is likely to be limited to the Riverview road.	
DOV-W-010	River Dove Diversion Weir	SE70518607	Substantial diversion weir, crest width approximately 50m, throw 2m, complete with sluice on right bank.	105 (based on a head of 1.5m)	Weir is able to convey the estimated 1% probability (100-year return period) flow at a head of 1.5m, which would probably only result in inundation of the Riverview road. Bypassing of the weir across the fields on the left bank would further increase the flow capacity.	
DOV-S-026	Keldholme Bridge	SE70848632	Masonry arched hump- backed bridge: Span 10m, rise 2.8m.	60	Capacity is theoretically between the 4% and 2% probability (25 to 50-year) flow, but overtopping of roads would begin before this capacity could be reached. Overtopping could result in flooding to five adjacent properties.	

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7 FINDINGS & RECOMMENDATIONS

This section aims to collate the information gathered, assesses the likely level and extent of flood risk and examines whether further studies would improve knowledge and flood risk planning and alleviation.

7.1 Findings

- 7.1.1 It is clear that the River Dove was placed on the Section 105 Schedule because of the recent flood history and the substantial number of properties affected. This study has revealed that there are two separate problem areas. At Keldholme there are six houses and local roads at risk. At Kirkby Mills there are at least 21 houses, 6 commercial properties and local roads at risk.
- 7.1.2 The full flood mechanism at Keldholme is not clear. Certainly some flooding below Keldholme Bridge, in particular Priory Cottage, arises from the River Dove. There is other evidence of flooding arising from roads and land above Keldholme following the extreme rainfall events in Autumn 2000 and August 2002.
- 7.1.3 The flood mechanism at Kirkby Mills is connected with high flows in the River Dove backing up the Mill Race, which causes overflow at the lowest points. Recently this has been accompanied by surcharge from the 600mm diameter pipeline which discharges to the River Dove upstream of the A170 such that floodwater is often contaminated with sewage. High levels in the Mill Race cause backing up of road drains, all of which contribute to the accumulation of floodwater.
- 7.1.4 It is likely that the road drainage problems are exacerbated by water rising above Swinehead Lane, which is now understood to be connected into the highway drainage system. Direct overflow of the Mill Race downstream of the A170 floods almost all the houses, the access road to Kirkby Mills Industrial Estate and potentially six commercial properties on the Estate.
- 7.1.5 Flood levels in the River Dove at Kirkby Mills are exacerbated by the constricted access bridge to Riverside Farm and the poor standard of channel maintenance. River flooding is often accompanied by surface run-off from the A170 road.
- 7.1.6 Flood estimates for this study have been based on methods recommended in the Flood Estimation Handbook. Kirkby Mills Gauging Station has 30 years of records and lies within the Study Reach. The flood hydrology should therefore be very reliable. The river flood hydrology does not help in explaining the flooding from surface water run-off since this is a function of catchment wetness. Furthermore, it does not predict the flooding caused by overloading of the road drainage systems. This could be caused by blockages with litter or silt, lack of maintenance or simply that the rainfall intensity in the event was greater than the drainage design standard.
- 7.1.7 The performance of the surface water, foul and highway drainage systems against high levels in the receiving watercourses can only be analysed by use of detailed hydraulic models of both the river system and the drainage systems.
- 7.1.8 The small communities of Keldholme and Kirkby Mills have grown recently, but there is no evidence from the Local Plan that further large scale development is likely. There is very little available in-fill land available. Nonetheless PPG25 recommends the use of appropriate Sustainable Urban Drainage Systems (SUDS) in any new developments and these should be incorporated into any future proposals. The Local Plan Deposit Draft does show land liable to flood at Kirkby Mills, but not at Keldholme. The inset plans in the Deposit Draft could be improved by use of the 2001 Indicative Floodplain Mapping.
- 7.1.9 In flood emergencies Ryedale District Council does respond by provision of pumping plant and sandbags even when resources are stretched, as they were in November 2000.
- 7.1.10 There are no special flood warnings for Keldholme and Kirkby Mills. There is an NTS site at Cherry Tree Farm on the Hodge Beck (OS NGR SE 65150 90300), which is immediately adjacent to and west of the River Dove Catchment. In the absence of any river level alarms upstream of Keldholme, it ought to be possible to relate the response at Cherry Tree Farm to that at Kirkby Mills Gauging Station. This should provide a reliable prediction although the target lead time⁸ of two hours may be unachievable because of the steepness of these catchments. It may also be possible to use the Kirkby Mills Gauging Station as a trigger station for the villages although, as this station is downstream of the affected areas, achievement of a 2-hour lead time would be problematic.

⁸ Flood Warning Service Strategy for England and Wales, Environment Agency, September 1999

7.1.11 The 2001 IFM does encompass all the houses identified in this study as being at risk of flooding. It also includes some areas of housing which may be above flood levels. The problems in Keldholme and Kirkby Mills involve different mechanisms, including surface run-off, foul, surface water road drainage combined with river flooding. There are no sound reasons to alter the present flood outline, based on the findings of the simple visual examination undertaken for this study.

7.1.12 This study is primarily concerned with flood defence. However, there are water quality issues at Kirkby Mills associated with licensed CSO discharges. Yorkshire Water are unlikely to address any of these matters, obviously of local concern, during the present phase in Asset Management Planning which runs until 2005 unless otherwise directed by the Environment Agency.

7.2 Recommendations

Environment Agency

7.2.1 Landowners adjacent to the watercourses should be made aware of their rights and responsibilities as riparian owners.

7.2.2 The Environment Agency should review the planned maintenance activities for the River Dove. In particular tree management should ensure that the canopy is maintained well above flood level throughout Reaches 03 and 04. Trees which are in a precarious state, and accumulations of gravel islands, should be removed.

7.2.3 Residents should be aware that there is a Medium to High flood risk from the watercourses (as defined by the Environment Agency⁹). They should be aware of the present information and warning systems provided by the Environment Agency and advised to make their own contingency plans, in case of flood alerts.

7.2.4 Since the number of properties at risk is in the order of 30 (Medium Numbers) and the chance of flooding is Medium to High some improvement in direct flood warnings to Keldholme and Kirkby Mills may be justified. As a minimum, use of the relationship between Hodge Beck and the River Dove for flood warning purposes should be investigated

7.2.5 The Agency should continue to encourage appropriate use of SUDS through the planning process to prevent increase in run-off through development within the catchment.

7.2.6 The Environment Agency should consider inclusion of a capital scheme in the Long Term Plan to reduce the flood risks in Kirkby Mills and Keldholme. This should take account of different parties who have an interest, including Yorkshire Water and North Yorkshire County Council (Highways Division).

7.2.7 The Environment Agency should reconsider whether the flood problems in Kirkby Mills require a review of YWS's present Asset Management Plan. In particular, the 600mm pipe crossing of the Mill Race at the Corn Mill Access is an obstruction to flow. Under normal circumstances, under Sections 109 and 110 of the Water Resources Act 1991, illegal obstructions can be removed by the Agency, costs recovered and the culprit charged with a criminal offence. It is therefore recommended that discussions with YWS regarding this pipe crossing are initiated.

Ryedale District Council

7.2.8 The Council should maintain and rehearse their emergency response procedures to take account of the possibility of flooding at Keldholme and Kirkby Mills. Both areas should be included in the Major Incident Plans.

7.2.9 The Council should inform residents of the service they are able to give residents in a flood emergency.

7.2.10 It is recommended that the policy on Development and Flood Risk in the final adopted version of The Local Plan be endorsed. In the River Dove catchment generally, the use of SUDS will prevent the effects of future development contributing to flood problems elsewhere within the River Derwent catchment.

North Yorkshire County Council (Highways Division)

7.2.11 It is recommended that the proposal to improve road drainage, by interception and diversion to below the Mill Race, be encouraged.

7.3 Further Section 105 Investigations

7.3.1 The Indicative Flood Map does include the parts of Keldholme and Kirkby Mills which were flooded in both Autumn 2000 and August 2002. Further study work could be commissioned to review the flood outline. It is considered that this would tend to reduce the numbers of houses within the floodplain. The value of this is difficult to justify in isolation. However, if further investigations were also used to examine the maintenance

⁹ Flood Warning Strategy for England and Wales, Environment Agency, September 1999

regime and needs for engineering works to prevent flooding as well as providing improved flood mapping, the extra analytical work would receive more local support. It could be used to make progress towards solving the problems, rather than restating them in more detail. It is not recommended that a Phase 2 study be undertaken solely for the purpose of re-defining the floodplain.

- 7.3.2 The costs of survey, modelling and flood mapping could be justified under the Section 105 Investigations. Option selection and economic evaluation leading to scheme justification would normally lie outside the scope of Section 105 studies.

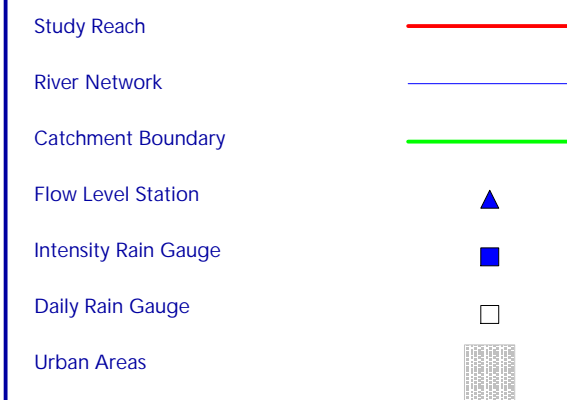
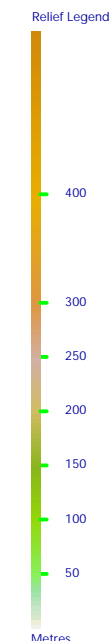
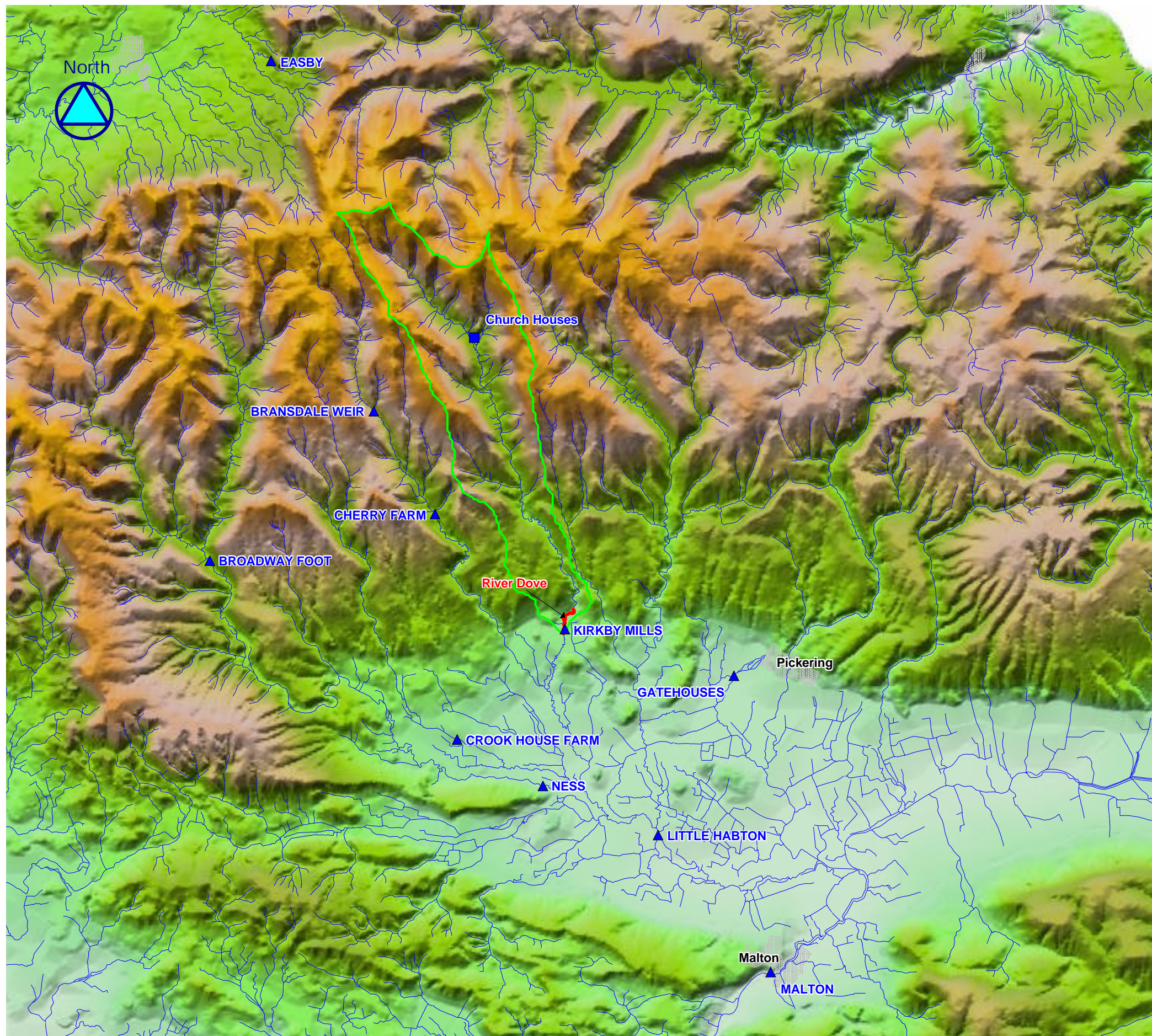
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FIGURES

Contents:

Figure 1:	Study Reach Catchment Plan
Figure 2:	Study Reach Location Plan
Figure 3:	Photograph Location Map
Figure 4:	Indicative Floodplain Map

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Based on the Panorama data of Ordnance Survey Map.
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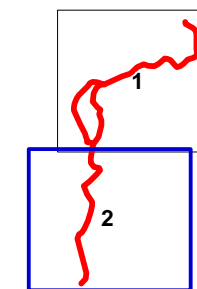
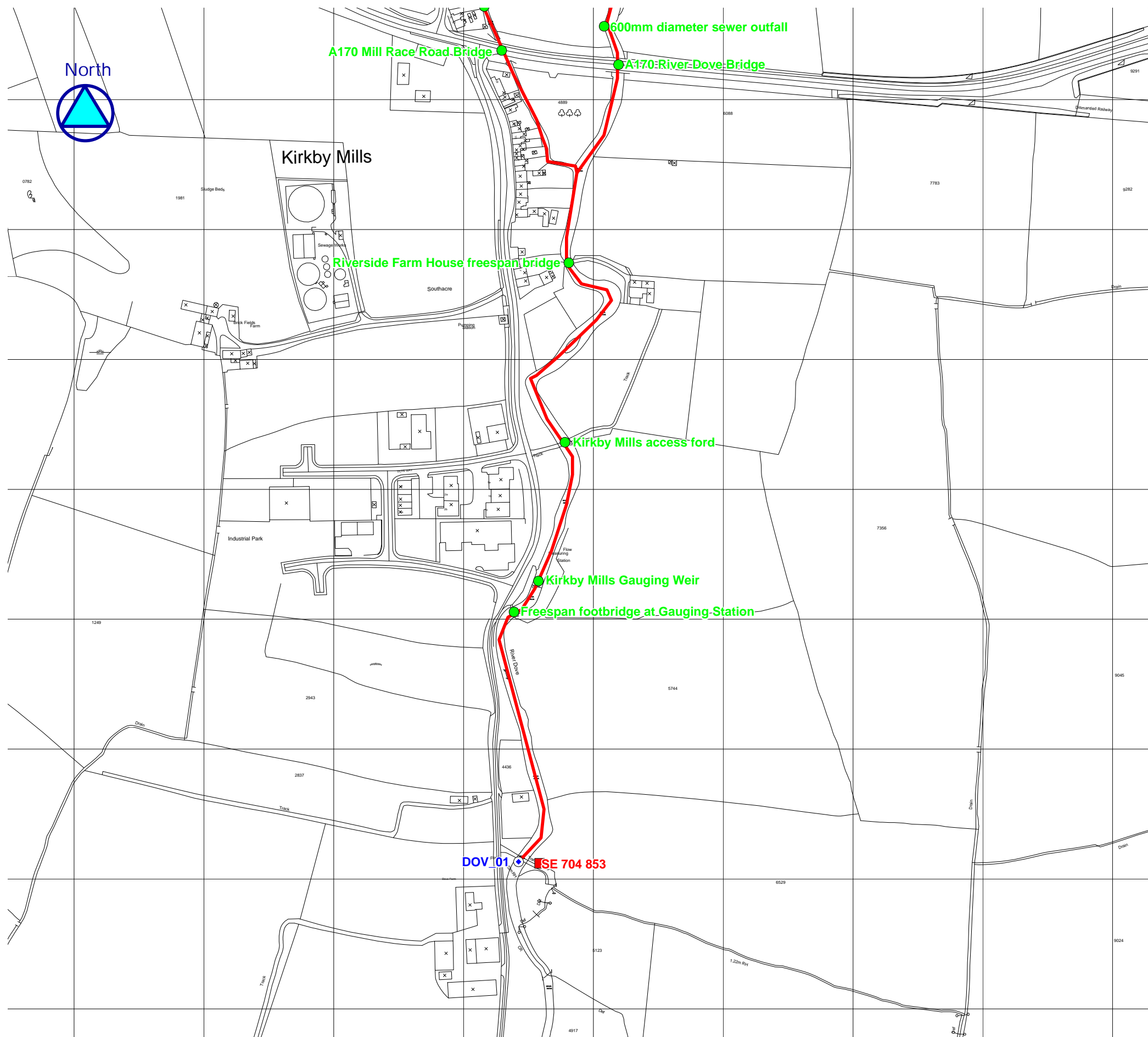


for

THE ENVIRONMENT AGENCY
North East Region
Coverdale House
Aviator Court
Amy Johnson Way
Clifton Moor
YORK
YO30 4GZ



Dales Area S105 Phase 1 Studies 2002
Figure 1: Study Reach Catchment Map
River Dove at Kirkby Mills



LEGEND

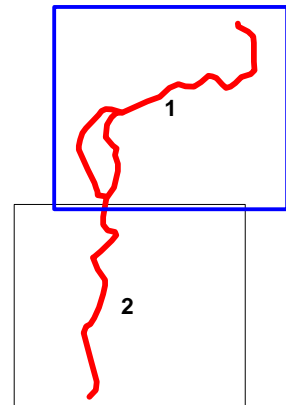
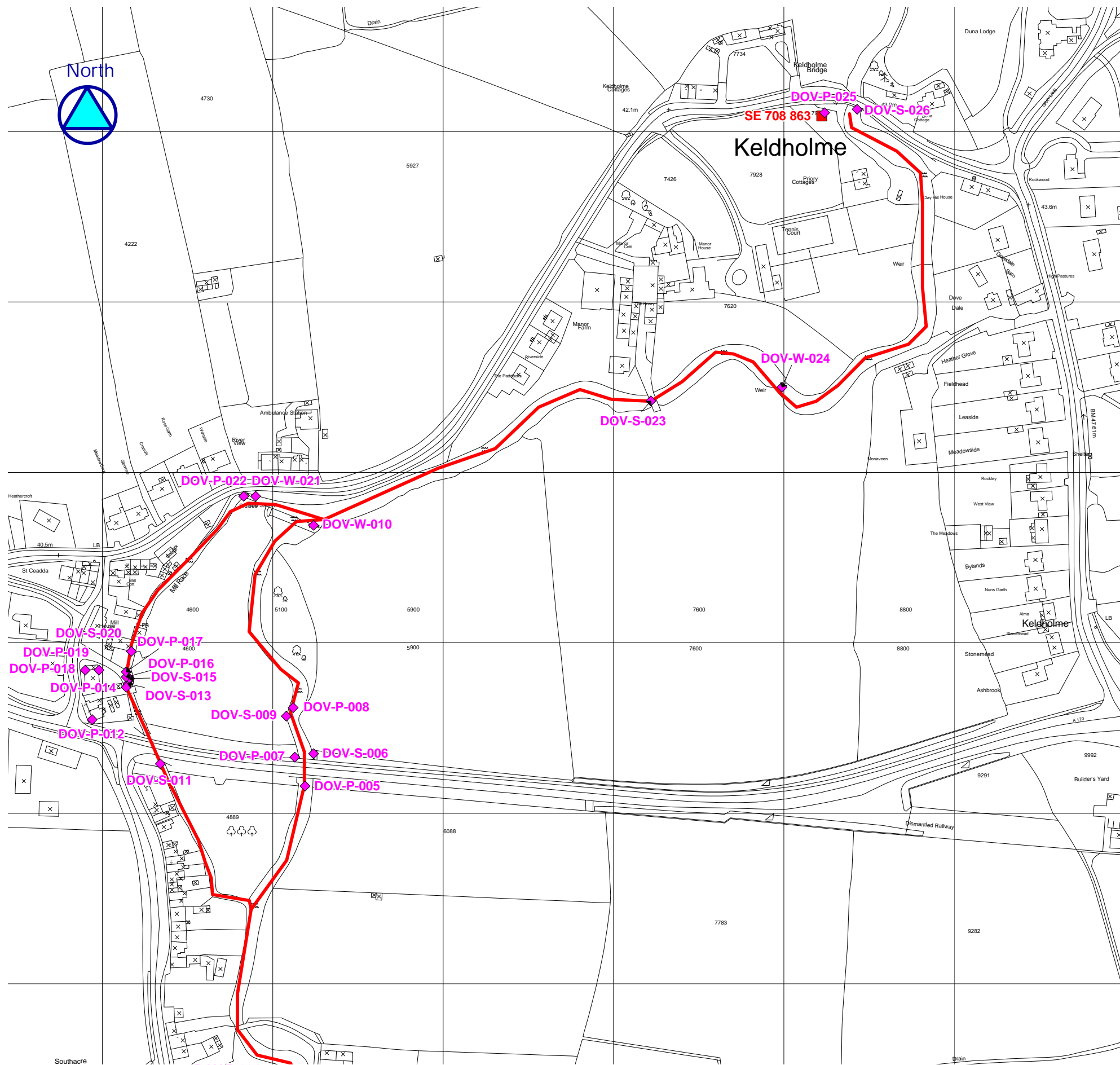
- Study Reach
- Study Extents
- Key Structures
- Flow Estimation Points

Based on the 1:2500 scale Ordnance Survey Map.
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Dales Area S105 Phase 1 Studies 2002
Figure 2: Study Reach Location Map
Page 2 of 2
River Dove at Kirkby Mills



LEGEND

Study Reach

Study Extents

Photograph Locations

SE 708 863

DOV-P-001

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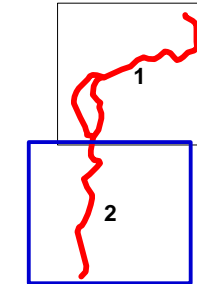
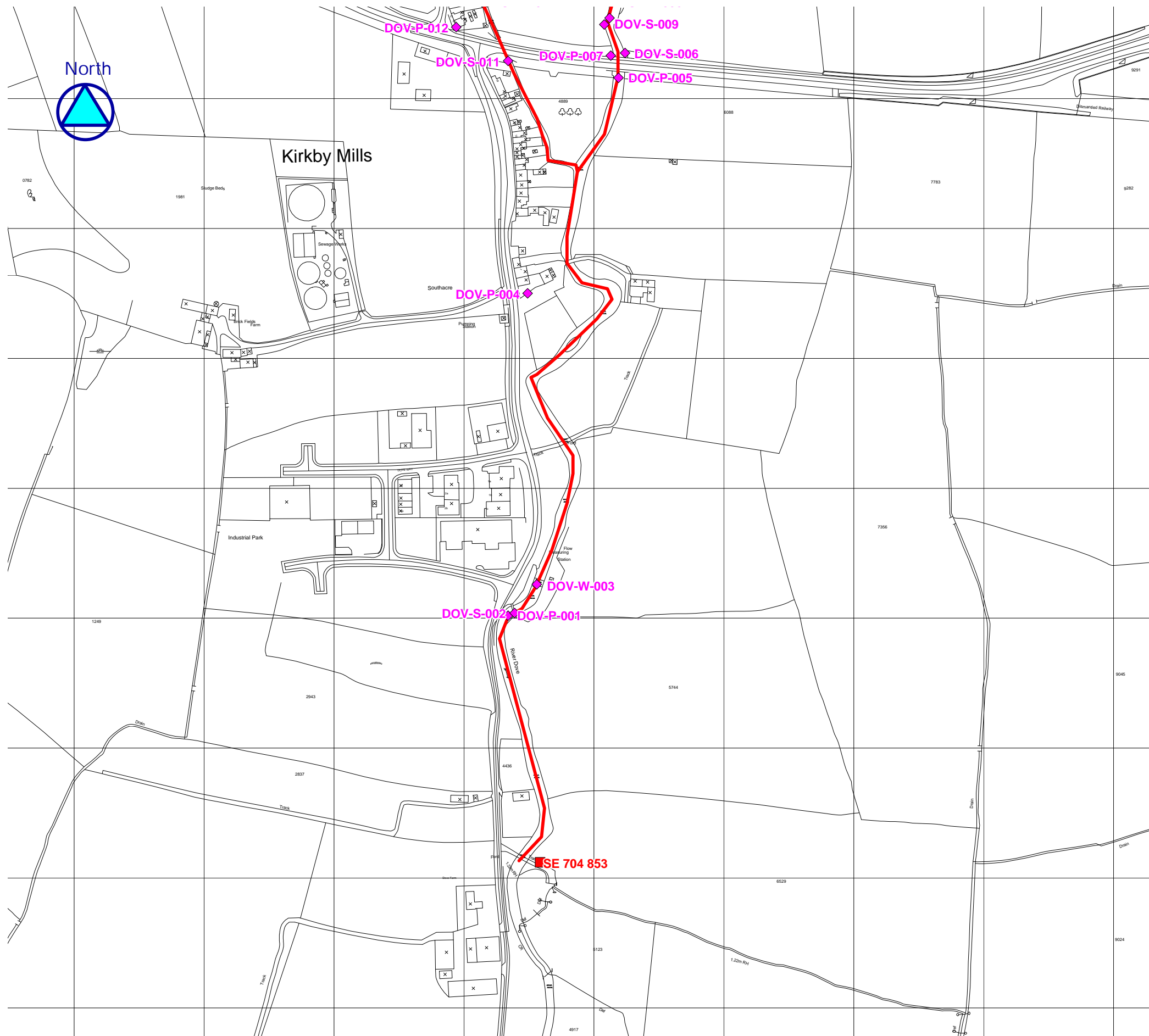


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Dales Area S105 Phase 1 Studies 2002
Figure 3: Photograph Location Map
Page 1 of 2
River Dove at Kirkby Mills



LEGEND

Study Reach

Study Extents

Photograph Locations



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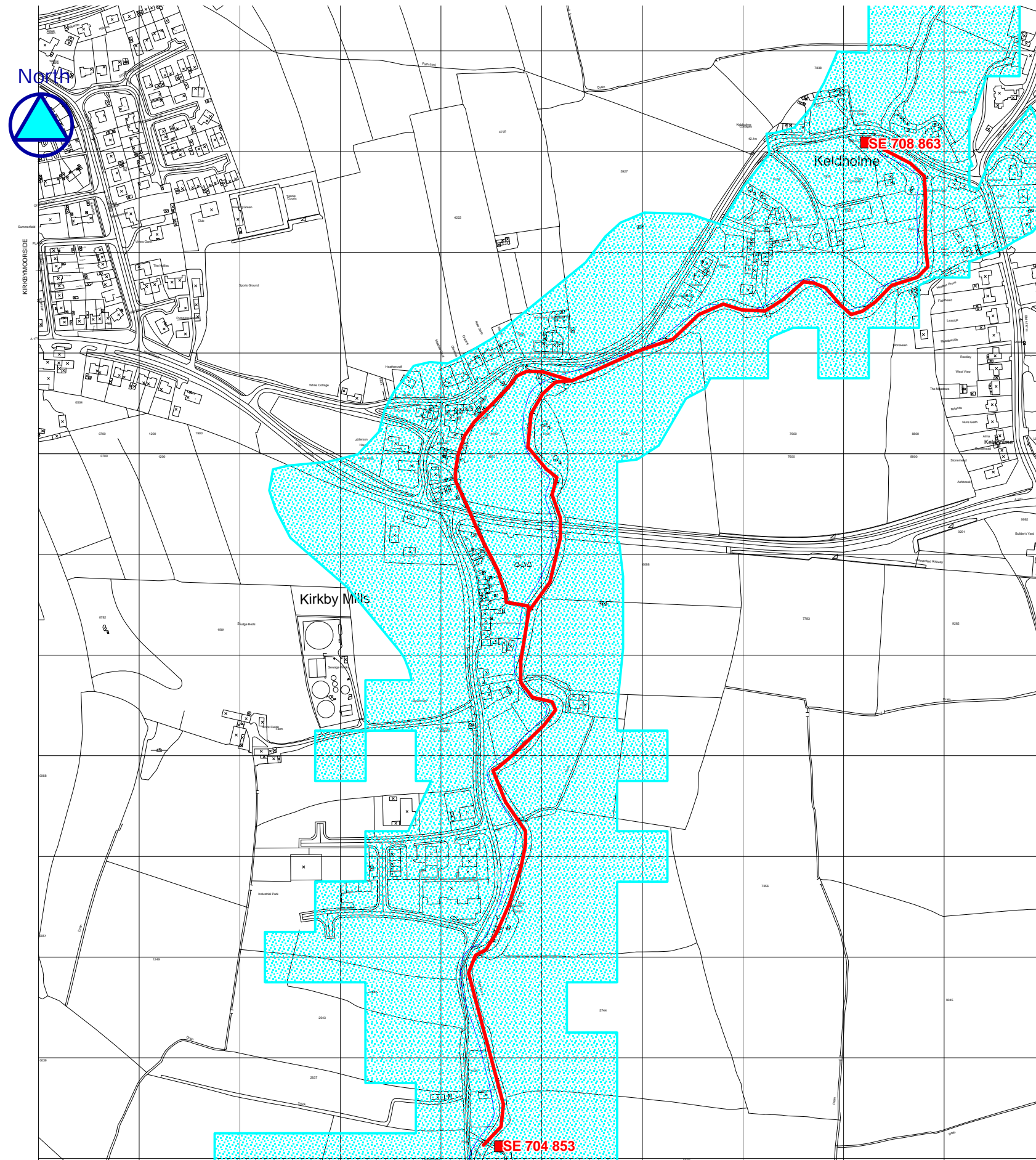


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Dales Area S105 Phase 1 Studies 2002
Figure 3: Photograph Location Map
Page 2 of 2
River Dove at Kirkby Mills



LEGEND

Study Reach



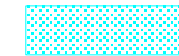
River Network



Study Extents



2001 Indicative Floodplain
(Fluvial)



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Dales Area S105 Phase 1 Studies 2002

Figure 4: Indicative Floodplain Map

River Dove at Kirkby Mills

PHOTOGRAPHS

Notes:

1. All photographs are also supplied as digital (jpeg) files on the Archive CD-ROM (supplied as a separate deliverable).
2. The location of each of the photographs is shown on Figure 3.
3. Photographs showing flooding events, as provided by residents in their responses to questionnaires, are also included.

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PHOTOGRAPHS

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Photograph Ref: DOV-P-001

Description: Heavily overgrown channel below gauging station.

View: Downstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0050.JPG



Photograph Ref: DOV-S-002

Description: Small access bridge below Kirkby Mills Gauging Station.

View: Downstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0049.JPG



Photograph Ref: DOV-W-003

Description: Kirkby Mills Gauging Station.

View: Upstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0048.JPG



Photograph Ref: DOV-P-004

Description: Sandbags ready for deployment at Southacre, Kirkby Mills.

View: N/A

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0051.JPG



Photograph Ref: DOV-P-005

Description: General view of overgrown River Dove channel below A170.

View: Downstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0036.JPG



Photograph Ref: DOV-S-006

Description: Staff gauge board on right bank at A170 Road Bridge over River Dove.

View: N/A

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0053.JPG



Photograph Ref: DOV-P-007

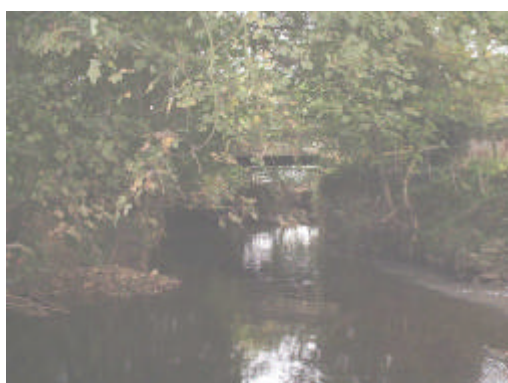
Description: Upstream face of A170 Bridge over River Dove from right bank.

View: Downstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0052.JPG



Photograph Ref: DOV-P-008

Description: Upstream face of A170 Road Bridge over River Dove.

View: Downstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0035.JPG



Photograph Ref: DOV-S-009

Description: Sewage overflow from 600mm diameter outfall on right bank of River Dove upstream of A170.

View: N/A

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0054.JPG



Photograph Ref: DOV-W-010

Description: River Dove diversion weir below River View.

View: Downstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0034.JPG



Photograph Ref: DOV-S-011

Description: Downstream face of A170 bridge over Mill Race.

View: Upstream

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0047.JPG



Photograph Ref: DOV-P-012

Description: Stop board grooves No 20 Station Cottages.

View: N/A

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0046.JPG



Photograph Ref: DOV-S-013

Description: Upstream face of access bridge at Mill Chase.

View: Downstream

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0043.JPG



Photograph Ref: DOV-P-014

Description: Upstream face of access bridge over Mill Race at Mill Chase.

View: Downstream

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0038.JPG



Photograph Ref: DOV-S-015

Description: Close up view of pipe crossing at Corn Mill.

View: Upstream

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0044.JPG



Photograph Ref: DOV-P-016

Description: Downstream face of Corn Mill Access Bridge and pipe crossing.

View: Upstream

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0042.JPG



Photograph Ref: DOV-P-017

Description: Downstream face of Corn Mill access bridge and 600mm pipe crossing.

View: Upstream

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0039.JPG



Photograph Ref: DOV-P-018

Description: Private flood defences to front of Mill Chase.

View: N/A

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0055.JPG



Photograph Ref: DOV-P-019

Description: Private flood defence wall at rear of Mill Chase.

View: N/A

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0045.JPG



Photograph Ref: DOV-S-020

Description: Mill Race outlet downstream of Corn Mill.

View: Upstream

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0037.JPG



Photograph Ref: DOV-W-021

Description: Undershot sluice gate at entry to Mill Race.

View: Downstream

Watercourse Name: River Dove, Mill Race

Date Taken: 11/10/2002

Filename: DSCF0040.JPG



Photograph Ref: DOV-P-022

Description: General view of diversion weir from right bank.

View: Downstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0041.JPG



Photograph Ref: DOV-S-023

Description: Downstream face of access bridge at Manor Farm.

View: Upstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0033.JPG



Photograph Ref: DOV-W-024

Description: Small check weir within grounds at Keldholme Priory.

View: Downstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0032.JPG



Photograph Ref: DOV-P-025

Description: Sandbags deployed at entry to Priory Cottage.

View: Downstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0031.JPG



Photograph Ref: DOV-S-026

Description: Downstream face of Keldholme Bridge.

View: Upstream

Watercourse Name: River Dove

Date Taken: 11/10/2002

Filename: DSCF0030.JPG

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FLOOD PHOTOGRAPHS

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Photograph Number: 1

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: Car stuck in flood coming from Industrial Estate.

Date Taken: 01/10/2000

Filename: Photo 01.jpg



Photograph Number: 2

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View from bathroom to kitchen.

Date Taken: 01/10/2000

Filename: Photo 02.jpg



Photograph Number: 3

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View from kitchen to bathroom.

Date Taken: 01/10/2000

Filename: Photo 03.jpg



Photograph Number: 4

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View of garden before flood.

Date Taken: 01/10/2000

Filename: Photo 04.jpg



Photograph Number: 5

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View of garden after flood.

Date Taken: 01/10/2000

Filename: Photo 05.jpg



Photograph Number: 6

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View of kitchen water still rising.

Date Taken: 01/10/2000

Filename: Photo 06.jpg



Photograph Number: 7

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View of kitchen water still rising.

Date Taken: 01/10/2000

Filename: Photo 07.jpg



Photograph Number: 8

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View of kitchen water 10 minutes later.

Date Taken: 01/10/2000

Filename: Photo 08.jpg



Photograph Number: 9

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View of bathroom after flood (b).

Date Taken: 01/10/2000

Filename: Photo 09.jpg



Photograph Number: 10

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View of bathroom after flood (a).

Date Taken: 01/10/2000

Filename: Photo 10.jpg



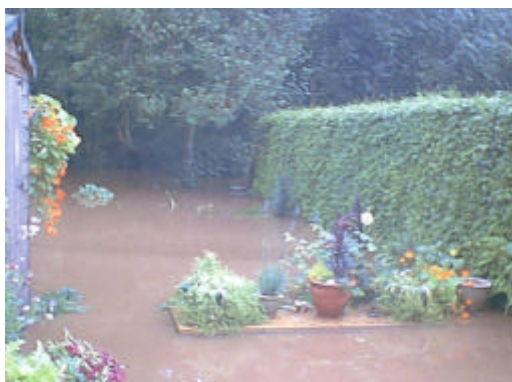
Photograph Number: 11

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View of back garden.

Date Taken: 01/08/2002

Filename: Photo 11.jpg



Photograph Number: 12

Provided By: Mr & Mrs Lea, Liliem Cottage, 10 Kirby Mills.
Kirkbymoorside, York.

Description: View of back garden, 15 minutes later.

Date Taken: 01/08/2002

Filename: Photo 12.jpg



Photograph Number: 13

Provided By: Mr & Mrs Young, 21a Kirbymills, Kirkbymoorside, York

Description: View of back garden.

Date Taken: Unknown

Filename: Image 1.jpg



Photograph Number: 14

Provided By: Mr & Mrs Young, 21a Kirbymills, Kirkbymoorside, York

Description:

Date Taken: Unknown

Filename: Image 2.jpg



Photograph Number: 15

Provided By: Mr & Mrs Young, 21a Kirbymills, Kirkbymoorside, York

Description:

Date Taken: Unknown

Filename: Image 3.jpg



Photograph Number: 16

Provided By: Mr & Mrs Young, 21a Kirbymills, Kirkbymoorside, York

Description:

Date Taken: Unknown

Filename: Image 4.jpg



Photograph Number: 17

Provided By: Mr & Mrs Young, 21a Kirbymills, Kirkbymoorside, York

Description:

Date Taken: Unknown

Filename: Image 5.jpg



Photograph Number: 18

Provided By: Mr & Mrs Young, 21a Kirbymills, Kirkbymoorside, York

Description:

Date Taken: Unknown

Filename: Image 6.jpg



Photograph Number: 19

Provided By: Mr B Hughes, 3 Keldholme Cottages, Keldholme, Kirkbymoorside.

Description:

Date Taken: Unknown

Filename: 1.jpg



Photograph Number: 20

Provided By: Mr B Hughes, 3 Keldholme Cottages, Keldholme, Kirkbymoorside.

Description:

Date Taken: Unknown

Filename: 2.jpg



Photograph Number: 21

Provided By: Mr B Hughes, 3 Keldholme Cottages, Keldholme, Kirkbymoorside.

Description:

Date Taken: Unknown

Filename: 3.jpg



Photograph Number: 22

Provided By: Mr B Hughes, 3 Keldholme Cottages, Keldholme, Kirkbymoorside.

Description:

Date Taken: Unknown

Filename: 4.jpg



Photograph Number: 23

Provided By: Mr B Hughes, 3 Keldholme Cottages, Keldholme, Kirkbymoorside.

Description:

Date Taken: Unknown

Filename: 5.jpg



Photograph Number: 24

Provided By: Mr B Hughes, 3 Keldholme Cottages, Keldholme, Kirkbymoorside.

Description:

Date Taken: Unknown

Filename: 6.jpg



Photograph Number: 25

Provided By: Mr B Hughes, 3 Keldholme Cottages, Keldholme, Kirkbymoorside.

Description:

Date Taken: Unknown

Filename: 7.jpg



Photograph Number: 26

Provided By: Mrs J Sinfield, Rosebay Cottage, Kirby Mills, Kirkbymoorside.

Description: View of Rosebay Cottage garage.

Date Taken: Unknown

Filename: Photo 13.jpg



Photograph Number: 27

Provided By: Mrs J Sinfield, Rosebay Cottage, Kirby Mills, Kirkbymoorside.

Description: View of Rosebay Cottage garage.

Date Taken: Unknown

Filename: Photo 14.jpg



Photograph Number: 28

Provided By: Mrs J Sinfield, Rosebay Cottage, Kirby Mills, Kirkbymoorside.

Description: View of Rosebay Cottage garden.

Date Taken: Unknown

Filename: Photo 15.jpg



Photograph Number: 29

Provided By: Mrs J Sinfield, Rosebay Cottage, Kirby Mills, Kirkbymoorside.

Description: View of Rosebay Cottage garden.

Date Taken: Unknown

Filename: Photo 16.jpg



Photograph Number: 30

Provided By: Mrs J Sinfield, Rosebay Cottage, Kirby Mills, Kirkbymoorside.

Description: View of Rosebay Cottage garden after flood.

Date Taken: Unknown

Filename: Photo 17.jpg



Photograph Number: 31

Provided By: Mrs J Sinfield, Rosebay Cottage, Kirby Mills, Kirkbymoorside.

Description: View of Rosebay Cottage kitchen after flood.

Date Taken: Unknown

Filename: Photo 18.jpg



Photograph Number: 32

Provided By: Mrs J Sinfield, Rosebay Cottage, Kirby Mills, Kirkbymoorside.

Description: View of Rosebay Cottage downstairs toilet after flood.

Date Taken: Unknown

Filename: Photo 19.jpg



Photograph Number: 33

Provided By: Mr C Tinkler, The Cornmill, Kirby Mills, Kirkbymoorside.

Description: View of the front of Millhouse.

Date Taken: Unknown

Filename: Photo 20.jpg



Photograph Number: 34

Provided By: Mr C Tinkler, The Cornmill, Kirby Mills, Kirkbymoorside.

Description: View of the front of Millhouse.

Date Taken: Unknown

Filename: Photo 21.jpg



Photograph Number: 35

Provided By: Mr C Tinkler, The Cornmill, Kirby Mills, Kirkbymoorside.

Description: View of Kirby Mills.

Date Taken: Unknown

Filename: Photo 22.jpg



Photograph Number: 36

Provided By: Mr C Tinkler, The Cornmill, Kirby Mills, Kirkbymoorside.

Description: View of Mill Race approaching The Cornmills.

Date Taken: Unknown

Filename: Photo 23.jpg



Photograph Number: 37

Provided By: Mr C Tinkler, The Cornmill, Kirby Mills, Kirkbymoorside.

Description: View of the carpark and paddocks behind The Cornmills.

Date Taken: Unknown

Filename: Photo 24.jpg



Photograph Number: 38

Provided By: Mr C Tinkler, The Cornmill, Kirby Mills, Kirkbymoorside.

Description: View of river and weir with sluice visible in the middle right.

Date Taken: Unknown

Filename: Photo 25.jpg



Photograph Number: 39

Provided By: Revd. J M Stephens, Southacre, Kirby Mills,
Kirkbymoorside.

Description:

Date Taken: 11/04/1998

Filename: Photo 26.jpg



Photograph Number: 40

Provided By: Revd. J M Stephens, Southacre, Kirby Mills,
Kirkbymoorside.

Description:

Date Taken: 02/11/2000

Filename: Photo 27.jpg

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APPENDIX A: Returned flooding questionnaires

Contents:

1. List of addresses to which questionnaires were sent/delivered.
2. Returned flooding questionnaires:-
 - Mr and Mrs W Young, Mill Chase, 21A Kirkby Mills, Kirkbymoorside, YORK, YO62 6NP
 - Mr Brian Hughes, 3 Keldholme Cottages, Kirkbymoorside, YORK YO62 6NA
 - Mrs Mary Farrow, 21 Kirkby Mills, Kirkbymoorside, YORK YO62 6NP
 - Mrs J Sinfield, Rosebay Cottage, Kirkby Mills, Kirkbymoorside, YORK YO62 6NR
 - Miss V Watts, 18 Kirkby Mills, Kirkbymoorside, YORK
 - Mr Chris Tinkler, The Corn Mill, Kirkby Mills, Kirkbymoorside, YORK YO62 6NP
 - Mr W John Bulmer, Duna Cottage, Keldholme, Kirkbymoorside, YORK YO62 6NB
 - Revd J M Stephens, Southacre, Kirkby Mills, Kirkbymoorside, YORK YO62 6NR
 - Mrs Dorothy Anstead, Ivy Cottage, Keldholme, Kirkbymoorside, YORK YO62 6NN
 - Mr David Hopkinson, Keldholme Priory, Keldholme, YORK YO62 6LZ
 - Mrs I M Owston, 4 Kirkby Mills, Kirkbymoorside, YORK YO62 6NR
 - Mr and Mrs M Lea, Liliem Cottage, 10 Kirkby Mills, Kirkbymoorside, YORK YO62 6NR
 - Mrs M Curtis, Priory Lodge, Keldholme, Kirkbymoorside, YORK, YO62

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QUESTIONNAIRE RECIPIENTS

Addressee	Returned	Comment
Local Planning Authorities/Emergency Services		
North Yorkshire Fire Service	X	
Ryedale District Council		Schedule of flooded property
Internal Drainage Boards		
River Rye IDB	N/A	Personal Interview
Individual Properties/Businesses		
Mr and Mrs W Young, Mill Chase, 21A Kirkby Mills, Kirkbymoorside, YORK, YO62 6NP	✓	Detailed 5 separate flood events since 1998. Included newspaper cuttings, photographs and minutes of meetings.
Mr Brian Hughes, 3 Keldholme Cottages, Kirkbymoorside, YORK YO62 6NA	✓	Details of flooding in October 2000 and August 2002. Flood reports, newspaper cuttings and minutes of meetings
Mrs Mary Farrow, 21 Kirkby Mills, Kirkbymoorside, YORK YO62 6NP	✓	Detailed 6 separate flood events since 1998 confirmed flooding 750mm in property
Mrs J Sinfield, Rosebay Cottage, Kirkby Mills, Kirkbymoorside, YORK YO62 6NR	✓	Confirmed flooding November 2000 and August 2002, both from River Dove and roads.
Miss V Watts, 18 Kirkby Mills, Kirkbymoorside, YORK	✓	Flooding of houses 75-100mm deep in October 2000 and August 2000 from Mill Race.
Mr Chris Tinkler, The Corn Mill, Kirkby Mills, Kirkbymoorside, YORK YO62 6NP	✓	Flooding 30 October 2000 and 2 August 2002 caused by high levels in River Dove, Mill Race and surcharge of combined sewer.
Mr W John Bulmer ¹⁰ , Duna Cottage, Keldholme, Kirkbymoorside, YORK YO62 6NB	✓	Flooding in 30 October 2000 caused by surface water run off from Gray Lane and track below Bogg Hall; had not occurred before in 20 years.
Revd J M Stephens, Southacre, Kirkby Mills, Kirkbymoorside, YORK YO62 6NR	✓	4 flood events since 11 April 1998 up to 900mm deep in roads. Affected up to 30 houses
Mrs Dorothy Anstead, Ivy Cottage, Keldholme, Kirkbymoorside, YORK YO62 6NN	✓	Overflow of floodwater into fields from Mill Race, but has not flooded cottage in 30 years.
Mr David Hopkinson, Keldholme Priory, Keldholme, YORK YO62 6LZ	✓	Confirms flooding of property at Keldholme Bridge caused by overland flow. No property at Priory flooded in last 12 years.
Mrs I M Owston, 4 Kirkby Mills, Kirkbymoorside, YORK YO62 6NR	✓	Flooding of road access to Industrial Estate, 750mm deep. Included comprehensive commentary covering last 60 years.
Mr and Mrs M Lea, Liliem Cottage, 10 Kirkby Mills, Kirkbymoorside, YORK YO62 6NR	✓	3 separate events from 30 October 2000 to 2 August 20002 – up to 20 houses affected by flooding from Mill Race.
Mrs M Curtis, Priory Lodge, Keldholme, Kirkbymoorside, YORK YO62	✓	No flooding at Priory Lodge, Keldholme since built or during my life time (82 years) in the area.

¹⁰ Copy letter to EA and NYCC dated 3 November 2002 forwarded, referring to problems with road drainage and high river flows on 3 November 2002 also received.

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APPENDIX B: Output from database/Other information

Contents:

1. Other historical information



- OS Historical map, 1910.
- Extract from Ryedale District Council Local Plan.
- Extract from draft amendments to Ryedale Local Plan (ENV25).
- Findings of JBA library searches.
- Ryedale District Council, schedule of flooded property in November 2000.
- Press Cuttings:

2. Sources of information

- Environment Agency report sources.
- Environment Agency consultees.
- Other consultees.

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ENVIRONMENT AGENCY REPORT SOURCES

	Title:	Local Environment Agency Plan. Derwent. Consultation Report.
	Author:	The Environment Agency
	Publisher:	The Environment Agency
	Date:	Sep 1996
	Synopsis:	Provides background to the Tees catchment as a whole and the Agency's objectives with regard to environmental improvement, resource management and flood defence.
	Relevance to this Study	<ul style="list-style-type: none"> • Low, but information still valid.
	Availability :	<ul style="list-style-type: none"> • Widely available.
	Title:	Local Environment Agency Plan. Derwent. Action Plan.
	Author:	The Environment Agency
	Publisher:	The Environment Agency
	Date:	Mar 1998
	Synopsis:	Outlines the strategy that the Agency intends to undertake in partnership with others in the Derwent area for a five year period.
	Relevance to this Study	<ul style="list-style-type: none"> • Low, but information still valid.
	Availability :	<ul style="list-style-type: none"> • Widely available.

Details of other more general information sources are included in the Summary Report for the Phase 1 studies.

ENVIRONMENT AGENCY CONSULTEES

Robin Bailey (Rivers House, Leeds)	<i>Current Job Title/Role:</i>	Regional Section 105 Project Manager
	<i>Previous Job Title/Role relevant to this Investigation:</i>	Flood Defence Officer, York.
	<i>Knowledge of catchment:</i>	Flood warning duties.
Phil Edwards (Coverdale House, York)	<i>Current Job Title/Role:</i>	Team Leader - Development Control
	<i>Previous Job Title/Role relevant to this Investigation:</i>	Development Control Engineer, North Dales (up to Sep 1999)
	<i>Knowledge of catchment:</i>	Development control
Mark Saunders (Coverdale House, York)	<i>Current Job Title/Role:</i>	Section 105 Project Manager
	<i>Previous Job Title/Role relevant to this Investigation:</i>	Not relevant
	<i>Knowledge of catchment:</i>	N/A
Ian Cooke (Coverdale House, York)	<i>Current Job Title/Role:</i>	Development Control Engineer
	<i>Previous Job Title/Role relevant to this Investigation:</i>	Not relevant
	<i>Knowledge of catchment:</i>	N/A
Kim Andrew (Coverdale House, York)	<i>Current Job Title/Role:</i>	Team Leader - Strategy
	<i>Previous Job Title/Role relevant to this Investigation:</i>	Not relevant
	<i>Knowledge of catchment:</i>	20 years
Peter Yerrel (Teesdale House, Darlington)	<i>Current Job Title/Role:</i>	Maintenance Engineer
	<i>Previous Job Title/Role relevant to this Investigation:</i>	
	<i>Knowledge of catchment:</i>	20 years
John Bell (Teesdale House, Darlington)	<i>Current Job Title/Role:</i>	Maintenance Engineer
	<i>Previous Job Title/Role relevant to this Investigation:</i>	Not relevant
	<i>Knowledge of catchment:</i>	10 years

OTHER CONSULTTEES



Ryedale District Council
<http://www.Ryedale.gov.uk/>
 Ryedale House
 Malton
 North Yorkshire
 YO17 7HH
 Tel: 01653 600666
 Fax: 01653 696801



Yorkshire Water Limited
<http://www.yorkshirewater.co.uk/>
 Yorkshire Water Services Limited
 2 The Embankment
 Sovereign Street
 LEEDS
 West Yorkshire
 LS1 4BG
 Tel: 00113 234 3234
 Fax: 0113 231 2822



North Yorkshire County Council
 Contact: Peter Renshaw, Divisional Engineer
 North Yorkshire County Council
 Highways Department
 Kirkbymoorside
 Tel: 01751 431248
 Fax 01751 432973

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APPENDIX C:
FEH Calculation Record and HiFlow Output

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INTRODUCTION

This report provides a record of the calculations and decisions made during design flood estimation using the techniques of the Flood Estimation Handbook (Institute of Hydrology, 1999).

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REVISION HISTORY

Revision Ref./ Date Issued	Amendments	Issued to
Draft 26 September 2002	-	Included in Draft Watercourse Report
Final 28 January 2003	-	Included in Final Watercourse Report

APPROVAL

Calculations prepared by:

Charlotte Davison BSc MSc
Analyst

Calculations checked by:

Jeremy Benn MA MSc CEng FICE FCIWEM MASCE
Director

Calculations approved by:

Jeremy Benn MA MSc CEng FICE FCIWEM MASCE
Director

NOTES FOR ANALYSTS

This report does not attempt to cover all aspects of the hydrological study: its aim is to enable your work to be reproduced. In the main project report, you should consider adding information not given here, such as details of the rating review, the flood history and a comparison with previous studies.

All analysts doing work for the Environment Agency should have read Part 2 of the Agency guidelines on use of the FEH. You should also ensure that your copy of the FEH is up-to-date by checking the corrigenda page on the FEH website, www.nwl.ac.uk/ih/feh. Check there also for any reported errors in the software that you should be aware of.

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FLOOD ESTIMATION HANDBOOK CALCULATION RECORD

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1 METHOD STATEMENT

Note: This section should be completed and agreed with the client at the inception of the project.

Table 1.1: Overview of study

Item	Comments
Purpose of study	Detailed hydrological study of the catchment possibly leading to further phase of modelling work.
Description of catchment	The River Dove is a relatively small predominately rural catchment, with moorland headwaters and rough grazing with some forestry as the principal land uses. The River Dove joins the River Rye approximately 9km downstream of the study reach. The catchment subsurface geology is Jurassic limestones, clays and sandstone
Flood estimates required	Design flows for a range of return periods
Approx. time available for study	To end October 2002.

Table 1.2: Flow or level data available

(at the sites of flood estimates or for nearby donor catchments)

Watercourse	Station	Gauging authority number	NVA number (used in FE I)	Grid reference	Raining	Period of data (WINFAS-FEH)	Period of additional data
Gauging station at downstream limit of study reach:							
River Dove	Kirkby Mills	2560	027042	SE 705 855	Yes	1973-2000	None
Comments on data quality and any checks made	Low flow gauge subject to drowning. High flows should be treated with caution.						

Table 1.3: Other data available

Item	Comments
Flow gaugings (if planned to update rating curve)	Gaugings at Kirkby Mills (1987-2000)
Historic flood data	See main report.
Extra data for other sites in pooling groups (if a major study)	Not sought, although some sites may already have been updated as part of other JBA studies.

Table 1.3: Other data available

Item	Comments
Flood event data (if planned to use rain all-runoff method)	Flood event data requested for River Dove at Kirkby Mills.
Rainfall event data (if planned to use rain all-runoff method)	15 minute rainfall data requested for Church Houses.

Table 1.4: Initial choice of approach

Item	Comments
Statistical, rainfall-runoff or hybrid approach?	Both, and compare results.
If statistical, single-site or pooled analysis?	Pooled
Review and update rating curves?	No
Any unusual factors to take into account? e.g. highly permeable or urban catchment)	None

2 LOCATIONS WHERE FLOOD ESTIMATES REQUIRED

Note: List any adjustment to the default catchment descriptors provided by the FEH CD-ROM 1999. Include any updating of URBEXT, which can be carried out when constructing a flood frequency curve in WINFAP-FEH.

Table 2.1: Summary of subject sites

Site code	Watercourse	Site	Easting	Northing	Catchment area from FEH CD-ROM (km ²)	Any adjustments to catchment descriptor extracted from FEH CD-ROM 1999
DOV_01	River Dove	D/S Study Limit	470450	485300	60.43	None
DOV_02	River Dove	U/S Study Limit	470850	486300	52.84	None
Record how catchment descriptors checked		Catchment boundary matches that derived from OS 1:25 000 map.				

In the Local Plan Deposit Draft there is no land allocated for housing in Keldholme or Kirkby Mills. Elsewhere in the two communities, there are very few opportunities for development without adversely affecting the character of the settlement. It should be noted that the representation of urbanisation in the FEH methods is that URBEXT is used to estimate the net effect of urbanisation – i.e. it assumes that some level of discharge control is implemented.

Table 2.1: Updating URBEXT

Site code	URBEXT 1990	Catchment area	Paved area 1990	Extra paved area	URBEXT 2001
DOV_01	0.005	60.43	N/A	N/A	0.005
DOV_02	0.001	52.84	N/A	N/A	0.001

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3 RECORD OF DATA USED

If using analysing flood peak data with WINFAP-FEH, copy the entire contents of the WINFAP-FEH data directory to a CD. This will form a record of the flow peak data used for estimating QMED and for fitting flood growth curves. Add comments to the "User" box in WINFAP-FEH to record any additional data or changes due to revised rating curves.

If analysing flood event data, attach printouts of rainfall hyetographs and flow/level hydrographs, or else a digital copy of the data.

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4 STATISTICAL METHOD

Table 4.1: Estimation of QMED at each subject site

Site code	Method: AM – Annual maxima POT – Peaks over threshold DT – Catchment descriptors with data transfer CD – Catchment descriptors alone	Initial estimate of QMED (m ³ /s)	If AM or POT, any adjustment due to climatic variation? (see below)	If DT, numbers of donor/analogue sites used (see Table 4.2) and reasons for choice	Final estimate of QMED (m ³ /s)
DOV_01	AM	30.0	n/a	N/A	30.0
DOV_02	DT	29.4	n/a	1, as it is at downstream model limit	29.4

Record here the details of any adjustments made due to climatic variation (whether at subject sites, donor sites or analogue sites).

Table 4.2: Donor and analogue sites for QMED

No.	Watercourse	Station	NVA number	Method (AM or POT)	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)
1	River Dove	Kirkby Mills	027042	AM	30.008	14.176	2.12

Record here any further comments on the use of analogue catchments: reasons for choosing them, method of combining adjustment ratios if several analogues used together.

River Dove at Kirkby Mills is located at the downstream model limit.

Table 4.3: Derivation of pooling groups

(Note: Several subject sites may use the same pooling group)

Name	Site code for which group initially derived	Target return period (years)	Changes made to default pooling group produced by WINFAP-FEH using the flood peak data now stored on the floppy disk. Note also any sites that were investigated but retained in the group.
D1	DOV_01	100	52004, 21002 & 68011 discordant all retained.

Table 4.4: Derivation of flood growth curves at each subject site

Site code	Method: SS – Single site P – Pooled A – Average of the two H – Incorporating historical data	If P or A, code of pooling group? (see Table 4.3)	Distribution(s) chosen and reason	Parameters of chosen distribution(s)
DOV_01	P	D1	GL: fits best	1, 0.231, -0.107
DOV_02	P	D1	as above	as above

Table 4.5: Flood estimates from the statistical method at each subject site

Site code	Flood peak (m³/s) for the following probabilities & return periods (in years)						
	0% 2-y ars	0% 5-y ars	0% 10-y ars	4% 25-y ars	2% 50-y ars	1.3% 75-y ars	1% 100-y ars
DOV_01	30.01	40.32	47.09	56.08	63.24	67.62	70.83
DOV_02	29.44	39.60	46.28	55.16	62.23	66.57	69.75

5 RAINFALL-RUNOFF METHOD

Table 5.1: Derivation of parameters for rainfall-runoff model

Methods: FEA : Flood event analysis (see Table 5.3)
LAG : Catchment lag (see Table 5.3)
DT : Catchment descriptors with data transfer from donor catchment
CD : Catchment descriptors alone
BFI : SPR derived from baseflow index calculated from flow data

Site code	Rainfall (for urban U)	Tp(0) method	Tp(l): value (hours)	SPR: method	SPR: value (%)	BFI: method	EF: value (m/s)	If DT, numbers of donor sites used (see Table 5.2) and reasons
DOV_01	R	FEA	7.30	FEA	32.10	CD	default	n/a
DOV_02	R	DT	7.24	DT	35.24	CD	default	n/a

Table 5.2: Donor sites for rainfall-runoff parameters

No.	Watercourse	Station	Tp(l) from data (A)	Tp(l) from CDs (B)	Adjustment ratio for Tp(0) (A/B)	SPR from data (C)	SPR from CDs (D)	Adjustment ratio for SPR (C/D)
1	River Dove	Kirkby Mills	7.24	6.43	1.13	32.10	36.80	0.87

Table 5.3: Availability of river and rainfall event data

Enter Y if data available, N if not available.

Station name	Station number	Flood event date							
Gauging stations									
Event raingauges									

Table 5.4: Inputs to and outputs from rainfall-runoff model

Site code	Design storm duration (hours)	Storm area (if not individual catchment area)	Flood peaks (m³/s) for the following probabilities & return periods (in year)						
			0%	0%	0%	4%	2%	1.3%	1%
			2-y ars	5-y ars	10-y ars	25-y ars	50-y ars	75-y ars	100-y ars
DOV_01	5	n/a	11.93	17.28	20.80	25.99	30.42	32.82	34.78
DOV_02	5	n/a	11.65	16.88	20.34	25.45	29.81	32.17	34.10
ISIS-Routing filename or Micro-FSR run reference					Dov.dat				

Record here any deviations from the default choices, for example storm profiles or return periods.

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Table 5.5: Flood estimates from the statistical method at each subject site

Site code	Flood peak (m ³ /s) for the following probabilities & return periods (in years)						
	0%	0%	0%	4%	2%	1.3%	1%
	2-y ars	5-y ars	10-y ars	25-y ars	50-y ars	75-y ars	100-y ars
DOV_01	30.01	40.32	47.09	56.08	63.24	67.62	70.83
DOV_02	29.44	39.60	46.28	55.16	62.23	66.57	69.75

6 SUMMARY OF RESULTS

Table 6.1: Overview of results

Item	Comments
Final choice of method and reasons	Because this catchment is gauged with a relatively long period of record, the Statistical Method is well suited. The size of the catchment gives rise to a large number of similar-sized catchments in the pooling group. The Statistical Method utilises up-to-date information from a large dataset, whereas the Rainfall Runoff Method is based on information from before the early 1970's. In consideration of these factors, it is therefore suggested that flood estimates for this catchment be derived from the FEH Statistical Method.

Table 6.2: Final flood estimates for each site

Note: If statistical method used alone, simply enter "See Table 4.5"
 If rainfall-runoff method used alone, simply enter "See Table 5.4"

Site code	Flood peak (m ³ /s) for the following probabilities & return periods (in years)					
	See Table 4.5.					


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River Dove at Kirkby Mills (2560)

1. Gauging Station Details

NWA Reference	27042		
Gauging Authority Reference	2560		
Name	Kirkby Mills		
Gauging Authority Region	North West	Area	North
Watercourse	River Dove	Catchment	Derwent
Catchment Area (km2)	59.2000007629395	Source	
NGR	SE705855	CEH Site	<input type="checkbox"/> FEH Site <input checked="" type="checkbox"/>
Photograph			

Status of Gauge			
Primary purpose of gauge			
Date opened	17/01/1972	Date closed	23/08/1999
Station Type*	Stage / Flow	* See station description for dimensions etc.	
Present means of gauging high flows			
Historic means of gauging high flows			Ended
Measured Parameter		Measurement Method	
Bankfull stage		Wingwall height	
Max gauged Q		Max Gauged H	

	Start Date	End Date
Digital Data		
CEH POT Data		
Chart Data		

	Suitable?	Explanation
QMED	No	
Pooling	No	

River Dove at Kirkby Mills (2560)

2. Gauging Station Control History

Datum Start Date	Datum End Date	Best Known Datum	Station Control Details
		35.600mAOD	

2. Rating History

Rating No.	Limb	Description	K	a	p	Maximum Stage	Start Date	End Date
		1	15.556	0	2.500	0.200m	01/01/1900	01/01/2050
		2	16.083	0.004	2.553	0.433m	01/01/1900	01/01/2050
		3	15.823	-0.14	1.7	0.758m	01/01/1900	01/01/2050
		4	15.809	-0.14	1.693	1.100m	01/01/1900	01/01/2050
		5	15.147	-0.12	1.735	1.800m	01/01/1900	01/01/2050

4. Missing Data

Start Date	Start Time	End Date	End Time	Days Missing
01/01/1972		16/01/1972		15
01/04/1973		01/04/1973		
01/05/1973		12/05/1973		11
01/10/1975		08/10/1975		7
01/11/2000		20/11/2000		19
01/12/2000		31/12/2000		30

5. Written Descriptions

Catchment
Artificial Influences
Catchment Changes
Gauge description
FEH Comments : STATION,Flat V weir, 8m wide. Theoretical rating. Predominantly natural flows. Subsurface inflow from R. Seven catchment (27057) may represent a significant proportion of summer baseflow. <input type="checkbox"/> CATCHMENT,Jurassic l'st, clays and s'st. Rural catchment with moorland headwaters. <input type="checkbox"/>