Hadfield Cawkwell Davidson

REPORT

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Client **JJ Gallagher Ltd**
Project **Retail Park, Biddulph, Staffordshire**
Discipline **Hadfield Cawkwell Davidson Engineering**
Subject **Flood Risk Assessment**

JJ GALLAGHER LIMITED

RETAIL PARK

BIDDULPH

FLOOD RISK ASSESSMENT

17 Broomgrove Road, Sheffield, S10 2LZ T 0114 266 8181 F 0114 266 6246 e-mail@hcd.co.uk www.hcd.co.uk

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JJ GALLAGHER LIMITED

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BIDDULPH

FLOOD RISK ASSESSMENT

Prepared by: P. S. Anderson

Approved by:

17 Broomgrove Road, Sheffield, S10 2LZ T 0114 266 8181 F 0114 266 6246 e-mail@hcd.co.uk www.hcd.co.uk

CONTENTS **Page**

APPENDICES

DRAWINGS

- Location Plan
- Catchment Boundary Plan
- Topographical Survey Drawing (Loose)
- WCEC Proposed Site Layout (Loose)
- United Utilities Sewer Record Drawing (Loose)
- Flood Contours Plan (Loose)

CALCULATIONS

- Watercourse and Flood Routing
- Site Greenfield Runoff

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1.00 INTRODUCTION

This report is prepared in support of a planning application for a retail park on the western edge of Biddulph. It considers the flood risk to the proposed development in accordance with the criteria and guidance provided in Planning Policy Guidance Note 25, but with particular emphasis given to a watercourse flowing through the site. The report makes recommendations for incorporation in the development proposals.

The scope of the report is limited to the above and excludes any consideration of the commercial implications of flood risk and flooding consequences for the developer, tenant, funders, insurers or other third parties.

2.00 SITE LOCATION

A location Plan is attached. The National Grid reference of the centre of the site is approximately 387950E, 357500N.

3.00 SITE DETAILS

The proposed development proposals are shown on the enclosed WCEC layout drawing.

The site lies across an upland stream valley flowing from south to north. Over the northern area the valley is infilled and the watercourse is culverted. United Utilities sewer plans record this culvert as a 600mm diameter pipe.

The topographical survey shows the pipe to be at a depth of up to 7m beneath the site. The survey and sewer record drawings are enclosed.

The open watercourse flows in a channel typically 0.5m wide and 100mm deep in normal low flow conditions. The valley has a narrow floor with steep slopes to higher ground alongside the old railway. To the east the ground rises more gently to the bottom of the bypass embankment.

The existing land use is a mixture of pasture to the west and coarse grassland elsewhere. There is an access road from the A527 to a telephone exchange on the northern boundary of the site. This road will provide access to the retail park.

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4.00 ENVIRONMENT AGENCY

The Environment Agency has been consulted and their expectations have been established in respect of flood risk assessment from the watercourse and the control of runoff from the site.

The Environment Agency has confirmed that the watercourse is not classified as a 'main-river' and that they have no stream flow or flood data. They expect flows to be established from a catchment assessment using the methods of the Flood Estimation Handbook. Water levels in the valley upstream of the culvert should be established for the 1 in 100 year event with a 20% allowance for climate change. In addition the consequences of culvert blockage should be considered.

It has also been established with the Environment Agency that the 1 in 100 year runoff from the site development should be restricted to the existing 'greenfield' runoff determined from the site 'Mean Annual Flood'. This has been calculated in accordance with Institute of Hydrology Report No.124 and agreed with the Environment Agency. A copy of the calculation is enclosed in the Appendices.

5.00 FLOOD RISKS

The flood risk needs to be considered against the development proposals and in particular the finished levels. In general the intention is that the building plateau will be at approximately 174.0m AOD, some 7m above the existing stream bed level.

The northern end of the site forms a dam across the valley so that flows exceeding the culvert capacity will cause water levels to rise in the upstream watercourse. Although the valley storage capacity is evidently large there exists the possibility that under sufficiently severe storm conditions water levels could inundate the site.

An assessment of this flood risk is made in the following sections by 'routing' flood hydrographs through a storage calculation model representing the culvert outfall and the depth/volume relationship of the upstream valley. Summer and winter 1 in 100 year storm events are assessed. The consequences of extreme events, such as longer return periods and culvert blockage, are also considered.

Other sources of flood risk have been considered and dismissed for this site. These include:

1. Site Runoff - This is to be controlled to 'greenfield' runoff and therefore off site discharge will be no greater than existing flows. Internal site flood risk will be controlled by the design of retention storage and appropriate building/external levels. Land drains to be provided at the toe of steep cuttings.

2. Existing Sewers - The only sewer crossing the site is that carrying the watercourse. There are no others in the vicinity which pose a significant flood risk.

3. Groundwater - The valley provides a natural drainage path. Existing land drainage crossing the site will be maintained or diverted.

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6.00 CATCHMENT STUDY

The catchment boundary and characteristic values have been determined from the Flood Estimation Handbook CD-ROM for the coordinates of the existing culvert entry. The catchment has an area of 0.56km^2 with an URBEXT1990 value of 0.206.

The catchment boundary has been transferred to a 1:25,000 Scale OS map and has been inspected 'in the field'. This shows a good correlation with the topography and with the sewer records for the urban area in the south east.

Past OS maps shows no significant change in the urbanisation of the catchment since 1985. The bypass has been built more recently but it is known that the runoff has been restricted with an orifice plate on the outfall to the watercourse. The catchment characteristics from the FEH CD-ROM have therefore been relied on.

On site a land-drain to the west issues and flows a short distance overland into the watercourse near its entry into the culvert. This is believed to be a continuation of a short open section of drain northwest of the site where Wharf Road passes over the redundant railway embankment. This is outside the catchment boundary but the indications are that it may be contributing additional runoff from the area between the railway embankment and Woodside Farm. This will be taken into consideration when assessing the results.

The flood hydrographs have been developed using the Rainfall-Runoff Method of the Flood Estimation Handbook.

Peak runoff calculations for the 1 in 100 year summer and winter storms are enclosed in full detail to show the interpretation of the FEH method. This shows a peak flow of 2.56cumecs for a summer profile storm of 76 minutes design storm duration.

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7.00 FLOOD ROUTING METHOD

Flood hydrographs for varying storm durations with both summer and winter profiles have been generated and routed through a storage model using the MicroDrainage Storage Design program. Peak flows match those determined in the 'long-hand' calculations discussed in the section above.

The culvert has been modelled as a 600mm diameter pipe with a gradient of 1 in 250 and an inlet of 68.30m AOD. The inlet level is approximately 1m higher than the existing stream bed to allow for the culvert diversion and the re-profiling of the valley floor for environmental improvements. A conservative assessment of the existing pipe gradient (i.e. relatively flat) has still been used to determine outfall conditions.

The sewer records show that the culvert changes to 900mm diameter downstream of the access road. The new culvert beneath the site has however been retained as a 600mm diameter pipe so as to maintain existing downstream flow conditions.

The storage volume of the valley has been determined from 'contouring' of a ground model of the existing ground levels in the valley up to the new headwall and the embankment of the development plateau. There is some additional valley capacity that has been ignored south of the limits of the topographical survey. However, given the narrowing and rising level of the valley floor beyond this point the difference in volume will be small and hence the results will be slightly conservative.

Note that the Flooding Contours plan in the appendices defines the volume of the valley in the calculation model.

The following normal design requirement has been checked:

- 1 in 100 year summer and winter storms with and without 20% climate change

The following conditions have been checked to assess the consequences of exceptional or extreme events:

- 1 in 100 year storms but with the culvert blocked
- 1 in 1000 year storms (culvert open)

Representative calculations have been chosen and printed and are shown in the appendices. Further detail can be provided if required.

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8.00 FLOOD ROUTING RESULTS

The table below summarises the results and considers them against a development plateau of 174.0m AOD to identify the flood risk.

CRITERIA				RESULTS	
	Return Period	Climate Change	Culvert	Flood Level	Flood Risk
1.	1 in 100 years	None	Open	170.55	No
2.	1 in 100 years	20%	Open	170.91	No
3.	1 in 1000 years	None	Open	172.38	No
4.	1 in 1000 years	20%	Open	173.00	No
5.	1 in 100 years	None	Blocked	174.00 36 hour storm	Yes
6.	1 in 100 years	20%	Blocked	174.00 24 hour storm	Yes

From the above it can be seen that there is adequate protection to the site for the 1 in 100 year return period including a 20% increase for climate change, provided that the culvert is free flowing. The flood water rises to a depth of 2.6m in front of the headwall but this is still more than 3m below the development plateau.

Even for 1 in 1000 year storms water levels do not rise to 174.0m. It should however be noted that the site drainage would be overwhelmed in such extreme conditions and that some local flooding would be likely and normally considered tolerable for this type of development.

The results do however show that the valley flood condition is sensitive to culvert blockage. For the 1 in 100 year storm event flooding could occur during a storm exceeding 24 hours duration.

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9.00 DISCUSSION

It has been identified that the site is at risk of flooding when the culvert is blocked. The probability of the site flooding is dependent on the degree of obstruction, when it occurs during the storm period and how long it takes to remove it.

Although the calculations assume a worst possible case of full choking at the onset of the storm it is clear from the results that there exists a risk for less onerous conditions. The culvert is relatively small and could be blocked by storm debris carried off the catchment and this could reasonably be considered to occur in the first half of the storm. Although this might not occur immediately the risk remains because of the difficulty of removing any blockage until the storm has abated.

Site flooding will occur in exceptional circumstances but this is no different to the current condition. Mitigation measures should therefore be included in the development to limit the consequences of flooding.

As discussed in section 6.00 the land drain entering the site from the northwest corner appears to carry runoff to the watercourse from an area outside the FEH CD-ROM catchment boundary. Inspection of the contours on the 1:25,000 scale map suggests that the additional rural area that may be connected is unlikely to be any greater than 7.5Ha, equivalent to a 13% increase in the catchment area.

The effect of a 20% (climate) change can be seen from the results. For the 1 in 100 year return period flood levels are approximately 350mm higher. Flood levels will therefore be slightly increased if the additional area is included but will still be substantially below the development plateau for normal design criteria. For exceptional events the potential increase will be considered in determining appropriate mitigation measures to limit the consequences of flooding. Alternatively, if the land drain is diverted along the access road and directly into the culvert then there is likely to be no or little influence on the upstream flood levels.

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10.00 MITIGATION PROPOSALS

The following mitigation measures are recommended.

AN OVERLAND FLOW PATH FOR FLOOD WATERS

A route should be identified for flood waters as they flow through the site to rejoin the open watercourse downstream. Inspection of the topographical survey shows that the site boundary levels are lowest on the existing access road at the position of the proposed car park entrance. The road levels are just less than 174.0m and falling slightly towards the junction with the Biddulph Bypass. An overflow route through the car park with finished levels of 174.0m or less will minimise the depth of water captured in the valley and across the site. Beyond the site, flood water will flow north along the bypass and down Dorset Drive to rejoin the watercourse.

BUILDING FLOOR LEVELS

Floor levels should be set to provide a margin of flood protection above the overland flow. It should be noted that the flood risk is caused only by an exceptional event after the valley is completely filled and that the flow rate would be relatively small as it is associated with the later stages of long duration storms. The mitigation measures should arguably not therefore be unduly onerous for the development.

A pragmatic approach would therefore seem reasonable. In this case a 7.3m wide car park entrance road with a 100mm depth of flowing water has a cross sectional area equivalent to a 1.0m diameter pipe. If the entrance road is no higher than 174.00m then a minimum building floor level of 174.30m would appear reasonable.

CAR PARK AND SERVICE YARD LEVELS

The flooding of the external areas may be considered acceptable provided that occupants can be safely evacuated and that damage to property is not disproportionate to the cause.

To allow safe evacuation in the event of longer duration storms or culvert blockage the car park should be graded from the watercourse up towards the site entrance. Flood waters will then encroach gradually across the car park without vehicles or persons being marooned.

The design criteria for the car park limits the maximum gradient to 1 in 40. The southern end of the car park will thus be lowest and at a minimum level of 171.75m. This level provides a margin of 0.85m above the predicted 1 in 100 year storm result. The consequences of more severe events do however need to be considered.

The predicted 1 in 1000 year maximum level is 173.00m for a 180 minute storm duration. It is clear that the car park would be partially inundated.

The time lag until commencement of flooding and the rate of inundation governs the period available for safe evacuation. The rising water levels in the valley would provide an obvious and early sign of flooding. A 1 in 40 car park gradient would mean that the flood would advance progressively from the extreme southern end of the site and enable a managed evacuation.

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It is important to recognise that the confidence in the prediction of extreme events is not high. In the worst case, when the culvert is completely blocked and the site is inundated to a depth of 174.0m, the car park will be largely underwater. The depth of flooding will be up to 2.25m at the southern end. However, this only occurs in long duration storms with durations in excess of 10 hours. Hence there is considerable time for evacuation.

FLOOD MANAGEMENT STRATEGY

A flood management strategy should be implemented so that occupiers are aware of the flooding risks and the procedures to be followed in the event of flooding

HEADWALL BYPASS CONNECTION

Culvert blockage is most likely to result from debris at the inlet headwall. This risk can be mitigated to some degree by a smaller secondary inlet above the main inlet screen and which connects into the top of the culvert behind the headwall.

11.00 CONCLUSIONS & SUMMARY

- A development plateau of 174.0m AOD is not predicted to be at risk from flooding for the normal 1 in 100 year design criteria.
- The development is at risk from flooding if the culvert should become blocked
- Mitigation measures are recommended to reduce and control the consequences of flooding from extreme events. These are in brief;
    - An overland flow path for flood water through the site to the entrance road.
    - Building floor levels which provide protection to overflowing waters. A minimum building floor level of 174.30m is recommended for a road entrance level of 174.00m.
    - Car park levels which are above the 1 in 100 year flood levels
    - The level of the car park to be graded up from the stream course to the car park entrance to allow safe evacuation of the site

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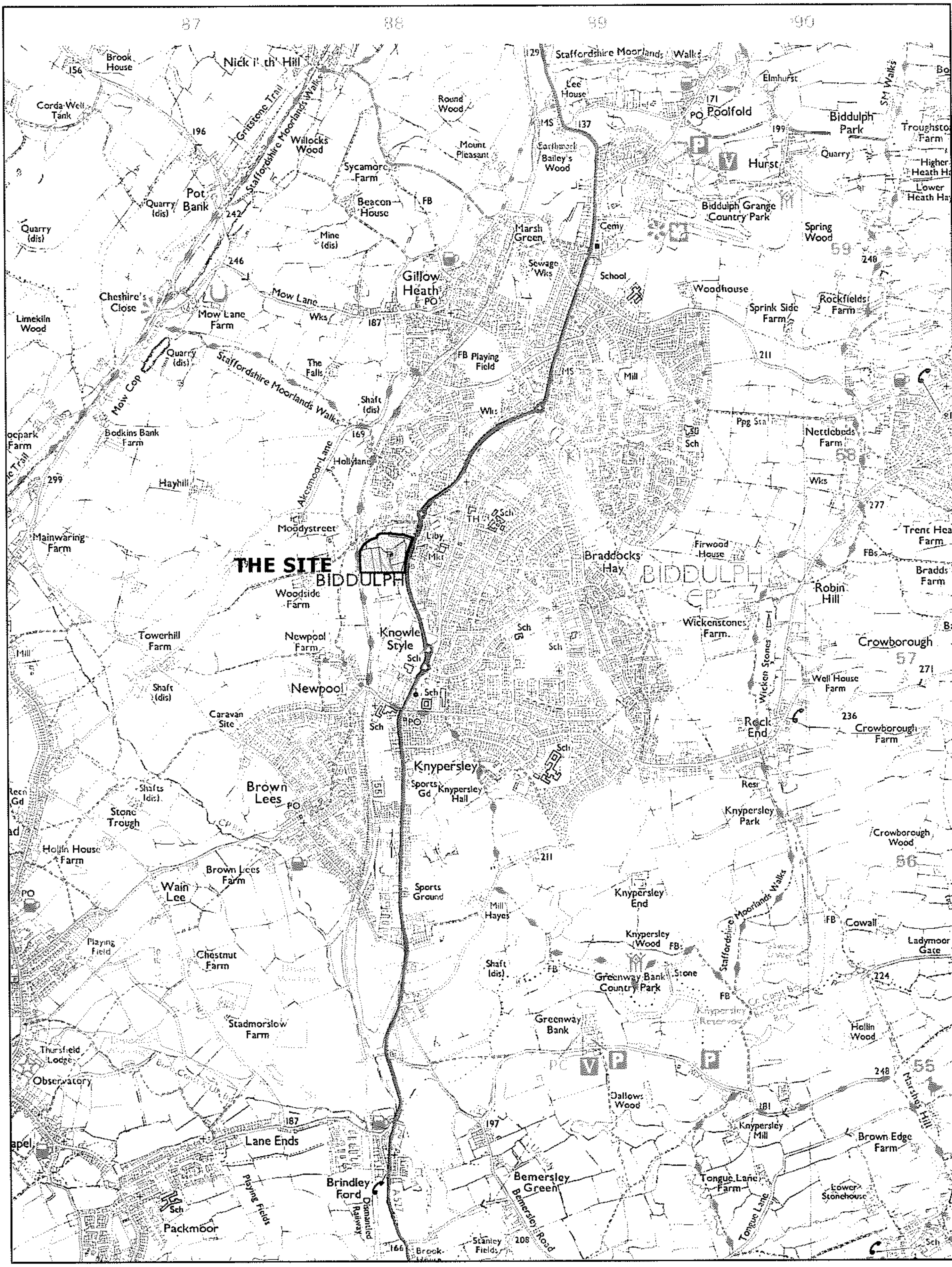

J. J. GALLAGHER

POTENTIAL RETAIL PARK | BIDDULPH, STAFFORDSHIRE

SITE LOCATION PLAN

ENG | 2003-022 | 001 | * | SCALE 1:25000 | 02/03/2006

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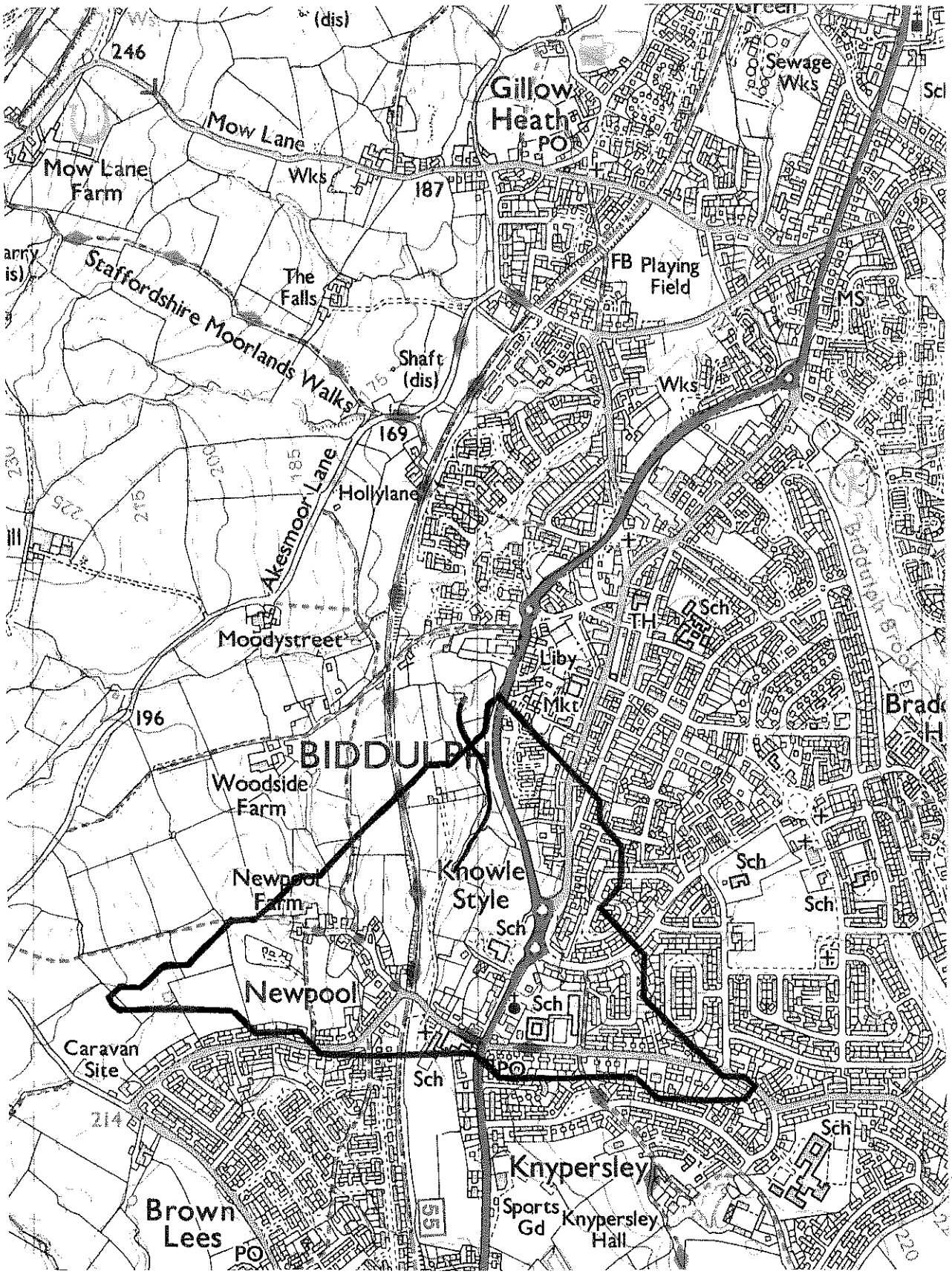

Catchment Boundary based on FEH CD-ROM. Culvert coordinates: E=388050, N=357500.

(Scale approx. 1:12500)