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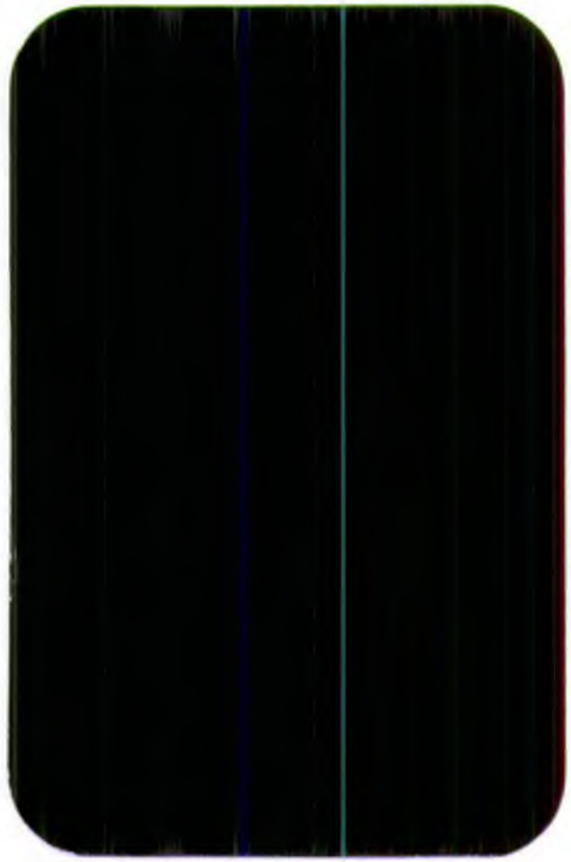

ENVIRONMENT AGENCY
NORTH EAST REGION

SECTION 105 - C30/92 SURVEYS CATCHMENT DRAINAGE STUDIES AND FLOOD PLAIN IDENTIFICATION

LUMLEY PARK BURN AND HERRINGTON BURN

JUNE 1998

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1	October 1997	T B Ellingham	T J Summers	S E Magenis	2nd Draft
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THE ENVIRONMENT AGENCY, NORTH EAST REGION, NORTHUMBRIA AREA
SECTION 105, CIRCULAR 30/92 FLOOD PLAIN MAPS
SUMMARY
LUMLEY PARK BURN AND HERRINGTON BURN

June 1998

This summary is to read in conjunction with maps reference:

- C1395/FPM/01/030
- C1395/FPM/01/031
- C1395/FPM/01/032

Study Reach

The study includes a 9.8km reach of Lumley Park Burn between the River Wear at NGR NZ282 512 and Houghton Road at NGR NZ348 489 and a 3.8km reach of Herrington Burn between the Lumley Park Burn at NGR NZ320 508 and Burn Hill at NGR NZ339 537.

Existing and Predicted Problems

Locations that are predicted to flood and the areas at risk during a 100 year event are as follows:

• Lumley Park Wood	Woodland
• Upstream of Floaters Mill Bridge	Residential and Open Space
• Herrington Burn and Lumley Park Burn confluence	New Lambton Works
• Between Dairy Lane Bridge and Sedgeletch Bridge	Agricultural land
• Upstream of Dairy Lane Bridge	Residential and Farmland
• Stotts pasture	Gardens and agricultural land
• New Herrington Pit Heap	Disused pit heap

The existing flooding problems on this reach are covered in the "Report on Survey of flooding Problems Volume 1, March 1997", Posford Duvivier.

CONTENTS

1.0 INTRODUCTION

1.1 Section 105 Surveys Circular 30/92

Section 105 – C30/92 surveys will be the Environment Agency's main input to the preparation of the Local Planning Authority (LPA) development plans. The surveys have been instigated by the Department of the Environment Circular 30/92 and are carried out by the Agency under the powers granted by section 105(2) of the Water Resources Act 1991.

Surveys within the Agency's Northeast Region encompass three elements:

- Indicative flood plain mapping.
- Surveys of flooding problems.
- Catchment drainage studies

1.2 Scope of this Study

The Section 105 – C30/92 Surveys reported here covers Lumley Park Burn between the River Wear and Rainton Bridge and Herrington Burn between the confluence with Lumley Park Burn and Burn Hill, all as detailed in the Agency's brief. Associated catchment details are also included where there is an impact on the reach under investigation.

The study includes a 9.85km reach of Lumley Park Burn and a 3.815km reach of Herrington Burn.

Lumley Park Burn was modelled between the confluence with the River Wear at NGR NZ 282 512 and the Broomhill Estate, Houghton Road at NGR NZ 348 489. This length is longer that the reach stated in the brief. It was extended at the upstream end to include the culvert under the A182.

Herrington Burn was modelled between the confluence with Lumley Park Burn at NGR NZ 320 508 at the downstream end and Burn Hill at NGR NZ 339 537 as defined in the brief.

The catchment associated with Lumley Park Burn has a total area of 53.12km^2. The catchment area was derived from 1:25,000 scale plans using contours which are shown every 5m. The catchment is principally drained by two watercourses. Lumley Park Burn drains the western and southern part of the catchment, which is approximately 80% of the catchment area. Upstream of the junction with Herrington Burn, Lumley Park Burn is named Moors Burn, and further upstream it is named Rainton Burn. Herrington Burn drains the North Eastern part of the catchment and flows into Lumley Park Burn at New Lambton works. The associated catchment has a total area of 11.54km^2. The 9.35km reach of Lumley Park Burn has an average bed slope of 1:148, whilst Herrington Burn has an average bed slope of 1:156.

Figure 1.1 shows the extent of the reach under consideration.

1.3 Purpose of this Report

This report describes the work carried out for the Flood Plain Mapping and Catchment Drainage Studies. It provides the details required by the Agency's Survey Brief. It should be read in conjunction with the Report on Survey of Flooding Problems Volume 1, March 1997 and the following 1:10,000 scale maps:

- C1395/FPM/01/030
- C1395/FPM/01/031
- C1395/FPM/01/032

and 1:2,500 scale maps:

- C1395/DM/01/030
- C1395/DM/01/031
- C1395/DM/01/032
- C1395/DM/01/033
- C1395/DM/01/034
- C1395/DM/01/035
- C1395/DM/01/036
- C1395/DM/01/037
- C1395/DM/01/038
- C1395/DM/01/039

2.0 DATA COLLECTION

2.1 Environment Agency Offices

Visits were made to the Newcastle office of the Agency to gain survey and flow data that would assist in the building of the model. The brief stated that substantial data was available. The Agency's Liaison Officer, Mr David Bassett, gave guidance during the visit as to where useful data could be found.

Although no flow or study data was available, a copy of the FD100 report for Lumley Park Burn was obtained. This document identified that historically there has been flooding at several areas along the reach. Land on the upstream side of Dairy Lane Bridge (ch. 6870) has been flooded in the past and there has been a threat to a housing estate on the right hand bank. In 1967 a recorded level of 42.37m (AOD) has been identified although its exact location is not known. In 1971 a level at Sedgeletch Bridge (ch. 5710) of 39.92m (AOD) was recorded, however again the exact details are unclear. There was no suitable historical survey data available for the reaches being investigated.

2.2 Site Visits

During site visits to the required catchment an assessment of the main hydraulic and hydrological features, to be included in the required model of both reaches was made. Each of the hydraulically significant structures on the watercourses was visited and a series of photographs taken during the visit. The knowledge gained from these visits was used to determine the location of the appropriate cross-sections (node points) to be surveyed in detail in order to build the required hydraulic model.

2.3 Topographical Survey

In order to construct the required hydraulic model a topographical survey of suitable cross-sections was undertaken by James Banks Survey during December 1996. Survey was undertaken at a total of thirty locations. Fifteen of these locations were at bridges. At seven of these bridges additional cross-sections were surveyed. One was taken just downstream of the structure, one just upstream and a third was taken of the upstream face of the bridge. At twenty two locations a cross-section of the channel and banks was surveyed. The final location was at the weir just upstream of Forge Lane, where cross-sections were taken on the weir crest, upstream and downstream of the weir and a longitudinal section taken through the weir. The survey was limited to the minimum number of cross sections needed to produce results that were appropriate to the accuracy of the model and other parameters used. Although detailed cross section at 50m centres would give excellent topographical detail it would have little effect on the final water level confidence.

3.0 INDICATIVE FLOOD PLAIN MAPPING (Brief 3.1)

3.1 Flow Estimation

Visits to the Agency Offices and discussions with Agency staff confirmed that no flow gauge data was available for either Lumley Park Burn or Herrington Burn. A river gauging station had been established under the bridge at New Lambton. It is understood that some records exist, but these were not available for this study. Therefore, in order to construct a useable hydraulic model it was necessary to make an estimation of flows based on the best theoretical data set available. The lack of gauge data or any event data meant that the modelling work could not be calibrated and this consequently has a significant impact also on the results.

The flow at various locations throughout the catchment was estimated using the methods identified in the Flood Studies Report and the subsequent supplementary reports. The Flood Studies Report was published by the Natural Environment Research Council in 1975. The document provides methods of flood estimation for use in engineering design. FSR was recognised in the brief as being an acceptable method of flow estimation.

There are fundamentally two types of flood prediction technique recommended in the Flood Studies Report. These are statistical methods (eg. frequency analysis) and unit hydrograph methods. The purpose of the statistical analysis is to derive a relationship between flood

magnitude and return period. The simplest form of frequency analysis is the annual maxima series where the largest flood event from each year is abstracted. In general the procedure for the unit hydrograph method is rather more complex than for the statistical methods. The unit hydrograph should be derived if possible from rainfall run off records but may be estimated from catchment characteristics if no records exist. The accuracy of each method depends on the amount and quality of data available. Estimates from gauged catchments are more accurate than those from ungauged catchments.

The method of flood estimation contained within the Flood Studies Report has been reviewed by D Archer in 'A Catchment Approach to Flood Estimation ". Archer suggests the use of catchment and regional flood parameters to adjust estimates of flood discharge. Archers method of estimation greatly reduces the predicted flows for the Lumley Park Burn Catchment.

The flood flows in the Lumley Park Burn were estimated using the flows recorded on the closest gauged catchment. The River Browney is gauged near its confluence with the River Wear and drains a catchment which is approximately three times the area of the Lumley Park Burn catchment. The mean annual flood for the River Browney catchment was factored using the difference in the values between the two catchments for the parameters included in the Flood Studies Report "six parameter" equation used to estimate the mean annual flood. The flood flows calculated using this method were similar to those estimated using Archers method.

The Agencys brief approved the use of the Flood Studies methods for the estimation of flood flows. This method was used as it was thought that the flows predicted were more conservative and in the areas where the predicted levels could be compared to historical levels these flows gave the best match.

Micro-FSR is a computer package produced by the Institute of Hydrology. Micro-FSR enables the estimation of design flood hygrographs and flood peaks using the methods contained in the Flood Studies Report. It requires the catchment characteristics to be input.

To estimate the increase in flows along both reaches being investigated the catchment was divided into sub-catchments. The flows were estimated using the unit hydrograph method in Micro FSR at the following nine locations as shown in Table 3.1 and Figure 1.1.

Table 3.1 – Location of Flow Estimates

Location	NGR/Description	Reach
1	NZ 346 486 Confluence with Hetton Burn	Lumley Park Burn
2	NZ342 485 Rainton Bridge	Lumley Park Burn
3	NZ 331 497 Confluence with Red Burn	Lumley Park Burn
4	NZ 320 508 Confluence Lumley/Herrington	Lumley Park Burn
5	NZ 311 508 Floaters Mill Bridge	Lumley Park Burn
6	NZ 299 509 Forge Lane	Lumley Park Burn
7	NZ 282 512 Confluence with River Wear	Lumley Park Burn
8	NZ 334 529 Penshaw Footbridge	Herrington Burn
9	NZ 323 518 Boundary Houses	Herrington Burn

These locations, which are spread along the study reaches, are generally at the confluence of Lumley Park Burn or Herrington Burn and one of their tributaries. The flows have been estimated immediately downstream of the confluence.

The characteristics estimated for each sub-catchment which are necessary inputs into Micro-FSR are shown in Table 3.2 below. A description of each characteristic has also been included.

Table 3.2 – Catchment Characteristics

Characteristic/ Parameters	Location								
	1	2	3	4	5	6	7	8	9
Area (km^2)	13.63	18.71	26.05	46.42	50.03	51.25	53.12	9.24	11.54
Urban Fraction	16.7%	15.1%	16%	17.8%	17.5%	17.5%	16.9%	17%	19.3%
Main Stream Length (MSL) m	3.25	3.74	5.43	7.33	8.34	9.55	12.11	1.4	3.09
Stream Slope (S1085) m/km	21.6	19.9	18.4	14.5	12.95	11.87	10.13	7.62	8.2
Soil Index	0.398	0.405	0.413	0.383	0.390	0.390	0.390	0.300	0.300
Annual Rainfall (SAAR) mm	700	690	680	720	680	680	680	700	700
M5-2 Day Rainfall mm	57	56	55.5	55	55	54	53	55	55
Ratio M5-60 min Rainfall/M5-2 Day Rainfall	34%	34%	34%	34%	35%	35%	35%	34%	34%
Effective mean SMD (mm)	11.5	11	11	11	11	11	11	11	11

Characteristic/Parameter Description

Area	-	The area draining to a site
Urban Fraction	-	An index of urban development
Main Stream Length	-	The longest stream length measured upstream of a station
Stream Slope	-	Mainstream Slope between the 10 and 85 percentiles of mainstream length
Soil Index	-	Determined from the fractions of five classes of soil which are based on their winter rain acceptance potential
Annual Rainfall (SAAR)	-	Standard average annual rainfall
M5-2 Day Rainfall	-	2 day rainfall of 5 year return period
Ratio M5-60min/M5-2 day	-	The ratio of the 60 minute rainfall of 5 year return period to the 2 day rainfall of 5 year return period
Effective mean SMD	-	Effective mean soil moisture deficit

The Soil Index, Annual Rainfall, M5-2 Day Rainfall, ratio of M5-60min rainfall to M5-2 day rainfall and the Effective Mean Soil Moisture Deficit values for the catchment were determined using the maps included in Volume V of the Flood Studies Report. The Soil Index is derived from the fractions of the catchment occupied by various soil classes. Five classes of soil, based on their winter rain acceptance potential, are shown on the map. The soil index for a catchment is derived by measuring the fractions of the catchment within each soil class, and adopting a weighted mean of these soil fractions.

The remaining values were derived from maps showing contours of each characteristic. Catchment average values are required and these were obtained by weighted areas.

The rainfall run-off method within Micro-FSR was used. This produces a flow peak for a flood of a particular return period and also has the option of producing flood hygrographs. The revised estimation equations summarised in Flood Studies Supplementary Report number 16 (FSSR 16) were used.

A total of four of the nine locations where flow estimates were made had a catchment area of less than 20km^2. This classes them as a small catchment. Institute of Hydrology Report No. 124, flood estimation for small catchments, suggests an alternative method to FSSR 16 for calculating the time-to-peak of the instantaneous unit hydrograph for catchments with an area less than 25km^2. The result of this is that the flows estimated using the Institute of Hydrology method are approximately 3% lower than those using FSSR16. This change in flow would not have a significant impact on the predicted water levels.

Table 3.3 shows the estimated flows from the Micro-FSR output for flood events with return periods of 5, 10, 20, 50 and 100 years. The critical storm duration for the study reach was

determined to be 9.0 hours

Table 3.3

Micro FSR Output

Return Period	Location								
	1 (m^3/s)	2 (m^3/s)	3 (m^3/s)	4 (m^3/s)	5 (m^3/s)	6 (m^3/s)	7 (m^3/s)	8 (m^3/s)	9 (m^3/s)
5 year	10.24	12.91	16.87	26.91	27.01	26.15	23.53	4.44	5.16
10 year	12.37	15.51	20.43	32.37	32.91	31.75	28.74	5.34	6.30
20 year	14.73	18.51	24.26	38.54	39	37.68	34.01	6.45	7.55
50 year	18.09	22.75	29.74	47.27	47.75	46.16	41.58	8.02	9.35
100 year	20.77	26.14	34.11	54.24	54.72	52.72	52.94	47.63	10.79

The predicted peak flows at the downstream end of the catchment are less than those at points further up the reach. The greatest peak flows occur at location 5. This occurs because at the lower end of the catchment there is very little increase in catchment area but the stream length is extended significantly. This has the affect of flattening the flood hydrograph and therefore reducing the peak flood flow.

The flows predicted by Micro-FSR were used to calculate the flows entered into the river model. The flows predicted downstream of the confluence of the Herrington Burn and Lumley Park Burn at locations 7, 6 and 5 were used in the length immediately upstream of each of these positions. This ensured that there were no underestimates of water level. A similar method was used to predict the water levels upstream of locations 8 and 9 on Herrington Burn. Downstream of location 9 but upstream of the confluence with the Lumley Park Burn a flow which was 10% greater than the flow at location 9 was used.

On the Lumley Park Burn, upstream of the confluence with Herrington Burn, but downstream of the confluence with Red Burn the flow used in the modelling was the flow estimated at location 3, just downstream of the Red Burn confluence. Upstream of the Red Burn confluence the flow used in the model was equal to the flow at Rainton Bridge added to a third of the increase in flow between the Rainton Bridge and the Red Burn confluence.

3.2 HEC-RAS Modelling

HEC-RAS River Analysis System is a one dimensional steady state model produced by the US Army Corps of Engineers. HEC-RAS has the ability to assess water levels and velocities in open channel river systems. It can model steady flow water surface profiles, branched channel networks, supercritical, subcritical or mixed flow regimes and a variety of structures.

These features make it suitable for modelling the reaches being investigated here.

The cross sectional survey data was entered into HEC-RAS. A series of derived cross sections had to be entered into the model in order to ensure its functionality.

Chainage 0m on Lumley Park Burn is at the confluence with the River Wear. Chainage 0m on Herrington Burn is at the confluence with Lumley Park Burn. All other chainages are measured in an upstream direction from these points.

Surveyed cross section 1 (ch. 240m on Lumley Park Burn) was copied with a decreased elevation to ch. 0m. The bed gradient was estimated by considering the gradient between sections 1 and 2 (ch. 240m and ch. 1250m respectively).

The fifteen bridges included in the model each required four cross-sections to model them. A cross-section was located immediately upstream and downstream of the bridge and the other two cross-sections sufficiently upstream and downstream from the bridge so that the flow was not affected by the structure. A similar arrangement of cross-sections was used to model the weir at chainage 2355m.

Whenever new cross-sections were added to the model their bed level was determined by linear interpolation between the two nearest surveyed sections. Again, without on extremely extensive survey this is the most suitable way forward to produce results of an accuracy appropriate to all the available data.

The junction between Lumley Park Burn and Herrington Burn was constructed using the junction facility within HEC-RAS and by adding cross sections by interpolating from adjacent surveyed sections.

It was necessary to extend the width of the cross-sections when the predicted water levels were above the highest ground level. This was done by plotting a higher ground level, taken from the position of the nearest 5m contour on a 1:25000 scale map.

3.3 Model Parameters

Several types of coefficient are utilised by HECRAS to evaluate energy losses. They are:

(1) Mannings n values for friction loss due to the roughness of the channel section material
(2) Contraction and expansion coefficients to evaluate transition losses.
(3) Bridge and culvert coefficients to evaluate losses related to weir shape, pier configuration, pressure flow and entrance and exit conditions.

A Mannings value of 0.050 was used on all cross-sections except at Dairy Lane Bridge, Sedgletch Bridge, Castle Dene Bridge, New Lambton works access bridge and the A182 road bridge. A value of 0.050 represents an earth channel with some natural vegetation. The Mannings value was changed at the five locations above because the model produced an error

when ran with the original value. The cross-sections on the bridge faces and those immediately upstream and downstream of the bridge (typically between 2m and 5m from the face) were adjusted. The revised Mannings values varied between 0.02 and 0.04.

All cross-sections had an expansion coefficient of 0.3 and contraction coefficient of 0.1 except for those immediately upstream and downstream of the bridges. These cross-sections had an expansion coefficient of 0.5 and contraction coefficient of 0.3. These parameters are those suggested when the changes in river cross section are small and for typical bridge sections. HECRAS models the overtopping of bridge decks by considering them as a weir. A weir coefficient of 1.7 was used on all fifteen bridges. This is the suggested value for weir flow over bridges.

There are several choices available when selecting methods for computing surface profiles through a bridge. Low flows (water surface below underside of deck) through the bridges were calculated using the Energy Equations and Momentum Balance Method and the technique that produced the greatest energy loss through the bridge used. High flows were calculated using the pressure flow computation at all fifteen bridges.

The model was run with a mixed flow regime to allow the flow regime to pass from subcritical to supercritical, or supercritical to subcritical. The water level at the downstream boundary and upstream boundary was equal to the normal depth.

3.4 Areas Predicted to Flood

The model shows two significant areas of flooding. Other flooding problems caused by a reduced channel capacity at structures are less significant. The watercourse is in a wooded steep sided valley at these locations.

The first area of significant flooding occurs at the confluence of the Herrington Burn and the Lumley Park Burn. Flooding upstream of the confluence between the two watercourses will affect a sewage treatment works. The capacity of the railway culvert, the limited capacity of the channel through the New Lambton Works, and the low lying land between the two watercourses are reasons for the flooding.

Further upstream on the Lumley Park Burn flooding occurs immediately upstream of Dairy Lane Bridge. There is a floodplain on both sides of the channel. Flooding on the right floodplain will affect residential properties at Longacre.

4.0 SURVEY OF FLOODING PROBLEMS (Brief 3.2)

4.1 Identified Flooding Problems

No flooding problems where identified through discussions with the Agency during the work completed for the Catchment Drainage Studies.

4.2 Other Problem Areas

Other flooding problems on this reach not associated with fluvial inundation are covered in the "Report on Survey of Flooding Problems Volume 1 March 1997" Posford Duvivier. This report includes the responses and information gathered through consultation with councils.

5.0 CATCHMENT DRAINAGE STUDIES (Brief 3.3)

5.1 Development Proposals

Within the Agency's brief a number of development sites were identified as requiring examination for possible effects on the undeveloped catchment predicted water levels. Site details included in the brief had been supplied by the Local Planning Authority (LPA).

No development was found upstream of Rainton Bridge. The following proposed development was identified:

- 0.13km^2 at Glebe Sewage Works
- 0.33km^2 at Rainton Bridge South
- 1.28km^2 at Herrington Pit Heap
- 0.02km^2 at Philadelphia
- 0.65km^2 at Lambtons coke-works

Some of the areas shown above, which have been treated as urbanisation, are sites of land reclamation. These areas may be returned to parkland or open space. For the purpose of this report these sites have been identified as becoming urban areas, which is adopting a pessimistic approach.

A comparison of the urban fraction at the locations shown in Figure 1.1 are shown below in Table 5.1.

Table 5.1

Comparison of Urban Fractions

Reach	Location		Existing Urban Fraction	Urban Fraction Including Development	Increase in Urban Fraction
Lumley Park Burn	1	Confluence with Hetton Burn	17%	17%	0%
Lumley Park Burn	2	Rainton Bridge	15%	15%	0%
Lumley Park Burn	3	Confluence with Red Burn	16%	18%	13%
Lumley Park Burn	4	Confluence with Herrington Burn	18%	25%	39%
Lumley Park Burn	5	Floaters Mill Bridge	18%	21%	17%
Lumley Park Burn	6	Forge Lane	18%	21%	17%
Lumley Park Burn	7	Confluence with River Wear	17%	20%	18%
Herrington Burn	8	Penshaw Footbridge	17%	25%	47%
Herrington Burn	9	Boundary Houses	19%	25%	32%

5.2 Effects of Proposals

Table 5.2 shows flows that were estimated from the Micro-FSR output at the seven locations shown on Figure 1.1 for flood events with return periods of 5, 10, 20, 50 and 100 years for both the existing catchment and the catchment with the identified development.

Table 5.2

Development Impact on Flows

Return Period Location		5 year (m^3/s)	10 year (m^3/s)	20 year (m^3/s)	50 year (m^3/s)	100 year (m^3/s)
1	Existing	10.24	12.37	14.73	18.09	20.77
	Developed	10.24	12.37	14.73	18.09	20.77
2	Existing	12.91	15.51	18.51	22.75	26.14
	Developed	12.91	15.51	18.51	22.75	26.14
3	Existing	16.87	20.43	24.26	29.74	34.11
	Developed	17.23	20.57	24.62	30.26	34.75
4	Existing	21.23	25.44	30.24	36.99	42.37
	Developed	22.58	27.21	32.36	39.45	44.70
5	Existing	27.01	32.91	39.00	47.75	54.72
	Developed	28.12	33.95	40.37	49.52	56.81
6	Existing	26.15	31.75	37.68	46.16	52.94
	Developed	27.32	33.16	39.33	48.17	55.23
7	Existing	23.53	28.74	34.01	41.58	47.63
	Developed	24.52	29.95	35.42	43.29	49.57
8	Existing	4.44	5.34	6.45	8.02	9.28
	Developed	4.91	5.90	7.13	8.85	10.22
9	Existing	5.16	6.30	7.55	9.35	10.79
	Developed	5.10	6.09	7.26	9.12	10.96

Note: Flows predicted at location 9 for the developed catchment are similar to those for the same catchment with a lower urban fraction. As the urban fraction after development is more than or equal to 25% Micro FSR considers the catchment to be urban and therefore uses a different method to estimate the flow. This change in the method of calculation is the cause of the predicted flows being less than expected.

The additional development causes only small increase in flows. At the downstream end of the catchment the peak flows increase by approximately 4%. The flow at the confluence of the Lumley Park Burn and Herrington Burn increases by 7% with the proposed development. There is no increase inflow at the upstream end of the catchment and only a 2% increase at the confluence of the Lumley Park Burn and Red Burn as a result of the proposed

development. The flows in Herrington Burn increase by approximately 10% with the additional urban area.

Using the HEC RAS model a comparison can be made between the water levels predicted for the existing and proposed catchment (Table 7.3). The flows during the 100 year event have been used to predict the water levels at Dairy Lane Bridge, New Lambton Works, Castle Dene Bridge, Lumley Ford Gate Footbridge and Lanton Street. A schematic drawing included in Appendix B shows the relative positions of the locations shown in Table 5.3.

Table 5.3

Comparison of Water Levels

Reach	Location	River Station Chainage (m)	Predicted 100 Year Water Level for the Existing Catchment (mAOD)	Predicted 100 Year Water Level for the Catchment with the Proposed Development (mAOD)
Lumley Park Burn	Dairy Lane Bridge	6873	43.07	43.09
Lumley Park Burn	New Lambton Works	4800	37.33	37.53
Lumley Park Burn	Castle Dene Bridge	2220	21.54	21.63
Lumley Park Burn	Lumley Ford Gate Footbridge	240	8.85	8.94
Herrington Burn	Lanton Street	2864	60.24	60.27

5.3 Mitigation Works

To alleviate the problem of flooding at the confluence of the Herrington Burn and the Lumley Park Burn the capacity of the railway culvert could be increased. More easily, the size of the channel through the New Lambton works and adjacent to the sewage works could be enlarged. The cost of increasing the size of the railway culvert or placing a parallel culvert is likely to be high. It would be more cost effective to construct flood banks along the river in the areas which need to be protected. The height and length of the banks would be dependent on the standard to which the area would be protected (indicative standards related to land use are given in the MAFF Project Appraisal Guidance Notes). For an event with a 100 year return period the model predicts water levels that are typically 1.2m above both banks over one length of approximately 170m, 2.2m above the right hand bank for a second length of 500m, and 1.0m above the left bank for a final length of 100m. The estimated cost of this

work is in the region of £150,000.

Further upstream on the Lumley Park Burn flooding occurs. There is a floodplain on both sides of the channel. Flooding on the right floodplain will affect residential properties at Longacre. To alleviate the flooding to the properties immediately upstream of Dairy Lane Bridge, it would be most appropriate to construct a flood defence barrier. The barrier could either be in the form of a flood defence wall immediately to the rear of the properties or could be an earth embankment placed closer to the river. The height and length of the banks would be dependent on the standard to which the area would be protected. For an event with a 100 year return period the water level is approximately 1.5m above both banks for a length of 300m. The estimated cost of this work is in the region of £55,000.

5.4 Flood Warning Recommendations

The areas covered in the existing flood warning scheme include the houses and agricultural land upstream of Dairy Lane Bridge. To make the plan comprehensive for the Lumley Park Burn catchment it is recommended that any residential areas identified in Table 6.1 are included. Detailed survey of threshold levels of the properties at risk is required to determine the level of alert for each area.

6.0 RESULTS AND CONCLUSION

6.1 Discussion of Results

The modelling results have been used to identify flood risk areas on the accompanying Flood Plain Maps. The model predicts the width of flooding using the cross-section data. Where the survey has not been extended to ground higher than the 100 year water level the flooded area has been estimated by interpolation between the point furthest from the river which has been surveyed and the 5m contours shown on a 1:25000 scale plan. The maps generally show that predicted flood risk areas coincide with previously identified flooding problems. Historically, flooding has occurred in the vicinity of the B1286 culvert at New Herrington on Herrington Burn. The model does not predict flooding at this location so it is recommended that further investigation takes place around this culvert. Additional survey around the entrance of this culvert may increase the accuracy of the model. Also the maintenance of the culvert should be reviewed as blockages may have contributed to the flooding. This could explain why the model has not predicted any flooding.

These results have been achieved without any calibration of the model. There is no suitable data in existence with which to undertake calibration, therefore the level of confidence is very low. In order to calibrate this model, gauge data covering a significant time frame would be required. A river gauging station was once established under the bridge at New Lambton. This is an ideal location within the catchment to record flows. Records from the previous gauging station were intermittent because of vandalism, this is worth noting when deciding the location for a gauge.

The associated development plans which identify development at risk from flooding show predicted water levels after development. Whilst these flood levels do increase slightly with the proposed development, the extent of flooding is not significantly increased on the reach being considered.

The predicted extent of flooding for the 1 in 100 year event identifies a number of areas that are at risk from flooding and these are summarised in Table 6.1.

Table 6.1
1 in 100 year Flood Risk Areas

Reach and Chainage	Location	Area at Risk from Flooding	Estimated Flood Frequency
Lumley Park 2873-3200	Lumley Park Wood	Woodland	5 yr
Lumley Park 4042	Upstream of Floaters Mill Bridge	Open space and residential	50 yr
Lumley Park/Herrington 5100	Confluence of Herrington Burn and Lumley Park Burn	Flooding to land at the New Lambton Works	< 5 yr
Lumley Park 5730-6845	Flood plain between Dairy Lane Bridge and Sedgeletch Bridge	Agricultural land	50 yr
Lumley Park 6894	Upstream of Dairy Lane Bridge	Flooding to residential properties at Longacre and to farmland	< 5 yr
Herrington 1162	Stotts Pasture	Gardens and agricultural land	< 5 yr
Herrington 2891	New Herrington Pit Heap	Disused pit heap	< 5 yr

6.2 Conclusion

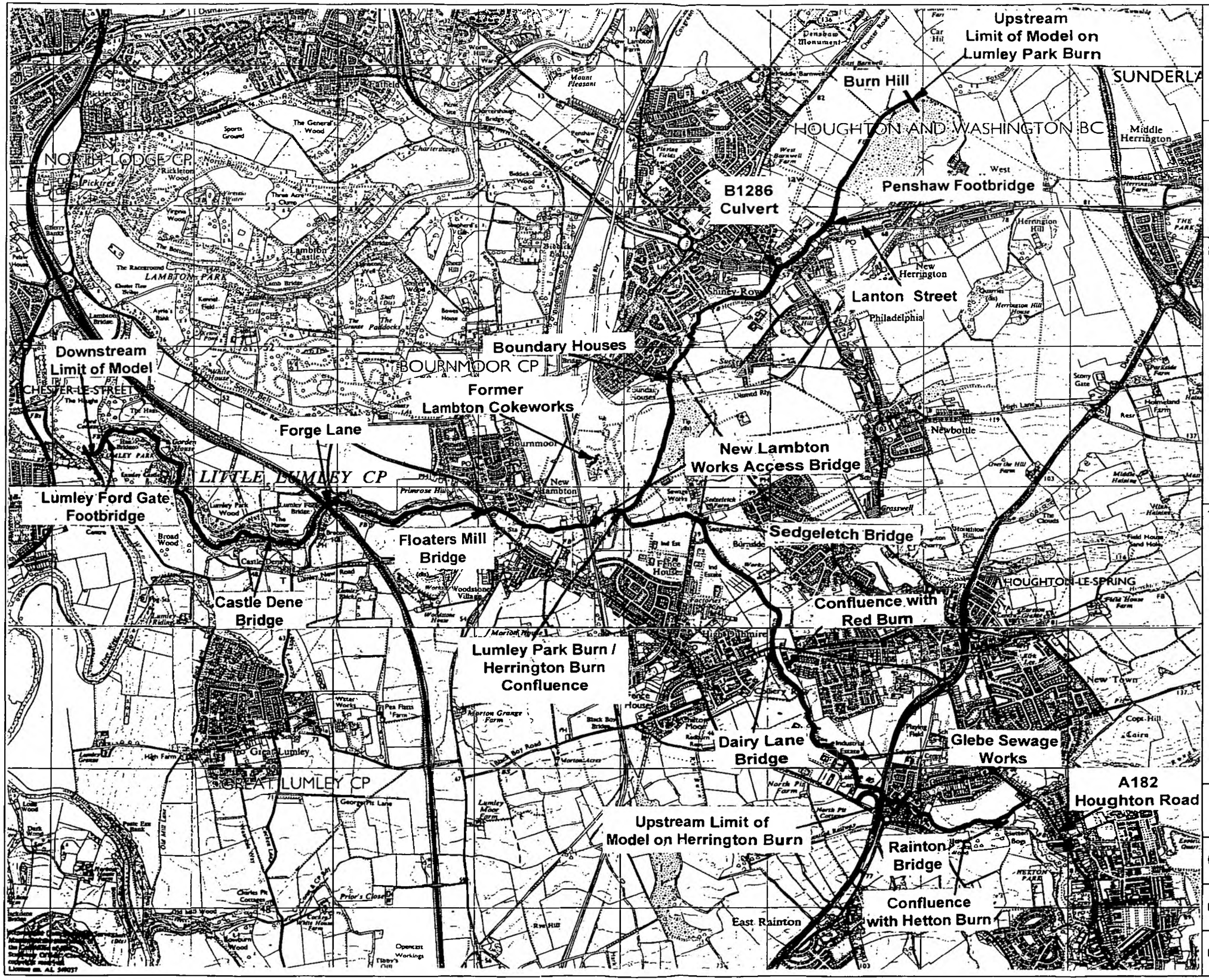
The predictions made from the modelling for the 100 year flooded area have a low level of confidence although in some locations the predicted water level closely matches the recorded level. The reason for this is because of the limitations of the data sets used. The flow data, has been predicted using Micro FSR. If it had been collected from a gauging station, ie real data, then a high degree of confidence would have been expected. If the topographical survey had been more detailed then greater confidence could have been achieved. Having cross-sections that extend further across the flood plain would give the greatest benefit as the need to interpolate using 5m contours would be eliminated. However, it is unlikely that having a greater number of cross-sections would influence the predicted water levels but it would assist in identifying the areas where out of bank flow occur. The number of cross sections required to produce this outcome would possibly be in the order of ten times those actually surveyed. Improving the accuracy of the parameters discussed in Section 3.3 would help in increasing confidence in the predicted results.

To enhance the model as constructed the following work should be considered.

- Extend the width of survey at cross-sections where the existing survey does not extend to a level equal to the 100 year water level.
- Survey bank levels in areas where flooding occurs so the extent of the out of bank flow can be estimated.
- Establish a gauging station so that the flows associated with each event can be predicted with greater accuracy.
- Calibrate the model so that the parameters discussed in Section 3.3 can be accurately predicted.

It should also be noted that river modelling is not an absolute science and that no amount of additional data will produce a 100% accurate answer. Equations within the model are theoretical, modelling of this nature is a useful tool in indicating possible scenarios and comparative analysis only.

Sensitivity testing at this stage would have some but limited benefit. Although it would give an indication to the impact that a parameter has on the flood levels, it is not possible to determine whether the change to the variable has given a better prediction.



POSFORD DUVIVIER
CONSULTING ENGINEERS

ENVIRONMENT AGENCY

North East Region

Project

Section 105 - C30/92

Surveys

Title

Northumbria Area

Lumley Park Burn

and Herrington Burn

LOCATION PLAN

Date: 23/03/98	Scale: 1 : 25,000
Drawn MDWP	Chkd. TE
Drg. No. Figure 1.1	

APPENDIX A
PHOTOGRAPHS

Photograph 1 - Lumley Park Burn. Downstream face of road bridge at New Lambton Works (ch 4880m)

Photograph 2 - Lumley Park Burn. Upstream face of access bridge at New Lambton Works (ch 4980m)

Photograph 3 - Confluence of Herrington Burn and Lumley Park Burn (ch 5098m)

Photograph 4 - Lumley Park Burn. Upstream face of Sedgeletch Bridge (ch 5715)

Photograph 5 - Lumley Park Burn. Upstream face of Dairy Lane Bridge (ch 6873m)

Photograph 6 - Lumley Park Burn. Looking downstream near Confluence with Red Burn (ch 7207m)

APPENDIX B
MODEL OUTPUT

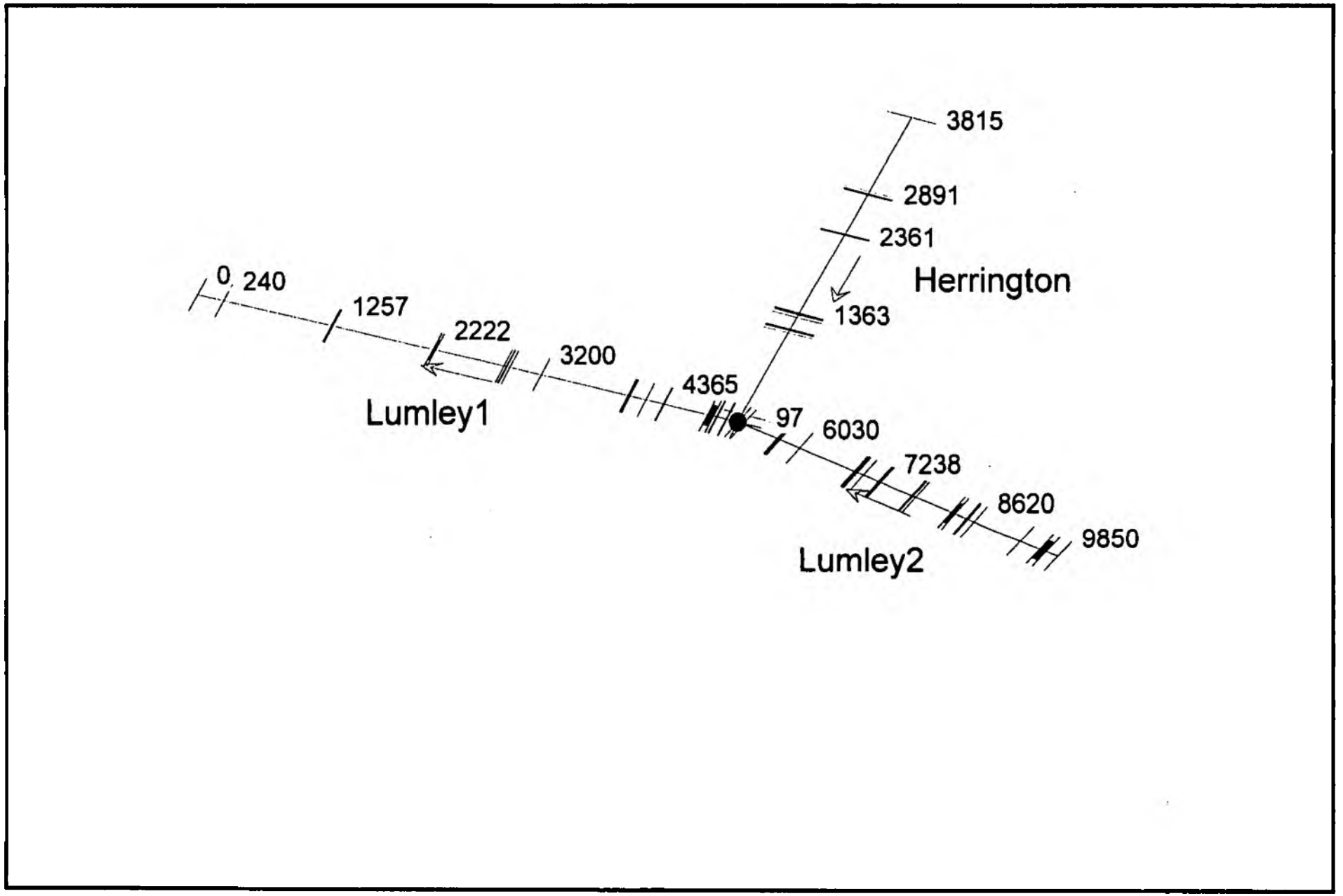
APPENDIX B

B.1 MODEL OUTPUT

Appendix B contains a selection of the output generated by HECRAS. The model run shown used the flows predicted for the catchment that included proposed development. The table lists each river station and the reaches that they are on. For each river station the total flow, water surface elevation, top width of the flow and the velocity within the channel has been given for flows with return periods of 100 years, 50 years, 20 years, 10 years and 5 years. For each river station, the results for the largest event are given first with the following result representing the next largest return periods. The model included 15 significant structures, all of which were bridges. The schematic drawing included in Appendix B shows the relative locations of River Stations.

The attached disc contains the files of all data used including cross-sections which can be output in hard copy as required.

Final Geometry File	Lum. G01
100 year Flow for Existing Catchment	Lum. F04
100,50,20,10,5 year Flows for Catchment with Proposed Development	Lum.F03


3815
2891
2361
Herrington
1363
0
240
1257
2222
3200
4365
Lumley1
97
6030
7238
8620
9850
Lumley2

HEC-RAS Plan: Developed 3/26/98

Reach	River Sta	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Lumley2	9850	29.01	72.46	13.39	3.03
Lumley2	9850	25.25	72.37	12.77	2.93
Lumley2	9850	20.55	72.26	11.95	2.77
Lumley2	9850	17.20	72.17	11.32	2.63
Lumley2	9850	14.35	72.08	10.75	2.49
Lumley2	9682	29.01	70.18	65.56	0.57
Lumley2	9682	25.25	70.11	62.51	0.53
Lumley2	9682	20.55	70.00	57.71	0.48
Lumley2	9682	17.20	69.91	53.39	0.45
Lumley2	9682	14.35	69.82	48.41	0.41
Lumley2	9680	29.01	70.18	65.51	0.57
Lumley2	9680	25.25	70.11	62.47	0.53
Lumley2	9680	20.55	70.00	57.67	0.48
Lumley2	9680	17.20	69.91	53.34	0.45
Lumley2	9680	14.35	69.82	48.36	0.41
Lumley2	9600	29.01	70.18		
Lumley2	9600	25.25	70.11		
Lumley2	9600	20.55	70.00		
Lumley2	9600	17.20	69.91		
Lumley2	9600	14.35	69.82		
Lumley2	9590	29.01	69.12	31.25	1.52
Lumley2	9590	25.25	69.06	30.21	1.44
Lumley2	9590	20.55	68.99	28.80	1.33
Lumley2	9590	17.20	68.93	27.74	1.24
Lumley2	9590	14.35	68.87	26.73	1.15
Lumley2	9585	29.01	68.25	7.80	9.36
Lumley2	9585	25.25	68.23	7.54	8.64
Lumley2	9585	20.55	68.85	26.49	1.69
Lumley2	9585	17.20	68.79	25.47	1.62
Lumley2	9585	14.35	68.75	24.82	1.48
Lumley2	9300	29.01	61.90	21.22	2.38
Lumley2	9300	25.25	61.82	18.31	2.39
Lumley2	9300	20.55	61.68	13.92	2.45
Lumley2	9300	17.20	61.51	8.75	2.67
Lumley2	9300	14.35	61.37	7.24	2.69
Lumley2	8620	29.01	54.49	19.38	1.34
Lumley2	8620	25.25	54.16	17.52	1.47
Lumley2	8620	20.55	53.89	16.74	1.50
Lumley2	8620	17.20	53.75	11.85	1.54

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Lumley2	8620	14.35	53.45	9.66	1.62
Lumley2	8532	29.01	54.45	72.76	0.64
Lumley2	8532	25.25	54.06	30.54	0.81
Lumley2	8532	20.55	53.74	22.22	0.85
Lumley2	8532	17.20	53.59	20.51	0.82
Lumley2	8532	14.35	53.19	13.25	1.00
Lumley2	8530	29.01	54.23	57.96	2.08
Lumley2	8530	25.25	53.84	25.06	2.10
Lumley2	8530	20.55	53.57	20.44	1.93
Lumley2	8530	17.20	53.46	18.40	1.70
Lumley2	8530	14.35	53.07	12.81	1.76
Lumley2	8520	29.01	54.23		
Lumley2	8520	25.25	53.84		
Lumley2	8520	20.55	53.57		
Lumley2	8520	17.20	53.46		
Lumley2	8520	14.35	53.07		
Lumley2	8510	29.01	52.93	12.32	3.86
Lumley2	8510	25.25	52.80	10.96	3.68
Lumley2	8510	20.55	52.62	8.14	3.44
Lumley2	8510	17.20	52.49	7.78	3.24
Lumley2	8510	14.35	52.37	7.49	3.05
Lumley2	8505	29.01	52.95	12.37	2.55
Lumley2	8505	25.25	52.80	10.92	2.63
Lumley2	8505	20.55	52.31	7.35	3.71
Lumley2	8505	17.20	52.25	7.20	3.38
Lumley2	8505	14.35	52.28	7.28	2.69
Lumley2	8342	29.01	52.02	14.54	1.58
Lumley2	8342	25.25	51.79	12.18	1.55
Lumley2	8342	20.55	51.93	13.63	1.17
Lumley2	8342	17.20	51.61	10.35	1.15
Lumley2	8342	14.35	51.10	5.68	1.20
Lumley2	8340	29.01	52.01	14.58	1.57
Lumley2	8340	25.25	51.75	11.87	1.73
Lumley2	8340	20.55	51.91	13.54	1.29
Lumley2	8340	17.20	51.59	10.24	1.28
Lumley2	8340	14.35	51.01	5.67	1.74
Lumley2	8315	29.01	52.01		
Lumley2	8315	25.25	51.75		

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Lumley2	8315	20.55	51.91		
Lumley2	8315	17.20	51.59		
Lumley2	8315	14.35	51.01		
Lumley2	8290	29.01	50.47	5.65	4.16
Lumley2	8290	25.25	50.31	5.64	3.97
Lumley2	8290	20.55	50.11	5.63	3.70
Lumley2	8290	17.20	49.95	5.62	3.49
Lumley2	8290	14.35	49.81	5.61	3.29
Lumley2	8285	29.01	50.12	5.63	3.71
Lumley2	8285	25.25	50.00	5.62	3.54
Lumley2	8285	20.55	49.85	5.61	3.27
Lumley2	8285	17.20	49.74	5.60	3.03
Lumley2	8285	14.35	49.41	5.58	3.73
Lumley2	7760	29.01	45.52	48.65	1.29
Lumley2	7760	25.25	45.44	44.59	1.26
Lumley2	7760	20.55	45.33	38.95	1.20
Lumley2	7760	17.20	45.24	18.21	1.13
Lumley2	7760	14.35	45.15	16.19	1.04
Lumley2	7720	29.01	45.42	56.68	1.04
Lumley2	7720	25.25	45.34	52.43	1.01
Lumley2	7720	20.55	45.22	46.57	0.97
Lumley2	7720	17.20	45.13	41.72	0.93
Lumley2	7720	14.35	45.05	37.42	0.87
Lumley2	7700	29.01	45.38	58.91	0.98
Lumley2	7700	25.25	45.30	54.61	0.96
Lumley2	7700	20.55	45.19	48.69	0.91
Lumley2	7700	17.20	45.09	43.79	0.88
Lumley2	7700	14.35	45.01	39.55	0.82
Lumley2	7238	29.01	43.72	33.54	1.76
Lumley2	7238	25.25	43.67	30.79	1.62
Lumley2	7238	20.55	43.58	25.73	1.49
Lumley2	7238	17.20	43.51	23.73	1.36
Lumley2	7238	14.35	43.38	15.80	1.35
Lumley2	7220	29.01	43.60	55.90	1.49
Lumley2	7220	25.25	43.55	51.84	1.43
Lumley2	7220	20.55	43.29	24.41	2.24
Lumley2	7220	17.20	43.15	4.15	2.34
Lumley2	7220	14.35	43.11	4.14	2.00

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Lumley2	7207	29.01	43.21	38.50	2.23
Lumley2	7207	25.25	43.09	21.89	2.41
Lumley2	7207	20.55	42.90	10.97	2.59
Lumley2	7207	17.20	43.01	15.90	1.84
Lumley2	7207	14.35	43.01	15.62	1.55
Lumley2	6980	34.75	43.22	116.48	0.47
Lumley2	6980	30.26	42.72	92.23	0.77
Lumley2	6980	24.62	42.53	82.90	0.85
Lumley2	6980	20.57	42.36	74.40	1.00
Lumley2	6980	17.23	42.25	69.09	1.07
Lumley2	6894	34.75	43.20	117.83	0.39
Lumley2	6894	30.26	42.67	89.25	0.59
Lumley2	6894	24.62	42.45	77.87	0.64
Lumley2	6894	20.57	42.23	65.72	0.76
Lumley2	6894	17.23	42.07	57.10	0.86
Lumley2	6875	34.75	43.13	59.76	1.20
Lumley2	6875	30.26	42.50	12.87	1.69
Lumley2	6875	24.62	42.30	11.84	1.57
Lumley2	6875	20.57	42.07	10.61	1.55
Lumley2	6875	17.23	41.92	9.80	1.47
Lumley2	6873	34.75	43.09	35.48	1.40
Lumley2	6873	30.26	42.13	10.94	3.02
Lumley2	6873	24.62	42.06	10.57	2.56
Lumley2	6873	20.57	41.87	9.56	2.40
Lumley2	6873	17.23	41.77	9.07	2.15
Lumley2	6871	34.75	43.09		
Lumley2	6871	30.26	42.13		
Lumley2	6871	24.62	42.06		
Lumley2	6871	20.57	41.87		
Lumley2	6871	17.23	41.77		
Lumley2	6870	34.75	41.91	9.77	3.95
Lumley2	6870	30.26	42.04	10.46	3.18
Lumley2	6870	24.62	42.02	10.34	2.62
Lumley2	6870	20.57	41.83	9.34	2.46
Lumley2	6870	17.23	41.73	8.96	2.20
Lumley2	6865	34.75	42.40	12.42	2.06
Lumley2	6865	30.26	42.32	11.99	1.89
Lumley2	6865	24.62	42.19	11.28	1.69
Lumley2	6865	20.57	41.96	10.08	1.68

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Lumley2	6865	17.23	41.83	9.38	1.57
Lumley2	6845	34.75	42.37	25.39	1.63
Lumley2	6845	30.26	42.27	23.83	1.58
Lumley2	6845	24.62	42.12	20.18	1.55
Lumley2	6845	20.57	41.87	11.45	1.71
Lumley2	6845	17.23	41.73	10.53	1.63
Lumley2	6030	34.75	40.89	24.92	0.87
Lumley2	6030	30.26	40.70	23.03	0.85
Lumley2	6030	24.62	40.47	21.53	0.81
Lumley2	6030	20.57	40.29	20.34	0.78
Lumley2	6030	17.23	40.12	19.25	0.74
Lumley2	5738	34.75	40.18	36.41	1.64
Lumley2	5738	30.26	39.94	12.44	1.78
Lumley2	5738	24.62	39.71	11.04	1.71
Lumley2	5738	20.57	39.53	10.27	1.65
Lumley2	5738	17.23	39.36	9.56	1.60
Lumley2	5717	34.75	40.05	11.97	1.74
Lumley2	5717	30.26	39.83	11.34	1.73
Lumley2	5717	24.62	39.61	10.69	1.64
Lumley2	5717	20.57	39.42	10.14	1.58
Lumley2	5717	17.23	39.25	9.64	1.52
Lumley2	5715	34.75	39.75	11.15	2.87
Lumley2	5715	30.26	39.57	10.63	2.74
Lumley2	5715	24.62	39.42	10.20	2.43
Lumley2	5715	20.57	39.28	9.78	2.22
Lumley2	5715	17.23	39.14	9.37	2.05
Lumley2	5711	34.75	39.75		
Lumley2	5711	30.26	39.57		
Lumley2	5711	24.62	39.42		
Lumley2	5711	20.57	39.28		
Lumley2	5711	17.23	39.14		
Lumley2	5710	34.75	39.63	10.82	3.04
Lumley2	5710	30.26	39.45	10.29	2.93
Lumley2	5710	24.62	39.35	9.98	2.54
Lumley2	5710	20.57	39.22	9.60	2.31
Lumley2	5710	17.23	39.08	9.21	2.13
Lumley2	5705	34.75	39.80	11.29	2.01
Lumley2	5705	30.26	39.59	10.68	2.02

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total (m3/s)	W.S. Elev (m)	Top Width (m)	Vel Chnl (m/s)
Lumley2	5705	24.62	39.44	10.24	1.84
Lumley2	5705	20.57	39.28	9.79	1.74
Lumley2	5705	17.23	39.13	9.33	1.67
Lumley2	5691	34.75	39.78	27.31	1.78
Lumley2	5691	30.26	39.55	11.64	1.90
Lumley2	5691	24.62	39.40	10.73	1.73
Lumley2	5691	20.57	39.25	9.76	1.63
Lumley2	5691	17.23	39.09	9.21	1.54
Lumley2	5180	34.75	39.86	78.69	0.14
Lumley2	5180	30.26	39.65	78.11	0.13
Lumley2	5180	24.62	39.49	77.66	0.11
Lumley2	5180	20.57	39.32	77.20	0.10
Lumley2	5180	17.23	39.16	76.75	0.09
Lumley2	5100	34.75	39.85	48.77	0.24
Lumley2	5100	30.26	39.65	48.20	0.22
Lumley2	5100	24.62	39.48	47.75	0.19
Lumley2	5100	20.57	39.32	47.30	0.17
Lumley2	5100	17.23	39.16	46.85	0.15
Herrington	3815	10.22	61.97	28.16	1.79
Herrington	3815	8.85	61.97	28.16	1.55
Herrington	3815	7.13	61.81	4.63	2.48
Herrington	3815	5.90	61.72	4.32	2.39
Herrington	3815	4.91	61.64	4.05	2.30
Herrington	2891	10.22	60.32	42.53	0.67
Herrington	2891	8.85	60.26	40.95	0.64
Herrington	2891	7.13	60.18	38.95	0.60
Herrington	2891	5.90	60.09	36.66	0.59
Herrington	2891	4.91	60.02	30.59	0.55
Herrington	2866	10.22	60.28	24.75	0.95
Herrington	2866	8.85	60.22	19.72	0.88
Herrington	2866	7.13	60.15	18.49	0.79
Herrington	2866	5.90	60.06	16.99	0.76
Herrington	2866	4.91	59.99	15.83	0.71
Herrington	2864	10.22	60.27	25.03	0.94
Herrington	2864	8.85	60.21	19.82	0.87
Herrington	2864	7.13	60.14	18.61	0.78
Herrington	2864	5.90	60.05	17.11	0.75
Herrington	2864	4.91	59.99	15.94	0.70

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Herrington	2863	10.22	60.27		
Herrington	2863	8.85	60.21		
Herrington	2863	7.13	60.14		
Herrington	2863	5.90	60.05		
Herrington	2863	4.91	59.99		
Herrington	2862	10.22	60.05	17.03	1.31
Herrington	2862	8.85	59.97	15.66	1.30
Herrington	2862	7.13	59.84	14.88	1.33
Herrington	2862	5.90	59.71	11.14	1.38
Herrington	2862	4.91	59.59	7.62	1.38
Herrington	2857	10.96	59.77	13.07	2.33
Herrington	2857	9.12	59.61	8.01	2.49
Herrington	2857	7.26	59.39	3.65	2.71
Herrington	2857	6.09	59.26	3.06	2.70
Herrington	2857	5.10	59.11	2.34	2.78
Herrington	2850	10.96	58.75	5.21	4.23
Herrington	2850	9.12	59.26	7.29	1.58
Herrington	2850	7.26	59.12	6.85	1.50
Herrington	2850	6.09	59.01	6.37	1.48
Herrington	2850	5.10	58.92	5.95	1.45
Herrington	2361	10.96	56.41	5.01	1.90
Herrington	2361	9.12	56.24	4.69	1.83
Herrington	2361	7.26	56.08	4.36	1.71
Herrington	2361	6.09	55.96	4.14	1.62
Herrington	2361	5.10	55.86	3.96	1.53
Herrington	2359	10.96	56.22	4.66	2.60
Herrington	2359	9.12	56.11	4.44	2.36
Herrington	2359	7.26	55.99	4.21	2.08
Herrington	2359	6.09	55.90	4.03	1.90
Herrington	2359	5.10	55.81	3.92	1.74
Herrington	2356	10.96	56.22		
Herrington	2356	9.12	56.11		
Herrington	2356	7.26	55.99		
Herrington	2356	6.09	55.90		
Herrington	2356	5.10	55.81		
Herrington	2354	10.96	56.03	4.30	3.02
Herrington	2354	9.12	55.99	4.20	2.62
Herrington	2354	7.26	55.91	4.05	2.24

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Herrington	2354	6.09	55.84	3.95	2.03
Herrington	2354	5.10	55.76	3.86	1.85
Herrington	2349	10.96	55.93	4.10	2.98
Herrington	2349	9.12	55.81	3.92	2.85
Herrington	2349	7.26	55.69	3.78	2.68
Herrington	2349	6.09	55.60	3.68	2.55
Herrington	2349	5.10	55.52	3.59	2.42
Herrington	1363	10.96	45.81	12.98	0.81
Herrington	1363	9.12	45.32	10.92	0.98
Herrington	1363	7.26	44.87	7.59	1.14
Herrington	1363	6.09	44.72	6.45	1.08
Herrington	1363	5.10	44.43	5.30	1.20
Herrington	1352	10.96	45.79	7.73	0.89
Herrington	1352	9.12	45.29	6.24	1.02
Herrington	1352	7.26	44.83	5.08	1.14
Herrington	1352	6.09	44.68	4.76	1.08
Herrington	1352	5.10	44.38	4.10	1.19
Herrington	1350	10.96	45.68	7.39	1.64
Herrington	1350	9.12	45.19	5.96	1.65
Herrington	1350	7.26	44.75	4.90	1.63
Herrington	1350	6.09	44.62	4.62	1.46
Herrington	1350	5.10	44.33	3.99	1.48
Herrington	1346	10.96	45.68		
Herrington	1346	9.12	45.19		
Herrington	1346	7.26	44.75		
Herrington	1346	6.09	44.62		
Herrington	1346	5.10	44.33		
Herrington	1344	10.96	44.55	4.47	2.75
Herrington	1344	9.12	44.46	4.27	2.42
Herrington	1344	7.26	44.33	3.99	2.10
Herrington	1344	6.09	44.21	3.74	1.92
Herrington	1344	5.10	44.09	3.47	1.77
Herrington	1339	12.06	44.27	3.86	3.14
Herrington	1339	10.03	44.13	3.55	3.04
Herrington	1339	7.99	43.96	3.19	2.92
Herrington	1339	6.70	43.86	2.98	2.75
Herrington	1339	5.61	43.79	2.83	2.51
Herrington	1306	12.06	42.91	8.11	2.84

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Herrington	1306	10.03	42.86	7.79	2.60
Herrington	1306	7.99	42.81	7.46	2.30
Herrington	1306	6.70	42.76	7.17	2.12
Herrington	1306	5.61	42.70	6.78	2.04
Herrington	1162	12.06	42.84	59.01	0.32
Herrington	1162	10.03	42.59	51.53	0.36
Herrington	1162	7.99	42.29	42.88	0.44
Herrington	1162	6.70	42.10	37.27	0.51
Herrington	1162	5.61	42.15	38.71	0.39
Herrington	1154	12.06	42.84	64.67	0.23
Herrington	1154	10.03	42.59	54.48	0.27
Herrington	1154	7.99	42.29	45.95	0.34
Herrington	1154	6.70	42.10	40.54	0.42
Herrington	1154	5.61	42.15	41.95	0.32
Herrington	1152	12.06	42.84	64.96	0.23
Herrington	1152	10.03	42.59	54.78	0.26
Herrington	1152	7.99	42.29	46.15	0.33
Herrington	1152	6.70	42.10	40.73	0.41
Herrington	1152	5.61	42.15	42.15	0.31
Herrington	1148	12.06	42.84		
Herrington	1148	10.03	42.59		
Herrington	1148	7.99	42.29		
Herrington	1148	6.70	42.10		
Herrington	1148	5.61	42.15		
Herrington	1147	12.06	42.84	64.92	0.23
Herrington	1147	10.03	42.58	54.73	0.26
Herrington	1147	7.99	42.29	46.08	0.34
Herrington	1147	6.70	42.09	40.62	0.42
Herrington	1147	5.61	41.83	2.44	1.88
Herrington	1142	12.06	41.96	3.28	3.68
Herrington	1142	10.03	41.75	2.39	3.56
Herrington	1142	7.99	41.56	2.26	3.30
Herrington	1142	6.70	41.65	2.32	2.57
Herrington	1142	5.61	41.67	2.33	2.12
Herrington	1115	12.06	41.09	18.46	2.76
Herrington	1115	10.03	41.09	18.49	2.26
Herrington	1115	7.99	41.08	18.43	1.86
Herrington	1115	6.70	40.95	10.53	2.11
Herrington	1115	5.61	40.77	3.91	2.45

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total (m3/s)	W.S. Elev (m)	Top Width (m)	Vel Chnl (m/s)
Herrington	97	12.06	39.86	99.43	0.20
Herrington	97	10.03	39.65	98.97	0.23
Herrington	97	7.99	39.49	98.60	0.25
Herrington	97	6.70	39.32	91.46	0.30
Herrington	97	5.61	39.16	68.78	0.35
Herrington	1	12.06	39.86	50.70	0.22
Herrington	1	10.03	39.65	50.33	0.22
Herrington	1	7.99	39.48	49.96	0.20
Herrington	1	6.70	39.32	49.60	0.21
Herrington	1	5.61	39.16	49.24	0.21
Lumley1	5098	56.81	39.76	34.07	1.59
Lumley1	5098	49.52	39.54	31.57	1.67
Lumley1	5098	40.37	39.39	29.85	1.56
Lumley1	5098	33.95	39.22	27.99	1.54
Lumley1	5098	28.12	39.06	26.18	1.49
Lumley1	4982	56.81	39.48	33.19	1.68
Lumley1	4982	49.52	39.04	28.21	2.18
Lumley1	4982	40.37	39.01	27.83	1.84
Lumley1	4982	33.95	38.68	23.35	2.14
Lumley1	4982	28.12	38.09	4.17	2.88
Lumley1	4980	56.81	39.47	34.88	1.74
Lumley1	4980	49.52	38.99	28.29	2.40
Lumley1	4980	40.37	38.98	28.16	1.97
Lumley1	4980	33.95	38.57	21.47	2.50
Lumley1	4980	28.12	38.05	4.16	2.95
Lumley1	4976	56.81	39.46	34.87	1.74
Lumley1	4976	49.52	38.94	27.74	2.49
Lumley1	4976	40.37	38.96	28.06	1.98
Lumley1	4976	33.95	38.20	13.85	3.37
Lumley1	4976	28.12	37.91	4.06	3.19
Lumley1	4971	56.81	39.46	33.05	1.45
Lumley1	4971	49.52	38.94	27.15	2.17
Lumley1	4971	40.37	37.87	4.04	4.62
Lumley1	4971	33.95	37.61	3.94	4.41
Lumley1	4971	28.12	37.38	3.91	4.15
Lumley1	4890	56.81	39.43	58.17	0.81
Lumley1	4890	49.52	38.93	24.22	0.89

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total (m3/s)	W.S. Elev (m)	Top Width (m)	Vel Chnl (m/s)
Lumley1	4890	40.37	37.97	18.59	1.14
Lumley1	4890	33.95	37.59	16.55	1.18
Lumley1	4890	28.12	37.30	15.05	1.15
Lumley1	4886	56.81	39.43	59.54	0.79
Lumley1	4886	49.52	38.92	22.97	0.86
Lumley1	4886	40.37	37.97	18.49	1.07
Lumley1	4886	33.95	37.59	16.66	1.09
Lumley1	4886	28.12	37.30	15.34	1.06
Lumley1	4885	56.81	39.43		
Lumley1	4885	49.52	38.92		
Lumley1	4885	40.37	37.97		
Lumley1	4885	33.95	37.59		
Lumley1	4885	28.12	37.30		
Lumley1	4880	56.81	39.12	33.85	0.91
Lumley1	4880	49.52	38.39	20.50	1.08
Lumley1	4880	40.37	37.75	17.38	1.19
Lumley1	4880	33.95	37.40	15.78	1.21
Lumley1	4880	28.12	37.14	14.60	1.16
Lumley1	4857	56.81	39.12	47.25	0.80
Lumley1	4857	49.52	38.38	16.94	0.88
Lumley1	4857	40.37	37.75	16.01	0.88
Lumley1	4857	33.95	37.40	15.50	0.84
Lumley1	4857	28.12	37.15	15.13	0.77
Lumley1	4852	56.81	39.10	35.19	0.95
Lumley1	4852	49.52	38.37	14.79	1.01
Lumley1	4852	40.37	37.73	13.50	1.01
Lumley1	4852	33.95	37.39	13.00	0.95
Lumley1	4852	28.12	37.13	12.63	0.87
Lumley1	4850	56.81	38.96	16.09	1.84
Lumley1	4850	49.52	38.22	14.48	1.88
Lumley1	4850	40.37	37.61	13.32	1.79
Lumley1	4850	33.95	37.28	12.85	1.65
Lumley1	4850	28.12	37.06	12.52	1.46
Lumley1	4825	56.81	38.96		
Lumley1	4825	49.52	38.22		
Lumley1	4825	40.37	37.61		
Lumley1	4825	33.95	37.28		
Lumley1	4825	28.12	37.06		

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Lumley1	4800	56.81	37.53	13.39	2.48
Lumley1	4800	49.52	37.18	12.89	2.38
Lumley1	4800	40.37	36.96	12.56	2.08
Lumley1	4800	33.95	36.68	12.16	1.92
Lumley1	4800	28.12	36.36	11.69	1.79
Lumley1	4795	56.81	37.62	13.53	1.41
Lumley1	4795	49.52	37.27	13.01	1.39
Lumley1	4795	40.37	37.02	12.65	1.24
Lumley1	4795	33.95	36.73	12.24	1.17
Lumley1	4795	28.12	36.40	11.75	1.13
Lumley1	4365	56.81	35.29	15.23	3.33
Lumley1	4365	49.52	35.81	23.91	1.81
Lumley1	4365	40.37	35.13	12.14	2.70
Lumley1	4365	33.95	34.53	5.37	3.45
Lumley1	4365	28.12	34.26	4.29	3.27
Lumley1	4363	56.81	35.23	13.79	3.55
Lumley1	4363	49.52	35.78	23.26	1.88
Lumley1	4363	40.37	34.32	4.30	4.57
Lumley1	4363	33.95	34.10	4.26	4.29
Lumley1	4363	28.12	33.88	4.22	4.04
Lumley1	4360	56.81	35.12	11.64	3.88
Lumley1	4360	49.52	35.73	22.44	1.96
Lumley1	4360	40.37	34.19	4.27	4.88
Lumley1	4360	33.95	33.98	4.24	4.61
Lumley1	4360	28.12	33.75	4.20	4.37
Lumley1	4355	56.81	34.92	9.05	4.52
Lumley1	4355	49.52	35.03	10.13	3.63
Lumley1	4355	40.37	33.92	4.23	5.65
Lumley1	4355	33.95	33.72	4.19	5.39
Lumley1	4355	28.12	33.50	4.15	5.23
Lumley1	4190	56.81	35.18	53.13	0.51
Lumley1	4190	49.52	34.99	52.89	0.48
Lumley1	4190	40.37	34.70	52.50	0.46
Lumley1	4190	33.95	34.41	50.29	0.45
Lumley1	4190	28.12	33.67	37.95	0.66
Lumley1	4042	56.81	35.09	43.00	0.91
Lumley1	4042	49.52	34.91	35.52	0.88
Lumley1	4042	40.37	34.62	22.56	0.83
Lumley1	4042	33.95	34.33	19.35	0.79

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total (m3/s)	W.S. Elev (m)	Top Width (m)	Vel Chnl (m/s)
Lumley1	4042	28.12	33.47	15.39	1.00
Lumley1	4040	56.81	35.09	42.96	0.91
Lumley1	4040	49.52	34.91	35.11	0.88
Lumley1	4040	40.37	34.45	19.99	1.88
Lumley1	4040	33.95	34.20	18.68	1.70
Lumley1	4040	28.12	33.33	14.79	1.86
Lumley1	4030	56.81	35.09		
Lumley1	4030	49.52	34.91		
Lumley1	4030	40.37	34.45		
Lumley1	4030	33.95	34.20		
Lumley1	4030	28.12	33.33		
Lumley1	4025	56.81	33.58	15.90	3.43
Lumley1	4025	49.52	33.46	15.41	3.11
Lumley1	4025	40.37	33.30	14.74	2.68
Lumley1	4025	33.95	33.16	14.11	2.39
Lumley1	4025	28.12	32.98	12.94	2.13
Lumley1	4020	55.23	33.78	16.78	1.65
Lumley1	4020	48.17	33.62	16.11	1.56
Lumley1	4020	39.33	33.42	15.22	1.43
Lumley1	4020	33.16	33.24	14.47	1.33
Lumley1	4020	27.32	33.04	13.43	1.24
Lumley1	3200	55.23	31.79	41.61	1.03
Lumley1	3200	48.17	31.67	39.98	0.99
Lumley1	3200	39.33	31.48	33.72	0.99
Lumley1	3200	33.16	31.33	32.16	0.95
Lumley1	3200	27.32	31.19	30.64	0.90
Lumley1	2902	55.23	29.64	11.04	3.66
Lumley1	2902	48.17	29.50	10.74	3.55
Lumley1	2902	39.33	29.32	10.36	3.36
Lumley1	2902	33.16	29.20	10.08	3.19
Lumley1	2902	27.32	29.06	9.78	3.03
Lumley1	2877	55.23	28.81	35.35	1.20
Lumley1	2877	48.17	28.73	35.12	1.11
Lumley1	2877	39.33	28.63	34.82	0.99
Lumley1	2877	33.16	28.55	34.59	0.89
Lumley1	2877	27.32	28.47	34.36	0.79
Lumley1	2875	55.23	28.81	35.33	1.20
Lumley1	2875	48.17	28.73	35.11	1.11

HEC-RAS Plan: Developed 3/26/98 (continued)

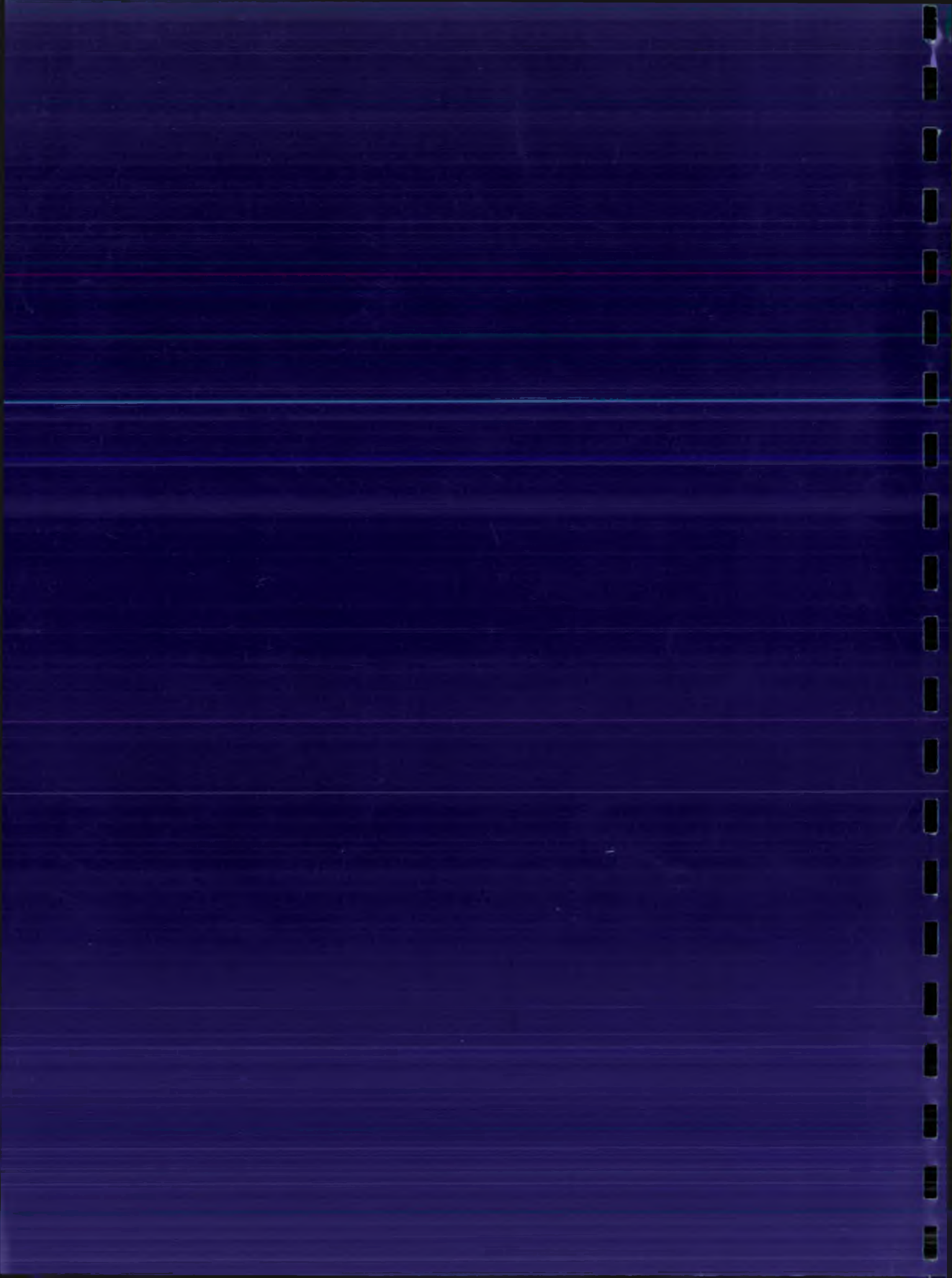
Reach	River Sta	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Lumley1	2875	39.33	28.62	34.81	0.99
Lumley1	2875	33.16	28.54	34.58	0.90
Lumley1	2875	27.32	28.46	34.35	0.79
Lumley1	2873	55.23	28.81		
Lumley1	2873	48.17	28.73		
Lumley1	2873	39.33	28.62		
Lumley1	2873	33.16	28.54		
Lumley1	2873	27.32	28.46		
Lumley1	2872	55.23	25.00	8.76	7.57
Lumley1	2872	48.17	24.88	8.36	7.69
Lumley1	2872	39.33	24.74	7.92	7.62
Lumley1	2872	33.16	24.64	7.58	7.61
Lumley1	2872	27.32	24.54	7.25	7.56
Lumley1	2867	55.23	26.74	10.87	2.26
Lumley1	2867	48.17	26.58	10.68	2.12
Lumley1	2867	39.33	26.12	10.13	2.20
Lumley1	2867	33.16	25.93	9.90	2.07
Lumley1	2867	27.32	25.73	9.66	1.95
Lumley1	2846	49.57	26.64	10.80	2.09
Lumley1	2846	43.29	26.49	10.61	1.96
Lumley1	2846	35.42	25.98	10.00	2.11
Lumley1	2846	29.95	25.78	9.76	2.02
Lumley1	2846	24.52	25.58	9.52	1.90
Lumley1	2222	49.57	22.11	9.76	2.48
Lumley1	2222	43.29	21.75	8.48	2.58
Lumley1	2222	35.42	22.00	9.36	1.87
Lumley1	2222	29.95	21.70	8.31	1.83
Lumley1	2222	24.52	21.35	7.04	1.80
Lumley1	2220	49.57	21.63	4.81	3.81
Lumley1	2220	43.29	21.36	4.79	3.69
Lumley1	2220	35.42	21.83	4.82	2.55
Lumley1	2220	29.95	21.58	4.80	2.35
Lumley1	2220	24.52	21.26	4.78	2.17
Lumley1	2210	49.57	21.63		
Lumley1	2210	43.29	21.36		
Lumley1	2210	35.42	21.83		
Lumley1	2210	29.95	21.58		
Lumley1	2210	24.52	21.26		

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Lumley1	2200	49.57	20.67	4.73	5.70
Lumley1	2200	43.29	20.52	4.72	5.40
Lumley1	2200	35.42	21.42	4.79	2.92
Lumley1	2200	29.95	21.28	4.78	2.61
Lumley1	2200	24.52	21.02	4.76	2.38
Lumley1	2195	49.57	20.58	5.57	5.40
Lumley1	2195	43.29	20.39	5.47	5.30
Lumley1	2195	35.42	21.44	7.39	2.44
Lumley1	2195	29.95	21.29	6.83	2.23
Lumley1	2195	24.52	21.02	5.86	2.10
Lumley1	1257	49.57	16.11	35.22	1.02
Lumley1	1257	43.29	15.75	23.71	1.13
Lumley1	1257	35.42	14.71	12.57	1.69
Lumley1	1257	29.95	14.39	10.60	1.75
Lumley1	1257	24.52	14.03	8.46	1.78
Lumley1	1255	49.57	15.76	24.15	2.68
Lumley1	1255	43.29	15.46	18.77	2.50
Lumley1	1255	35.42	14.47	11.16	2.65
Lumley1	1255	29.95	14.22	9.65	2.42
Lumley1	1255	24.52	13.94	7.93	2.18
Lumley1	1252	49.57	15.76		
Lumley1	1252	43.29	15.46		
Lumley1	1252	35.42	14.47		
Lumley1	1252	29.95	14.22		
Lumley1	1252	24.52	13.94		
Lumley1	1250	49.57	14.76	13.00	3.41
Lumley1	1250	43.29	14.59	11.97	3.12
Lumley1	1250	35.42	14.35	10.49	2.74
Lumley1	1250	29.95	14.14	9.21	2.48
Lumley1	1250	24.52	13.87	7.59	2.22
Lumley1	1242	49.57	14.90	14.11	2.08
Lumley1	1242	43.29	14.68	12.58	2.07
Lumley1	1242	35.42	14.39	10.82	2.02
Lumley1	1242	29.95	14.15	9.36	1.98
Lumley1	1242	24.52	13.86	7.59	1.94
Lumley1	240	49.57	8.94	8.76	2.03
Lumley1	240	43.29	8.66	8.40	1.96
Lumley1	240	35.42	8.31	8.31	1.85
Lumley1	240	29.95	8.06	8.25	1.75

HEC-RAS Plan: Developed 3/26/98 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Lumley1	240	24.52	7.79	8.19	1.65
Lumley1	0	49.57	7.76	8.56	2.08
Lumley1	0	43.29	7.49	8.38	2.01
Lumley1	0	35.42	7.15	8.30	1.90
Lumley1	0	29.95	6.90	8.24	1.81
Lumley1	0	24.52	6.64	8.18	1.70



Key:

- Fluvial Floodplain (100yr unless noted otherwise)
- Tidal Floodplain (200 yr unless noted otherwise)
- Washland
- Controlled Washland
- Limit of reach
- Floodplain extent (High confidence)
- Floodplain extent (Medium confidence)
- Floodplain extent (Low confidence)
- Known event line with estimated return period — eg 150 yr
- Main river included in survey
- Ordinary watercourse included in survey
- Main river excluded from survey
- Ordinary watercourse excluded from survey
- Culvert / tunnel
- Model node Point — 2883

Note :- for clarity only indicative model node points have been included on this plan. For full listing please refer to model output

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION

PROJECT TITLE

SECTION 105 - C30/92 SURVEYS
FLOOD PLAIN IDENTIFICATION
1 IN 100 YEAR EVENT

DRAWING TITLE

NORTHUMBRIA AREA
LUMLEY PARK BURN
SHEET 1 OF 3

ORIGINATED BY	DRAWN BY	CHECKED BY	APPROVED BY
SPT	TH-R	TJS	
DATE	DATE	DATE	DATE

SCALE: 1:10,000

PROJECT NO. / DRAWING NO. / REV: C1395/FPM/01/030

POSFORD DUVIVIER

USER NOTE

This plan has been produced with the requirements of Department of the Environment Circular 30/92. Because the information is indicative rather than specific,local planning authorities will nevertheless need to consult the Environment Agency on individual applications. Flood plain extent is based on the information available at the time of survey. Amendments will be required in future to account for information gathered subsequently eg. changes in hydrological river response or observations following flood events.

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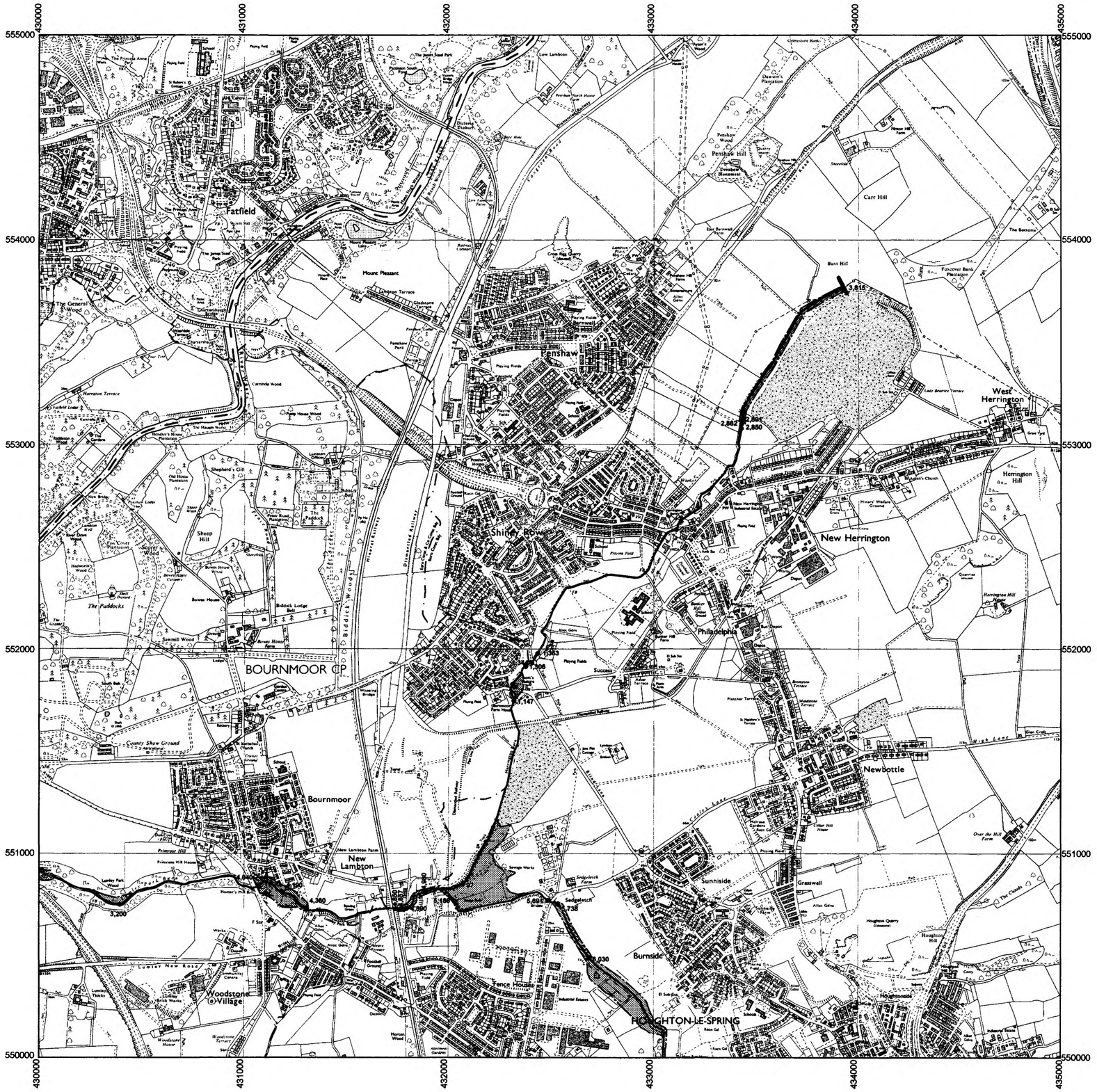
21-05-98



Key:

- Fluvial Floodplain (100yr unless noted otherwise)
- Tidal Floodplain (200 yr unless noted otherwise)
- Washland
- Controlled Washland
- Limit of reach
- Floodplain extent (High confidence)
- Floodplain extent (Medium confidence)
- Floodplain extent (Low confidence)
- Known event line with estimated return period — eg 150 yr
- Main river included in survey
- Ordinary watercourse included in survey
- Main river excluded from survey
- Ordinary watercourse excluded from survey
- Culvert / tunnel
- Model node Point — 2883

Note :- for clarity only indicative model node points have been included on this plan. For full listing please refer to model output

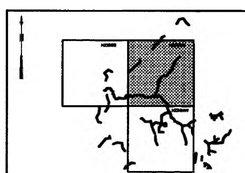
Originator		Date		Rev'n
Drawn By		Date		
Checked		Date		
Checked		Date		

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION

PROJECT TITLE

SECTION 105 - C30/92 SURVEYS
FLOOD PLAIN IDENTIFICATION
1 IN 100 YEAR EVENT



USER NOTE
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DRAWING TITLE

NORTHUMBRIA AREA
LUMLEY PARK BURN
SHEET 2 OF 3

ORIGINATED BY	DRAWN BY	CHECKED BY	APPROVED BY
SPT	TH-R	TJS	
DATE	DATE	DATE	DATE

SCALE: 1:10,000

PROJECT NO. / DRAWING NO. / REV: C1395/FPM/01/031

POSFORD DUVIVIER

21-05-98

Key:

- Fluvial Floodplain (100yr unless noted otherwise)
- Tidal Floodplain (200 yr unless noted otherwise)
- Washland
- Controlled Washland
- Limit of reach
- Floodplain extent (High confidence)
- Floodplain extent (Medium confidence)
- Floodplain extent (Low confidence)
- Known event line with estimated return period — eg 150 yr
- Main river included in survey
- Ordinary watercourse included in survey
- Main river excluded from survey
- Ordinary watercourse excluded from survey
- Culvert / tunnel
- Model node Point — 2983

Note :- for clarity only indicative model node points have been included on this plan. For full listing please refer to model output

Originated	Date	Details
Drawn By	Date	
Checked	Date	

List of revisions

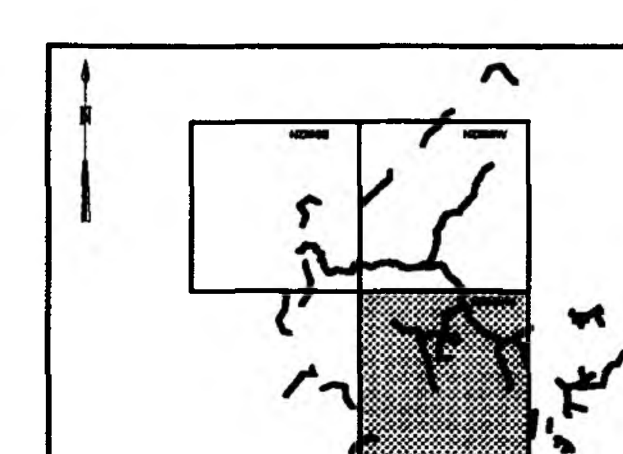
ENVIRONMENT AGENCY
NORTH EAST REGION

PROJECT TITLE

SECTION 105 - C30/92 SURVEYS FLOOD PLAIN IDENTIFICATION 1 IN 100 YEAR EVENT

DRAWING TITLE

NORTHUMBRIA AREA LUMLEY PARK BURN SHEET 3 OF 3



ORIGINATED BY	DRAWN BY	CHECKED BY	APPROVED BY
SPT	TH-R	TJS	
DATE	DATE	DATE	DATE

SCALE
1:10,000

PROJECT NO. / DRAWING NO. / REV
C1395/FPM/01/032

USER NOTE
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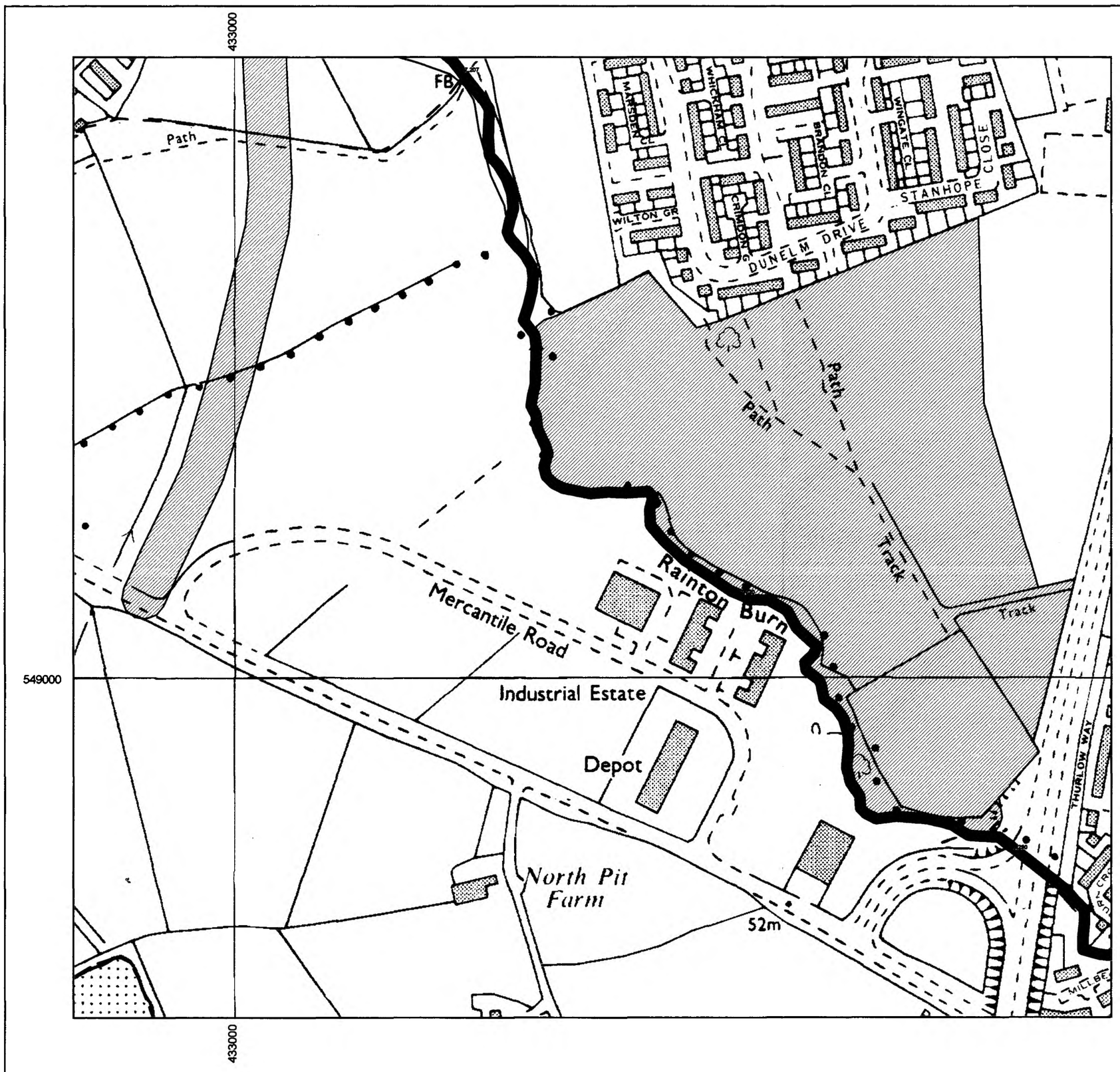
POSFORD DUVIVIER

19-05-98



KEY:

- Development Site
- Main river, hydraulic model node and cross section (154)
- Non-main river, hydraulic model node and cross section (154)
- Culvert / Tunnel main river
- Culvert / Tunnel non-main river
- Weir
- Indicative 100 year flood event
- Indicative 50 year flood event
- Indicative 20 year flood event
- Indicative 10 year flood event
- Indicative 5 year flood event

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION

PROJECT TITLE

SECTION 105 - C30/92 SURVEYS IDENTIFICATION OF DEVELOPMENT AT RISK FROM FLOODING

DRAWING TITLE

NOTHUMBRIA AREA LUMLEY PARK BURN (SHEET 1 OF 10)

DESIGNED BY	DRAWN BY	CHECKED BY	APPROVED BY
BPT	TN-R	TJB	
DATE	DATE	DATE	DATE

SCALE: 1 : 2,500

PROJECT NO. / DRAWING NO. / REV: C1395/DM/01/030

POSFORD DUVIVIER

USER NOTE

This plan has been produced with the requirements of Department of the Environment Circular 30/92. Because the information is indicative rather than specific, local planning authorities will nevertheless need to consult the Environment Agency on individual applications. Flood plain extent is based on data available at the time of survey. Amendments will be required in future to account for information gathered subsequently eg. changes in hydrological river respons e or observations following flood events.

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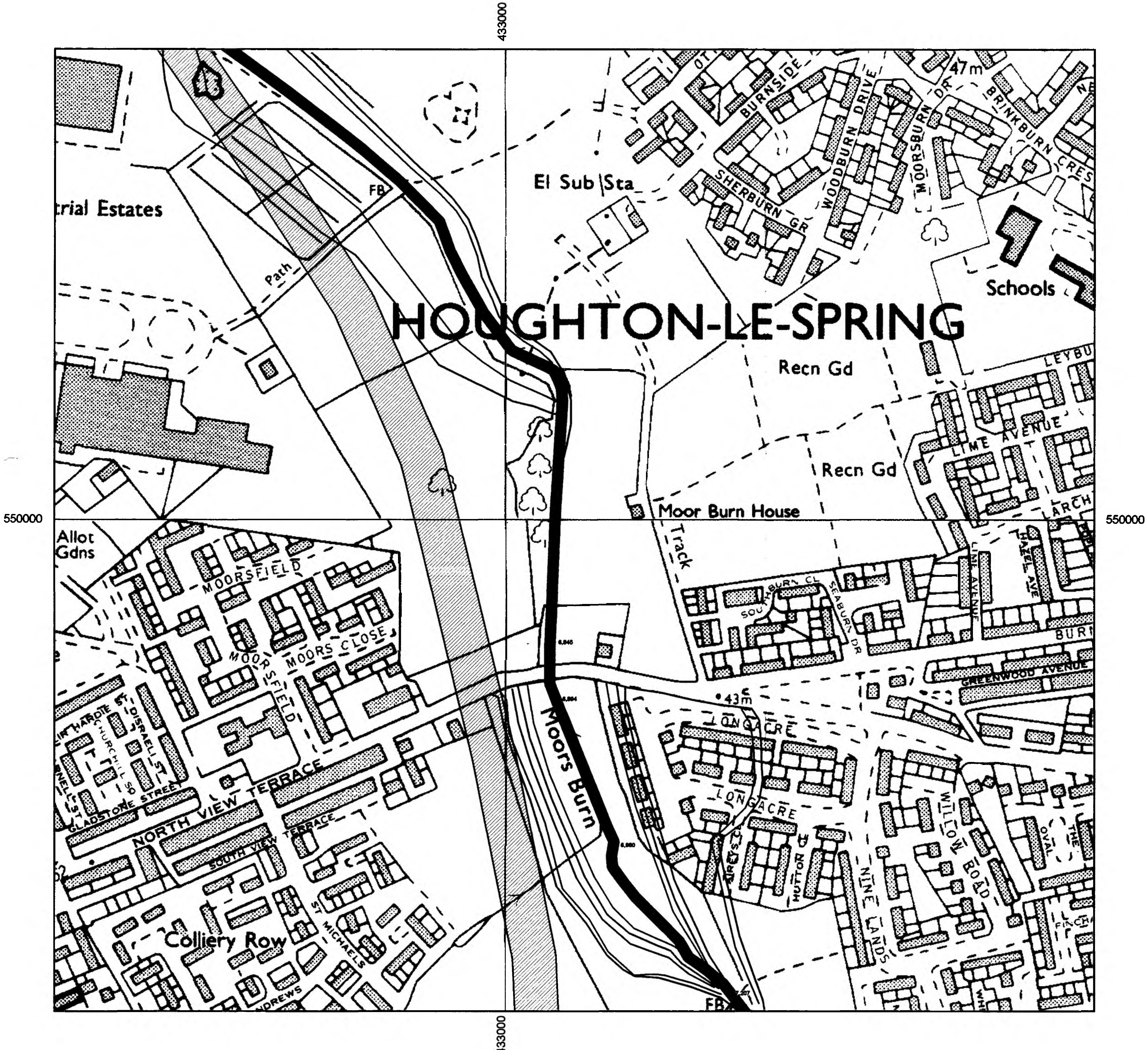
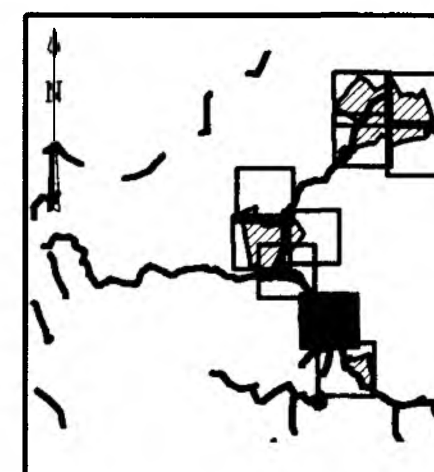
10/10/1997



KEY:

Development Site	
Main river, hydraulic model node and cross section	154
Non-main river, hydraulic model node and cross section	154
Culvert / Tunnel main river	
Culvert / Tunnel non-main river	
Weir	
Indicative 100 year flood event	
Indicative 50 year flood event	
Indicative 20 year flood event	
Indicative 10 year flood event	
Indicative 5 year flood event	



USER NOTE

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List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION

PROJECT TITLE

SECTION 105 - C30/92 SURVEYS IDENTIFICATION OF DEVELOPMENT AT RISK FROM FLOODING

DRAWING TITLE

NORTHUMBRIA AREA
LUMLEY PARK BURN
(SHEET 2 OF 10)

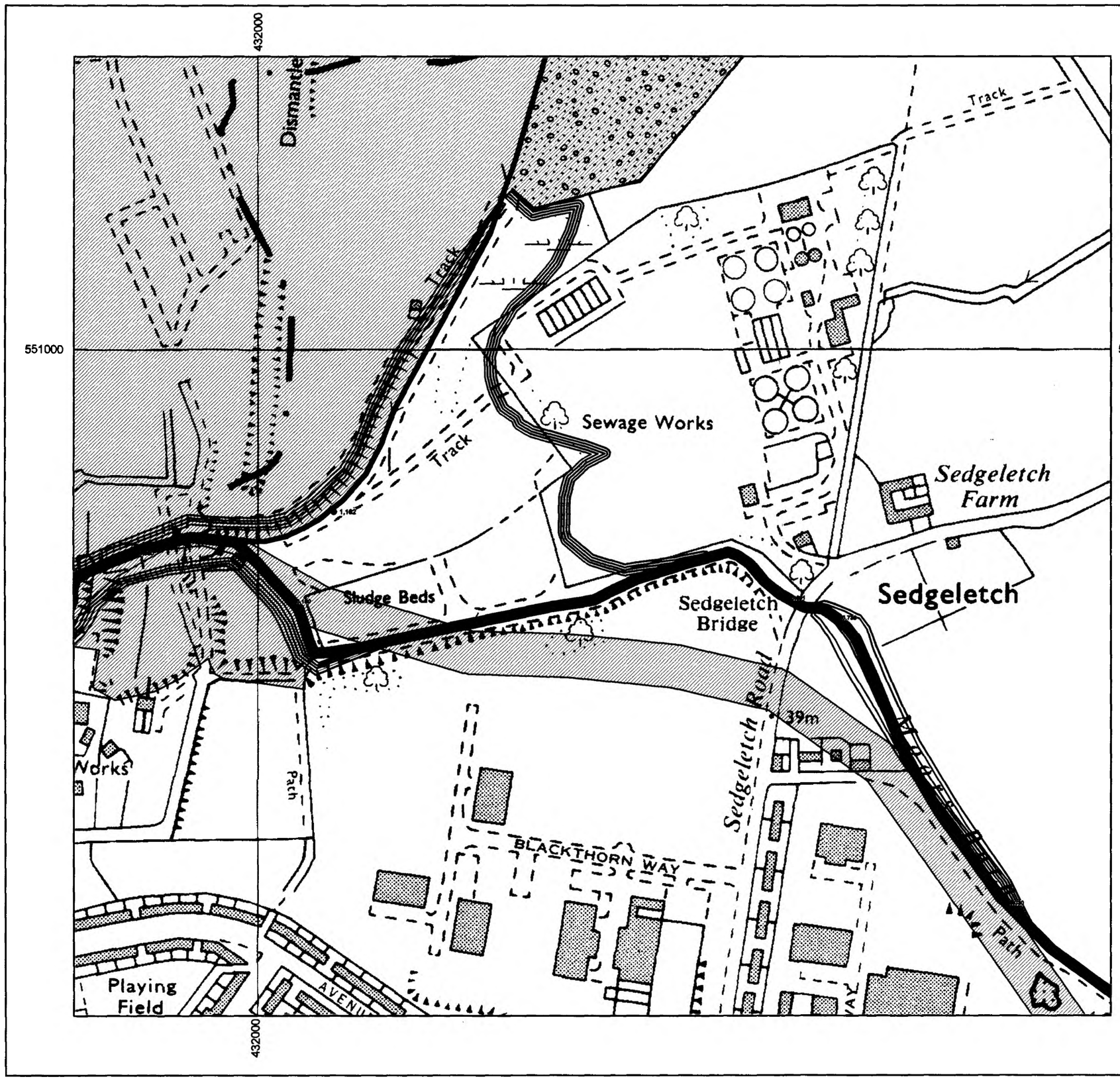
ORIGINATED BY	DRAWN BY	CHECKED BY	APPROVED BY
SFT	TH-R	TJS	
DATE	DATE	DATE	DATE

SCALE 1 : 2,500

PROJECT NO. / DRAWING NO. / REV C1395/DM/01/031

POSFORD DUVIVIER

10/10/1997

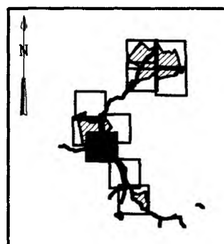


KEY:

- Development Site
- Main river, hydraulic model node and cross section (154)
- Non-main river, hydraulic model node and cross section (154)
- Culvert / Tunnel main river
- Culvert / Tunnel non-main river
- Weir
- Indicative 100 year flood event
- Indicative 50 year flood event
- Indicative 20 year flood event
- Indicative 10 year flood event
- Indicative 5 year flood event

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION



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USER NOTE

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PROJECT TITLE

SECTION 105 - C30/92 SURVEYS
IDENTIFICATION OF
DEVELOPMENT AT
RISK FROM FLOODING

DRAWING TITLE

NORTHUMBRIA AREA
LUMLEY PARK BURN
(SHEET 3 OF 10)

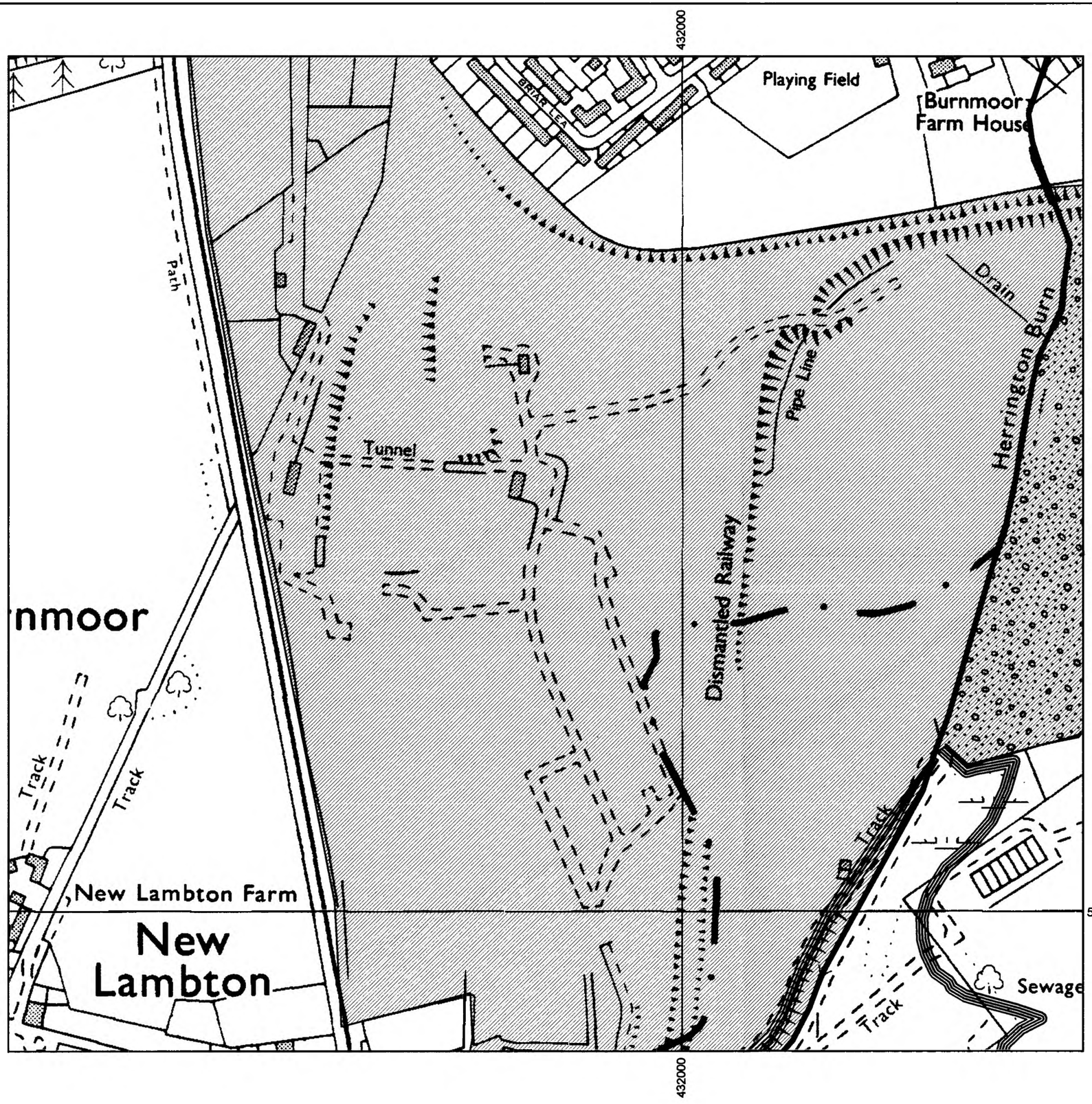
ORIGINATED BY	DRAWN BY	CHECKED BY	APPROVED BY
BPT	TH-R	TJS	
DATE	DATE	DATE	DATE

SCALE 1 : 2,500

PROJECT NO. / DRAWING NO. / REV
C139S/DM/O1/O32

POSFORD DUVIVIER

10/10/1997



KEY:

- Development Site
- Main river, hydraulic model node and cross section (154)
- Non-main river, hydraulic model node and cross section (154)
- Culvert / Tunnel main river
- Culvert / Tunnel non-main river
- Weir
- Indicative 100 year flood event
- Indicative 50 year flood event
- Indicative 20 year flood event
- Indicative 10 year flood event
- Indicative 5 year flood event

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION

N

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PROJECT TITLE

SECTION 105 - C30/92 SURVEYS IDENTIFICATION OF DEVELOPMENT AT RISK FROM FLOODING

DRAWING TITLE

NORTHUMBIRA AREA LUMLEY PARK BURN (SHEET 4 OF 10)

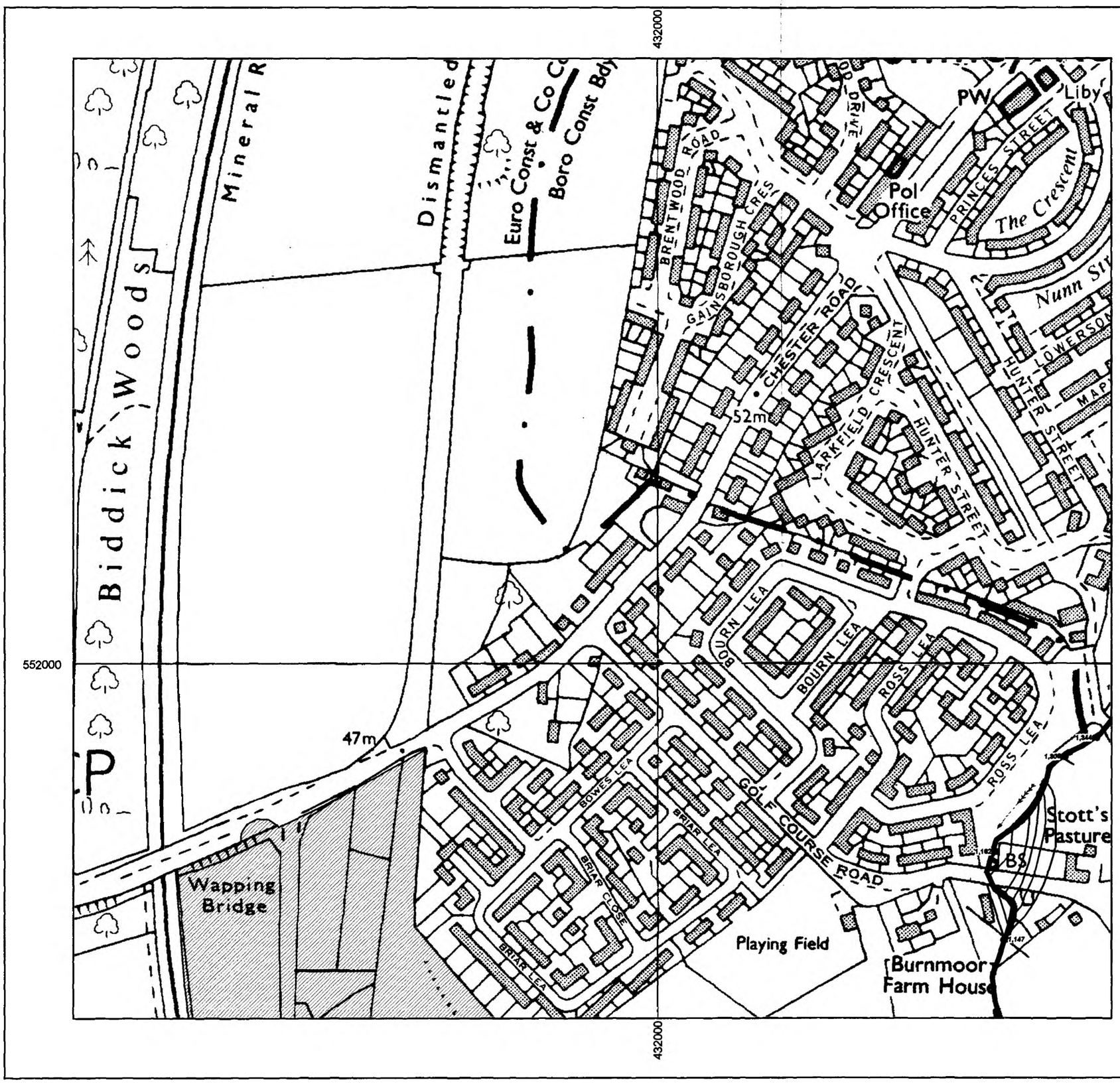
DRAWN BY	DESIGN BY	CHECKED BY	APPROVED BY
BPT	TH-R	TJS	
DATE	DATE	DATE	DATE

SCALE: 1 : 2,500

PROJECT NO. / DRAWING NO. / REV: C1395/DM/01/033

POSFORD DUVIVIER

10/10/1997

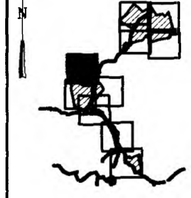


KEY:

- Development Site
- Main river, hydraulic model node and cross section (154)
- Non-main river, hydraulic model node and cross section (154)
- Culvert / Tunnel main river
- Culvert / Tunnel non-main river
- Weir
- Indicative 100 year flood event
- Indicative 50 year flood event
- Indicative 20 year flood event
- Indicative 10 year flood event
- Indicative 5 year flood event

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION



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PROJECT TITLE

SECTION 105 - C30/92 SURVEYS
IDENTIFICATION OF DEVELOPMENT AT RISK FROM FLOODING

DRAWING TITLE

NORTHUMBRIA AREA
LUMLEY PARK BURN
(SHEET 5 OF 10)

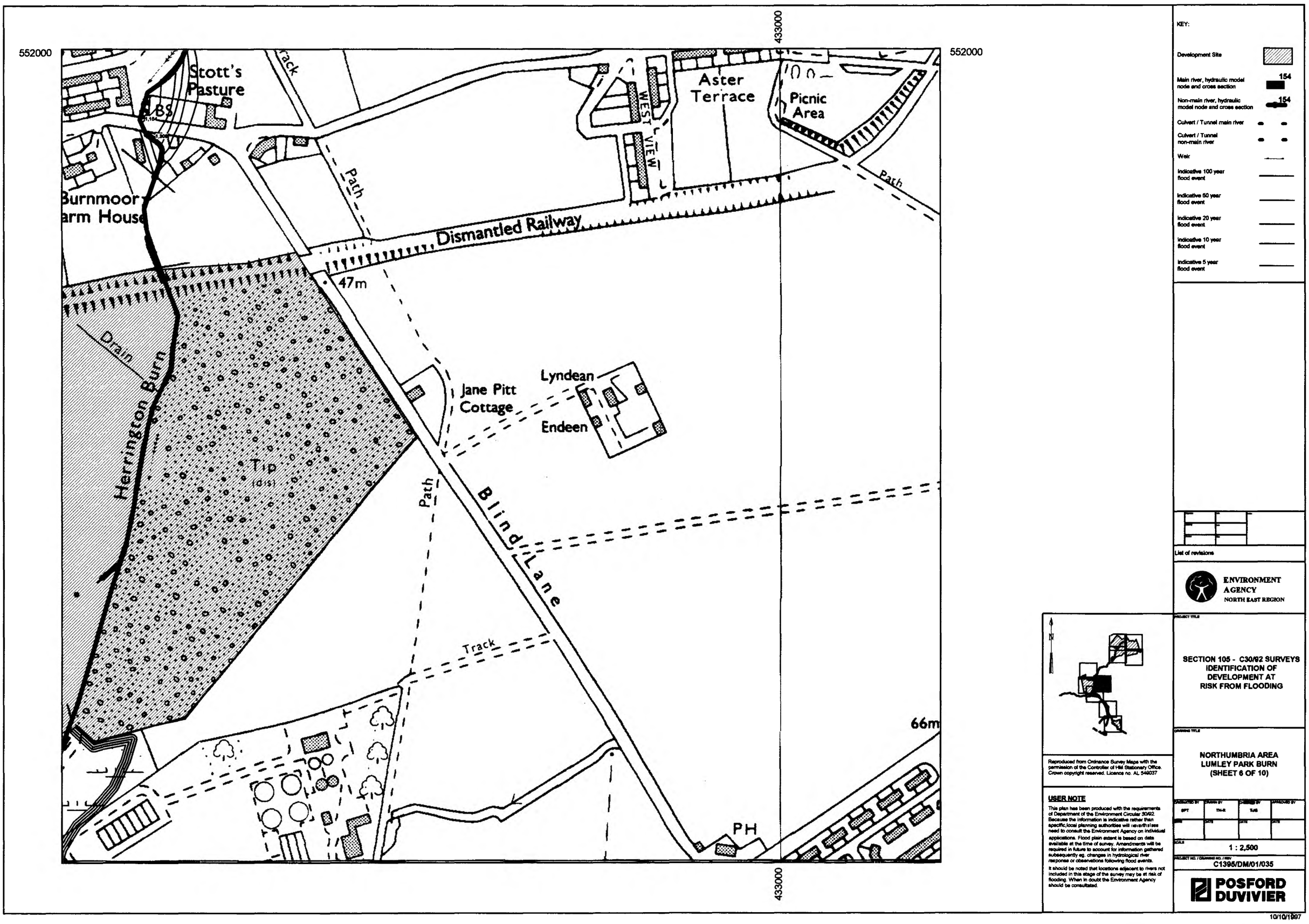
DESIGNED BY	DRAWN BY	CHECKED BY	APPROVED BY
BPT	THJR	TJS	
DATE	DATE	DATE	DATE

SCALE: 1 : 2,500

PROJECT NO. / DRAWING NO. / REV: C1395/DM/01/034

POSFORD DUVIVIER

10/10/1997



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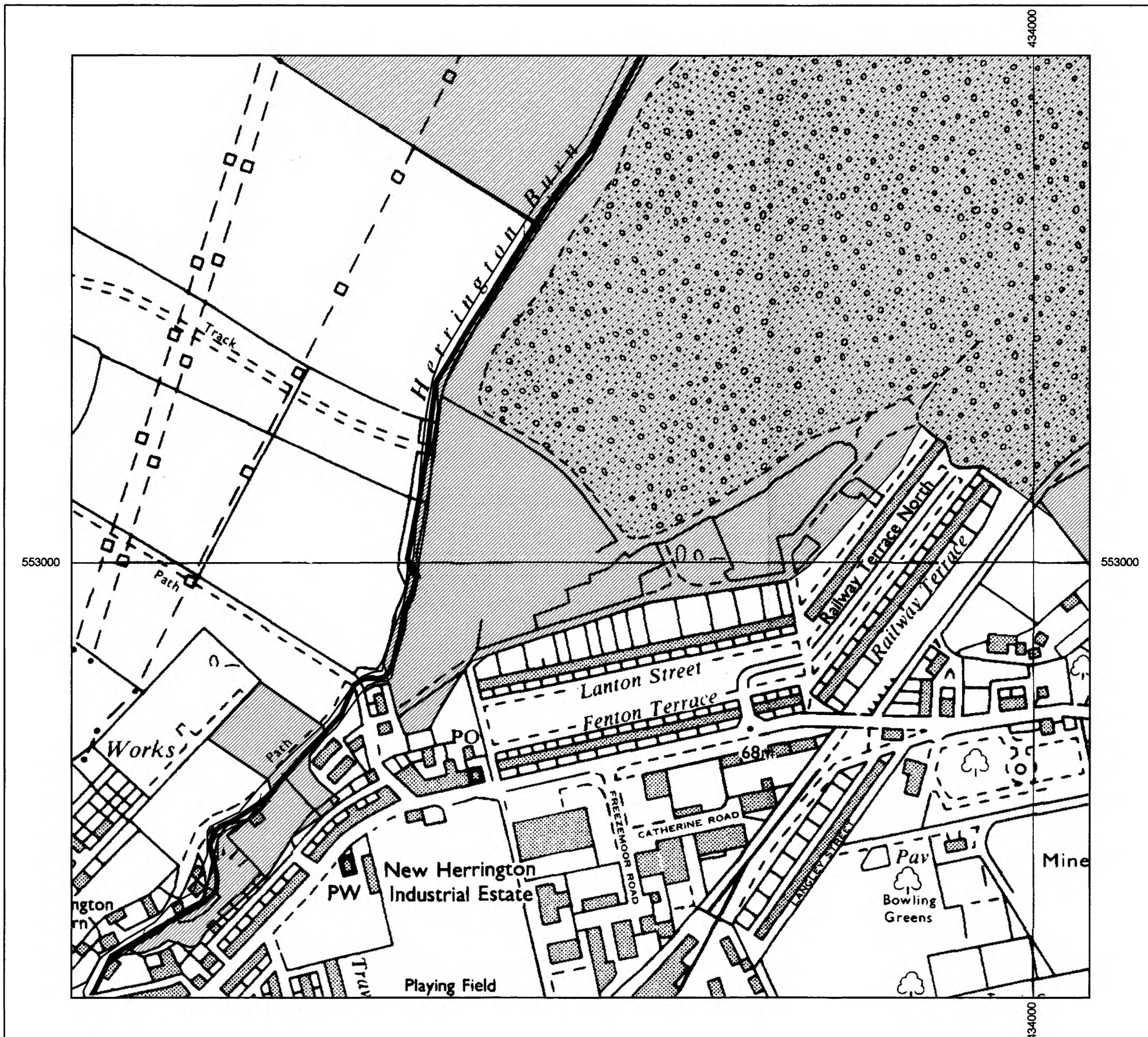

KEY:

- Development Site
- Main river, hydraulic model node and cross section (154)
- Non-main river, hydraulic model node and cross section (154)
- Culvert / Tunnel main river
- Culvert / Tunnel non-main river
- Weir
- Indicative 100 year flood event
- Indicative 50 year flood event
- Indicative 20 year flood event
- Indicative 10 year flood event
- Indicative 5 year flood event

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION

PROJECT TITLE

SECTION 105 - C30/92 SURVEYS
IDENTIFICATION OF DEVELOPMENT AT RISK FROM FLOODING

DRAWING TITLE

NORTHUMBRIA AREA
LUMLEY PARK BURN
(SHEET 7 OF 10)

USER NOTE

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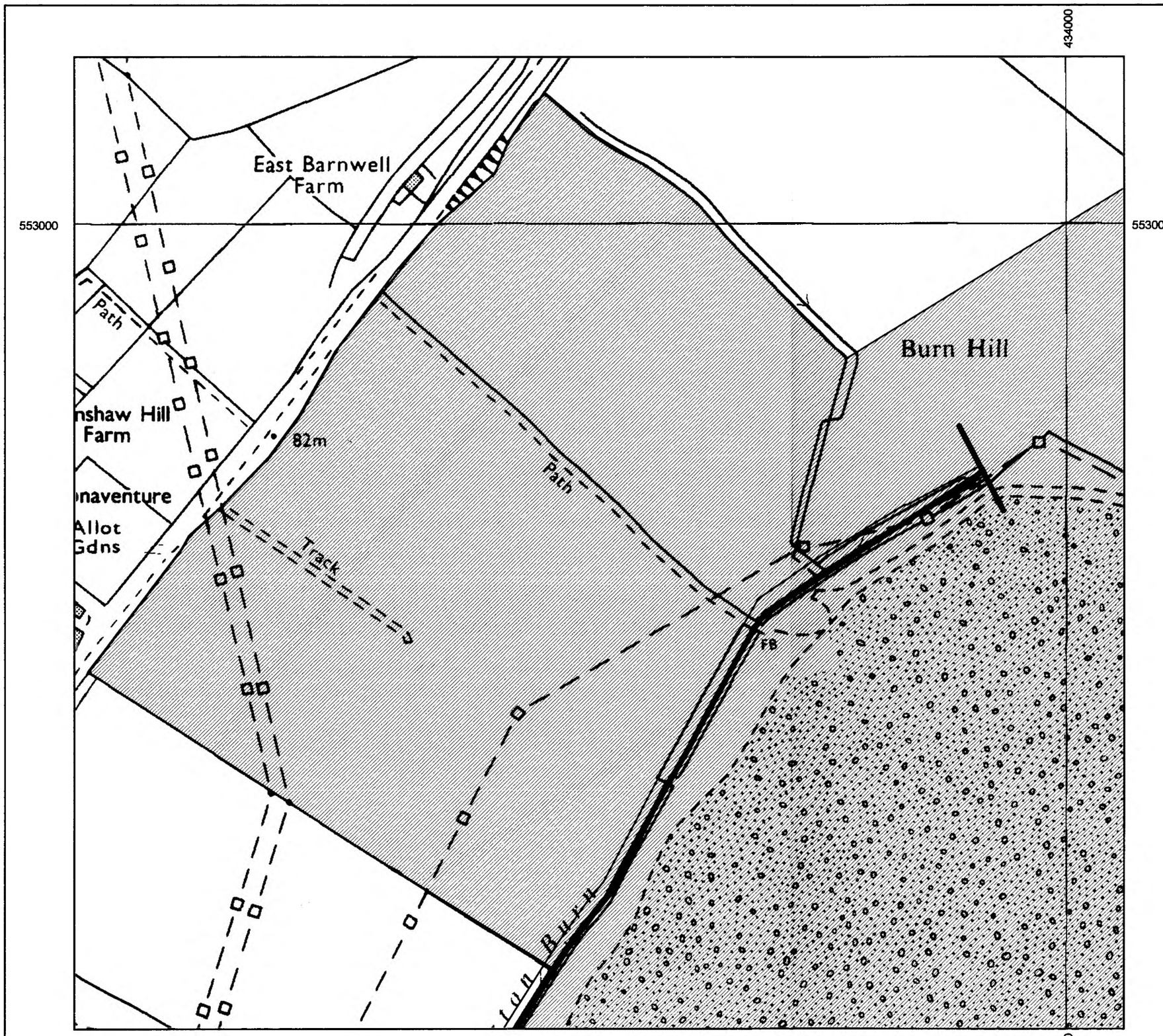
ORIGINATED BY	DRAWN BY	CHECKED BY	APPROVED BY
RPT	TMR	TJB	
DATE	DATE	DATE	DATE

SCALE: 1 : 2,500

PROJECT NO. / DRAWING NO. / REV: C1395/DM/01/036

POSFORD DUVIVIER

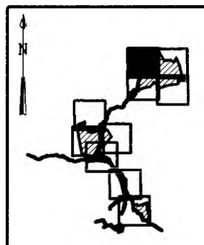


KEY:

- Development Site
- Main river, hydraulic model node and cross section (154)
- Non-main river, hydraulic model node and cross section (154)
- Culvert / Tunnel main river
- Culvert / Tunnel non-main river
- Weir
- Indicative 100 year flood event
- Indicative 50 year flood event
- Indicative 20 year flood event
- Indicative 10 year flood event
- Indicative 5 year flood event

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION



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PROJECT TITLE

SECTION 105 - C30/92 SURVEYS IDENTIFICATION OF DEVELOPMENT AT RISK FROM FLOODING

DRAWING TITLE

NORTHUMBRIA AREA LUMLEY PARK BURN (SHEET 8 OF 10)

DRAWN / RED BY	DESIGNED BY	CHECKED BY	APPROVED BY
BPT	TH-R	TJS	
DATE	DATE	DATE	DATE

SCALE: 1 : 2,500

PROJECT NO. / DRAWING NO. / REV: C1395/DM/01/037

POSFORD DUVIVIER

10/10/1997

434000

554000

554000

434000

The Bottoms

Foxcover Bank Plantation

Drain

Path

Drain

Track

Office Row

KEY:

Development Site

Main river, hydraulic model node and cross section 154

Non-main river, hydraulic model node and cross section 154

Culvert / Tunnel main river

Culvert / Tunnel non-main river

Weir

Indicative 100 year flood event

Indicative 50 year flood event

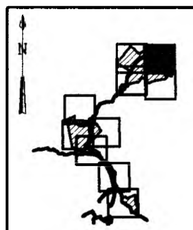
Indicative 20 year flood event

Indicative 10 year flood event

Indicative 5 year flood event

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION



USER NOTE

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PROJECT TITLE

SECTION 105 - C30/92 SURVEYS IDENTIFICATION OF DEVELOPMENT AT RISK FROM FLOODING

DRAWING TITLE

NORTHUMBRIA AREA LUMLEY PARK BURN (SHEET 9 OF 10)

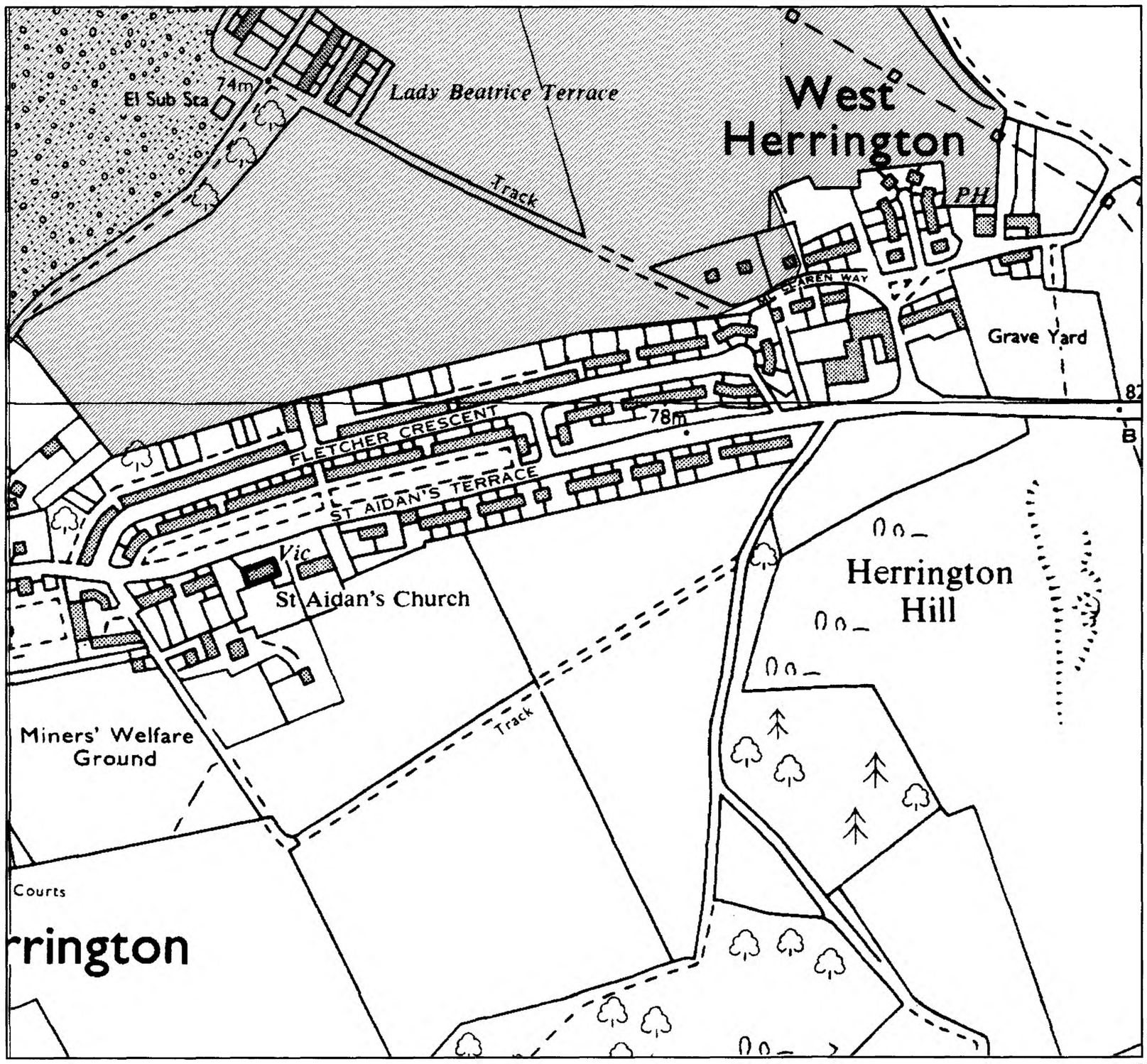
ORIGINATED BY	DRAWN BY	CHECKED BY	APPROVED BY
BPT	TH-R	TJB	
DATE	DATE	DATE	DATE

SCALE: 1 : 2,500

PROJECT NO. / DRAWING NO. / REV: C1395/DM/01/038

POSFORD DUVIVIER

10/10/1997

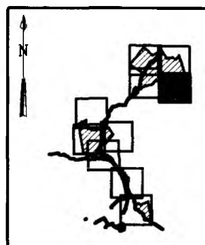


KEY:

- Development Site
- Main river, hydraulic model node and cross section (154)
- Non-main river, hydraulic model node and cross section (154)
- Culvert / Tunnel main river
- Culvert / Tunnel non-main river
- Weir
- Indicative 100 year flood event
- Indicative 50 year flood event
- Indicative 20 year flood event
- Indicative 10 year flood event
- Indicative 5 year flood event

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION



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USER NOTE

This plan has been produced with the requirements of Department of the Environment Circular 30/92. Because the information is indicative rather than specific, local planning authorities will nevertheless need to consult the Environment Agency on individual applications. Flood plain extent is based on data available at the time of survey. Amendments will be required in future to account for information gathered subsequently eg. changes in hydrological river response or observations following flood events.

It should be noted that locations adjacent to rivers not included in this stage of the survey may be at risk of flooding. When in doubt the Environment Agency should be consulted.

PROJECT TITLE

SECTION 105 - C30/92 SURVEYS IDENTIFICATION OF DEVELOPMENT AT RISK FROM FLOODING

DRAWING TITLE

NORTHUMBRIA AREA LUMLEY PARK BURN (SHEET 10 OF 10)

ORIGINATED BY	DRAWN BY	CHECKED BY	APPROVED BY
SPT	TH-R	TJS	
DATE	DATE	DATE	DATE

SCALE: 1 : 2,500

PROJECT NO. / DRAWING NO. / REV: C1395/DM/01/039

POSFORD DUVIVIER

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