ENVIRONMENT AGENCY
NORTH EAST REGION

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

TIPALT BURN AND PAINSDALE BURN

JUNE 1998

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THE ENVIRONMENT AGENCY, NORTH EAST REGION, RIDINGS AREA
SECTION 105, CIRCULAR 30/92 FLOOD PLAIN MAPS
SUMMARY
TIPALT BURN AND PAINSDALE BURN

June 1998

This summary is to be read in conjunction with the maps reference:

- C1395/FPM/01/040
- C1395/FPM/01/041

Study Reach

The study includes a 5.7km reach of the Tipalt Burn between the River South Tyne at NGR NY698 632 and Holmhead at NGR NY659 661 and a 2.7km reach of Painsdale Burn between Tipalt Burn at NGR NY698 633 and the B6318 at NGR NY675 654.

Existing and Predicted Problems

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

• Upstream of Glenwhelt Bridge	Properties and farmland
• Downstream of Glenwhelt Bridge	B6318 and properties
• Tipalt Burn and Painsdale Burn confluence	Farmland
• Upstream of A69 culvert	Woodland

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 Surveys

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

This report examines the reaches of Tipalt Burn between the River South Tyne near Haltwhistle and Holm Head and the Painsdale Burn between the confluence with Tipalt Burn and the B6318, 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 5.71km reach of Tipalt Burn and a 2.69km reach of Painsdale Burn.

Tipalt Burn was hydraulically modelled between Holmhead at NGR NY 659661 and its intersection with the River South Tyne at NGR NY 698632. Painsdale Burn was modelled from south of the B6318 at NGR 675654 and the confluence with the Tipalt Burn at NGR 698 633, as identified in the Brief.

The catchment associated with Tipalt Burn has a total area of 52.0km². The catchment area was derived from 1:25000 scale OS plans using the contours which are shown every 5m. The catchment is principally drained by Tipalt Burn. Painsdale Burn drains the eastern part of the lower catchment and flows into Tipalt Burn, its associated catchment has a total area of 2.5km². The 5.71km reach of Tipalt Burn has an average bed slope of 1 in 307, where as the 2.69km reach of Painsdale Burn has an average bed slope of 1 in 36.

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/01/040
- C1395/FPM/01/041

and 1:2500 scale map:

- C1395/DM/01/040

2.0 DATA COLLECTION

2.1 Environment Agency Offices

Visits were made to the Newcastle office of the Agency in 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.

No flow or survey data was available however, a copy of the FD100 report for Tipalt Burn was obtained. This document identified that historically there has been flooding around the original route of the A69 at Greenhead and Glenwhelt Bridge. In 1967/68 the original route of the A69 was impassable at Greenhead and more recently in 1979 flooding occurred downstream of Glenwhelt bridge. There is an unconfirmed recording of a flood level in 1979 on the original route of the A69 of 129.0m (AOD). Although none of the historical data has been verified, the report and visit to the Agency offices provided an opportunity to clarify the location of the area's that are likely to suffer the worst flooding.

2.2 Site Visits

During site visits to the 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 order to build the required hydraulic model.

2.3 Topographical Surveys

In order to construct the required hydraulic model a topographical survey of suitable cross sections was undertaken by James Banks Surveys during December 1996. Survey was undertaken at a total of eighteen locations. Nine of these locations were at bridges. At two of the bridges additional cross-sections were surveyed. One was taken just downstream of the structure, one just upstream and the third was taken of the upstream face of the bridge. At the other sixteen locations a cross-section of the channel and banks was surveyed. 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 sections 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 Tipalt or Painsdale Burn. 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 also meant that the modelling work could not be calibrated and this consequently has a significant impact on the confidence of 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 was considered for use during the section 105 surveys but has been rejected because of the significantly different flows predicted compared to Flood Studies results. The Agency's brief approved use of the Flood Studies Report method of estimation.

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 the 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 seven locations as shown in Table 3.1 and Figure 1.1.

Table 3.1 - Location of Flow Estimates

Location	NGR/Description	Reach
1	368000E/564800N/Painsdale Cottage	Painsdale Burn
2	368800E/564300N/Footbridge near Birchfield Gate	Painsdale Burn
3	369200E/563300N/Confluence Tipalt/Painsdale	Painsdale Burn
4	365800E/565900N/Footbridge downstream of Confluence of Charney Burn/Tipalt Burn	Tipalt Burn
5	367200E/564300N/Upstream of Confluence of Small Burn and Tipalt Burn	Tipalt Burn
6	368700E/563700N/ The Spittal	Tipalt Burn
7	369800E/563200N/confluence of Tipalt Burn and River South Tyne	Tipalt Burn

These locations which are spread along the study reaches are generally at the confluence of Tipalt Burn or Painsdale Burn and one of their tributaries. The flows have been estimated immediately upstream of the confluence. This has been done so that the predicted flow could then be included within the model in the reach upstream 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
Area	1.63km²	2.30km²	2.50km²	38.39km²	47.16km²	42.94km²	52.02km²
Urban Fraction	0	0	0	0	0	0	0
Main Stream Length (MSL)	1.6km	2.6km	3.7km	17.91km	22.07km	20.1km	23.39km
Stream Slope (S1085)	7.5m/km	27.2m/km	25.2m/km	7.37m/km	7.49m/km	7.69m/km	7.24m/km
Soil Index	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Annual Rainfall (SAAR)	980mm	970mm	960mm	1100mm	1050mm	1100mm	1050mm
M5-2 Day Rainfall	56mm	56mm	56mm	60mm	59mm	59mm	59mm
Ratio M5-60min Rainfall/M5-2 Day Rainfall	30%	31%	31%	28%	29%	28%	29%
Effective mean SMD	5mm	5mm	5mm	5mm	5mm	5mm	5mm

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	-	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 (FSSR16) were used.

Institute of Hydrology report no 124, flood estimation for small catchments, is applicable to catchments with an area less than 25km^2. As the area contributing at the upstream end of the study reach is approximately 32km^2 this alternative method has not been used here.

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 15 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)
5 year	1.33	2.3	2.33	23.56	25.66	27.40	29.69
10 year	1.62	2.77	2.80	28.15	30.70	32.75	35.49
20 year	1.90	3.26	3.31	32.63	35.60	37.97	41.14
50 year	2.31	3.98	4.02	39.05	42.63	45.45	49.23
100 year	2.63	4.54	4.60	44.12	48.18	51.36	55.63

The flows predicted by Micro-FSR (Table 3.3) were used as the basis of the flows entered into the river model.

The flow in Tipalt Burn upstream of the confluence with Charney Burn was calculated by subtracting the flow estimated in Charney Burn from the flow predicted at location 4. This flow was used in the model to estimate the water levels in this reach. The flow predicted at location 4 was used in the model immediately downstream of this point and was gradually increased further down the reach until the flow was equal to the flow predicted at location 5. A similar gradual increase in flow was used in the model between location 5 and 6. Downstream of location 6 the flow estimated at the downstream limit of the model was used to predict the water levels.

Each flow estimated for the Painsdale Burn was used in the reach immediately upstream of the location where the estimate was made. This ensures that the flood is not under predicted at any point.

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 Tipalt Burn is at the confluence with the River south Tyne. Chainage 0m on Painsdale Burn is at the confluence with Tipalt Burn. All other chainages were measured in an upstream direction from these points.

Surveyed cross-section 1 (ch 210m on Tipalt Burn) was copied with a decreased elevation to ch 0m. The bed gradient was estimated by considering the gradient between section 1 and 2, (ch 210 and ch 875). The nine 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. 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 an extremely extensive survey this interpolation method is the most suitable way forward to produce results of an accuracy appropriate to the available data for all parameters.

The junction between Painsdale Burn and Tipalt Burn was constructed using the junction facility within HECRAS and by adding cross-section derived by interpolating from the adjacent surveyed sections.

It was necessary to extend the widths of some 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 utilized 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 on the reaches being investigated here. The model was initially run with a lower value but it was found that the predicted flooding did not match historical records. One of the calibration methods available in this case, although quite crude, is endeavour to match known flooding by changing some of the model coefficients.

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 nine 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 nine bridges. This is the suggested value for weir flow over bridges.

There are several choices available when selecting methods for computing surface water profiles through a bridge. Low flows (water surface below underside of deck) through the bridges were computed using the Energy Equations and Momentum Balance Method and the technique that computed the greatest energy loss through the bridge used. High flows were calculated using the pressure flow computation at all nine 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 areas of significant flooding. Out of bank flow occurs in other locations on the Tipalt Burn. The extent of this other flooding typically covers a 20m to 40m wide strip of farmland along the line of the river from 300m upstream to 500m downstream of the College Farm and from just downstream of The Lodge to just upstream of The Spittal.

The first area of significant flooding occurs at Greenhead in the vicinity of Glenwhelt Bridge. Upstream of Glenwhelt Bridge relatively low banks cause out of bank flow. The frequency of flooding to the properties downstream of Glenwhelt Bridge, Greenhead, has been estimated to be 1 in 5 years. The lowest level of the right bank is 127.53m AOD, which is opposite the school. At this location, chainage 4898m, the five year water level is 127.56m AOD. This indicates the levels predicted by the model for low flows in this reach are close to those experienced historically. The limited channel capacity downstream of Glenwhelt Bridge and the access bridge to the Vicarage, causes flooding in the vicinity of the school and Vicarage.

The road on the course of the original B6318 is also flooded.

The second area of significant flooding is at the confluence of Tipalt Burn and Painsdale Burn where out of bank flow occurs on both sides of the watercourses. The banks are overtopped by an average 500mm over a length of approximately 1200m on Tipalt Burn and approximately 250m on Painsdale Burn. No residential or industrial properties are directly affected by this flooding. It would therefore be inappropriate to investigate any works at this location.

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 catchments predicted water levels. Site details included in the Agency's brief had been supplied by the Local Planning Authority (LPA). There are proposals to develop a site of some 0.21km² on the eastern edge of Painsdale Burn catchment. This site is not within the flood plain for a 100 year event. All of the run off from this site could enter the Painsdale catchment upstream of location 3. This was considered to be the worst case. A comparison of the Urban Fraction at the locations shown in figure 1.1 are shown in Table 5.1.

Table 5.1

Comparison of Urban Fractions

Location	1	2	3	4	5	6	7
Existing Urban Fraction	0%	0%	0%	0%	0%	0%	0%
Urban Fraction Including Development	0%	0%	8%	0%	0%	0%	0.4%

Micro-FSR allows the Urban Fraction to be input to the nearest whole percent. The increase in urban fraction at location 7 on the Tipalt Burn has therefore been ignored. The model was re-run with the greater urban fraction upstream of location 3 to predict the flows following development.

5.2 Affects 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

Location	Return Period	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	1.33	1.62	1.90	2.31	2.63
	Developed	1.33	1.62	1.90	2.31	2.63
2	Existing	2.3	2.77	3.26	3.98	4.54
	Developed	2.3	2.77	3.26	3.98	4.54
3	Existing	2.33	2.86	3.31	4.02	4.60
	Developed	2.60	3.10	3.68	4.49	5.14
4	Existing	17.79	21.25	24.46	29.08	32.72
	Developed	17.79	21.25	24.46	29.08	32.72
5	Existing	25.66	30.70	35.60	42.63	48.18
	Developed	25.66	30.70	35.60	42.63	48.18
6	Existing	27.4	32.75	37.97	45.45	51.36
	Developed	27.4	32.75	37.97	45.45	51.36
7	Existing	29.69	35.49	41.14	49.23	55.63
	Developed	29.96	35.79	41.51	49.70	56.17

The proposed development causes only small increases in flows. The peak flows at the downstream end of the Painsdale catchment increase by approximately 1%.

Using the HEC RAS model a comparison can be made between the water levels predicted for the existing and proposed catchment (Table 5.3). The flows during the 100 year event have been used to predict the water levels at the confluence with the River South Tyne, the Spittal Bridge, the Lodge Bridge and Glenwhelt Bridge on Tipalt Burn and at the confluence with Tipalt Burn and Birchfield Gate footbridge on Painsdale Burn. A schematic drawing included in Appendix B shows the relative positions of the locations shown in Table 5.3.

Table 5.3

Comparisons of Water Levels

Reach	Location	River Station Chainage (m)	Predicted 100 yr Water Level for the Existing Catchment (mAOD)	Predicted 100 yr Water Level for the Catchment with the Proposed Development (mAOD)
Tipalt	Confluence with River South Tyne	0	113.65	113.66
Tipalt	The Spittal Bridge	1430	117.14	117.14
Tipalt	The Lodge Bridge	2620	120.18	120.18
Tipalt	Glenwhelt Bridge	5118	129.26	129.26
Painsdale	Confluence with Tipalt Burn	1	115.50	115.53
Painsdale	Birchfield Gate footbridge	1270	137.35	137.36

5.3 Mitigation Works

To alleviate the problem of flooding upstream of Glenwhelt bridge on Tipalt Burn a number of options are available:

- Remove bridge
- Rebuild bridge with span sufficient to mitigate existing construction
- Make channel improvements
- Create washlands upstream of the bridge as storage areas
- Construction of flood banks

A broad brush consideration of these options would indicate that construction of flood banks appears to be the most cost effective option. This form of defence would be appropriate on the left bank, but its use on the right bank would be dependent on the available space. A flood wall may be more suitable if the properties between the railway and B6318 are close to the river bank. Downstream of Glenwhelt Bridge the capacity of the channel could be improved by removing debris and the cutting back of vegetation. In addition to this it is likely that a flood wall on both banks would be necessary.

The height and length of the flood walls and banks would be dependent on the standard to which the area would be protected (MAFF PAGN). For an event with a 100 year return period the model predicts water levels that are typically 900mm (400m length) and 700mm (150m length) above the left and right banks respectively upstream of Glenwhelt Bridge and 400mm (150m length) and 700mm (60m length) above the left and right banks respectively downstream of Glenwhelt Bridge. Assuming that a floodbank is constructed on the left bank upstream of Glenwhelt Bridge and all other flood barriers are walls, the estimated cost of the work (using recent similar examples) is in the order of £250,000.

The properties and land at risk includes a chapel and 4 houses upstream of Glenwhelt bridge and a school and highway downstream of the bridge. The likely benefits accruing to this flood relief scheme are in the order of £150,000 at a 100 year event.

Under MAFF PAGN the scheme would have a cost benefit ratio approaching unity and would therefore need further detailed investigation to proceed. A detailed assessment of benefits would be required.

5.4 Flood Warning Recommendations

The existing flood warning scheme does not include the properties at risk in the vicinity of Glenwhelt Bridge. For the scheme to be comprehensive the threshold levels of the properties in the flood plain are required so that the levels of alert can be determined. A detailed survey is therefore recommended of the existing defence levels and the properties in this area.

Establishing a gauging station would be beneficial as it would provide an accurate recording of water levels during an event. This could be used to trigger the flood warning scheme. A suitable location for the gauging station would be at The Lodge Bridge. There is no flooding at this location, it is away from tributaries and it is upstream of the Painsdale Burn confluence.

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. 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.

The associated development plan which identifies the development at risk from flooding shows 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

Location	Areas at Risk from Flooding	Existing Standard
Upstream of Glenwhelt Bridge, Greenhead	Flooding to farmland and low lying properties	<5 years
Downstream of Glenwhelt Bridge, Greenhead	Flooding to B6318 and low lying woodland/gardens	5 years
Confluence of Tipalt Burn and Painsdale Burn	Flooding to farmland	<5 years
Upstream of the A69 culvert on Painsdale Burn	Flooding to woodland	20 years

Upstream of Glenwhelt Bridge in Greenhead there are 4 houses and a Chapel within the flood risk area. The properties are immediately upstream of the bridge on the right bank.

Downstream of Glenwhelt Bridge the majority of properties at risk are on the right bank accessible from the road which was the A69. Immediately downstream of the bridge are two bungalows. Further downstream are St Cuthberts Church, a primary school, the school house and a Womens Institute building. On the left bank in the same location is a vicarage

6.2 Conclusion

The predictions made for the 100 year water level have a low level of confidence although identified flooded areas accord with locations where flooding has been reported to occur. 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 a slight increase in 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.

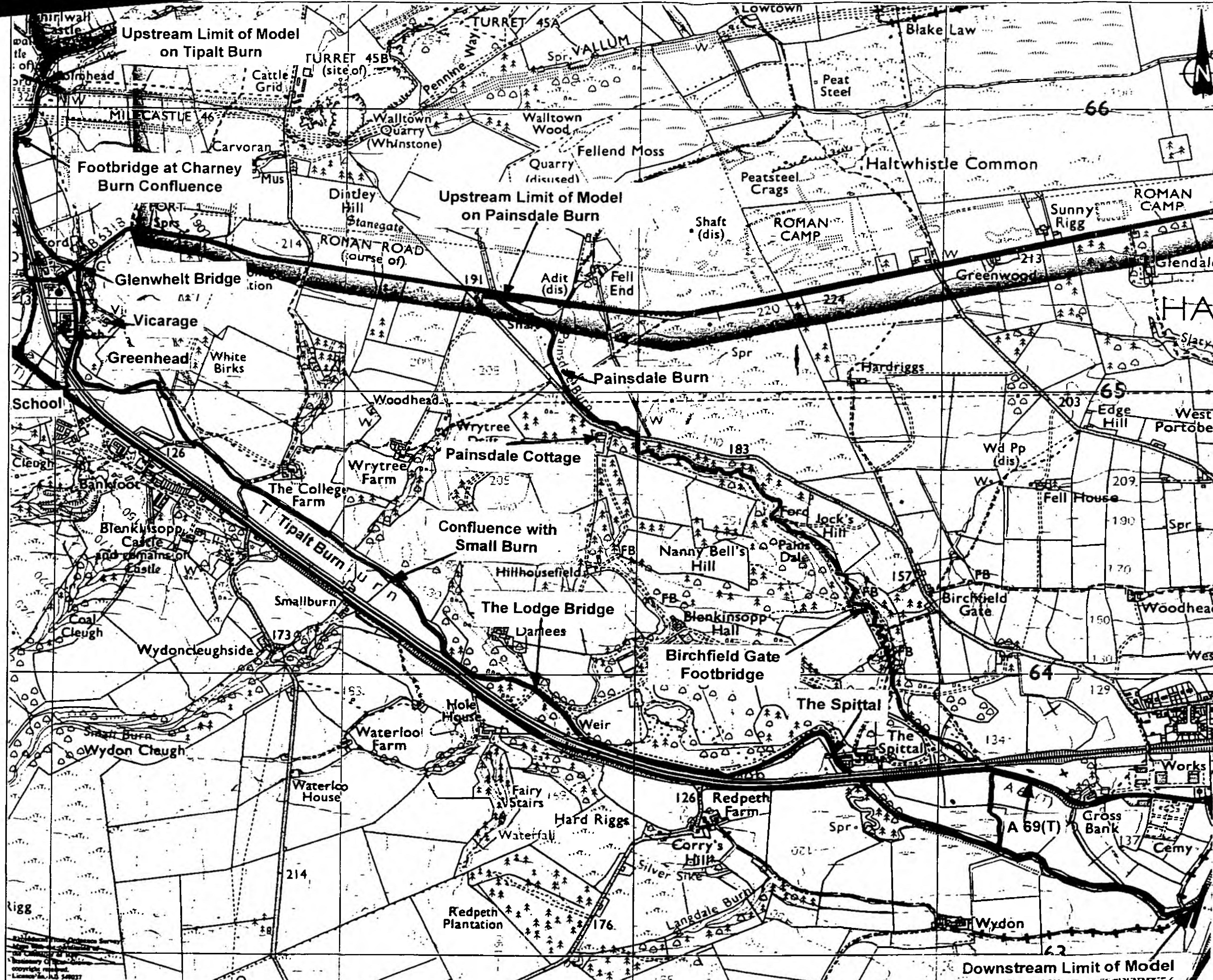
- Survey bank levels in areas where flooding occurs so the extent of the out of bank flow can be estimated.

- 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 3.0 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 limited benefit. Although it would give an indication to the impact that a particular 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

Tipalt and Painsdale Burn

LOCATION PLAN

Date: 23/03/98	Scale: 1 : 12.500
Drawn MDWP	Chkd. TE
Drg. No.	Figure 1.1

APPENDIX A
PHOTOGRAPHS

Photograph 1: Tipalt Burn - Downstream face of A69 road bridge (chainage 1299m)

Photograph 2: Tipalt Burn - Downstream face of railway bridge (chainage 1334m)

Photograph 3: Tipalt Burn - Looking downstream from The College Farm access bridge (chainage 3928m)

Photograph 4: Tipalt Burn - Upstream face of The College Farm access bridge (chainage 3930m)

Photograph 5: Tipalt Burn - Upstream face of Glenwhelt Bridge (chainage 5124m)

Photograph 6: Tipalt Burn - Looking upstream from Glenwhelt Bridge (chainage 5120m)

Photograph 7: Painsdale Burn - Looking upstream at A69 culvert exit (chainage 347m)

Photograph 8: Painsdale Burn - Looking upstream from Park Road (chainage 2397m)

APPENDIX B
MODEL OUTPUT

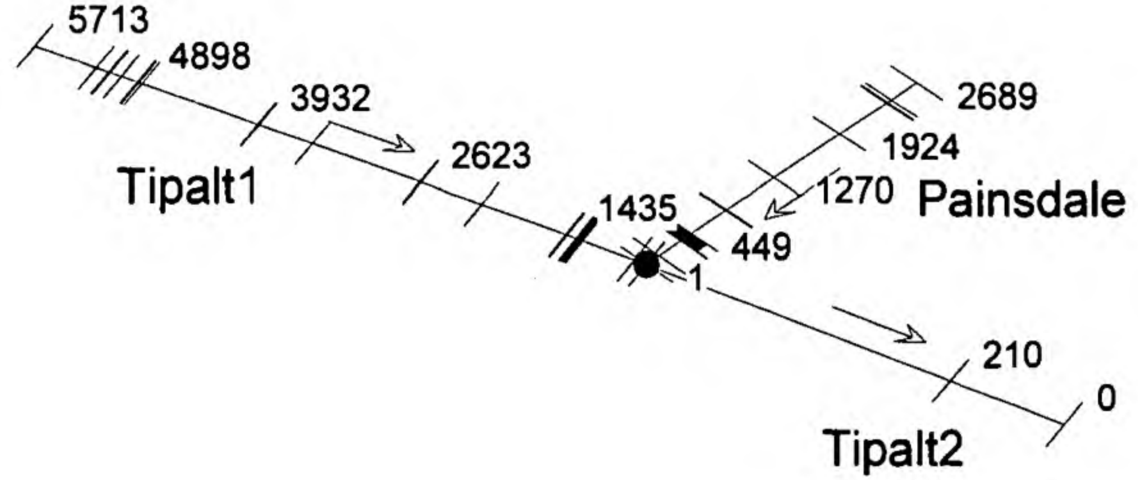
APPENDIX B

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 includes 10 significant structures, 9 bridges and 1 culvert. The schematic drawing included shows the relative positions of the 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	Tipa. G01
100 year Flow for Existing Catchment	Tipa. F01
100,50,20,10,5 year flows for catchment with proposed development.	Tipa. F02


5713
4898
3932
2623
Tipalt1
1435
1
2689
1924
1270
Painsdale
449
210
0
Tipalt2

HEC-RAS Plan: DEVELOPED 9/10/97

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Painsdale	2689	2.63	188.32	4.21	1.17
Painsdale	2689	2.31	188.25	3.50	1.18
Painsdale	2689	1.90	188.17	3.21	1.12
Painsdale	2689	1.62	188.11	2.98	1.08
Painsdale	2689	1.33	188.03	2.70	1.03
Painsdale	2436	2.63	183.82	3.58	1.93
Painsdale	2436	2.31	183.78	3.42	1.88
Painsdale	2436	1.90	183.73	3.18	1.81
Painsdale	2436	1.62	183.69	3.01	1.75
Painsdale	2436	1.33	183.64	2.82	1.67
Painsdale	2399	2.63	179.51	3.58	4.32
Painsdale	2399	2.31	179.50	3.53	4.12
Painsdale	2399	1.90	179.48	3.47	3.79
Painsdale	2399	1.62	179.46	3.41	3.62
Painsdale	2399	1.33	179.45	3.36	3.33
Painsdale	2397	2.63	179.77	8.02	1.24
Painsdale	2397	2.31	179.72	6.93	1.19
Painsdale	2397	1.90	179.65	5.49	1.11
Painsdale	2397	1.62	179.59	4.72	1.05
Painsdale	2397	1.33	179.54	4.50	0.98
Painsdale	2396	2.63	179.77		
Painsdale	2396	2.31	179.72		
Painsdale	2396	1.90	179.65		
Painsdale	2396	1.62	179.59		
Painsdale	2396	1.33	179.54		
Painsdale	2394	2.63	179.14	4.27	2.25
Painsdale	2394	2.31	179.12	4.18	2.12
Painsdale	2394	1.90	179.09	4.06	1.92
Painsdale	2394	1.62	179.07	3.99	1.75
Painsdale	2394	1.33	179.04	3.87	1.61
Painsdale	2389	2.63	178.48	3.85	2.99
Painsdale	2389	2.31	178.46	3.78	2.88
Painsdale	2389	1.90	178.43	3.67	2.72
Painsdale	2389	1.62	178.41	3.58	2.66
Painsdale	2389	1.33	178.39	3.50	2.53
Painsdale	1924	4.54	163.76	4.34	2.17
Painsdale	1924	3.98	163.72	4.21	2.10
Painsdale	1924	3.26	163.66	4.04	1.99
Painsdale	1924	2.77	163.61	3.91	1.91

HEC-RAS Plan: DEVELOPED 9/10/97 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Painsdale	1924	2.30	163.56	3.78	1.81
Painsdale	1270	4.54	137.36	10.65	1.70
Painsdale	1270	3.98	137.33	10.20	1.63
Painsdale	1270	3.26	137.30	9.30	1.55
Painsdale	1270	2.77	137.26	7.81	1.54
Painsdale	1270	2.30	137.21	5.91	1.58
Painsdale	798	4.54	124.07	3.55	1.43
Painsdale	798	3.98	123.96	3.39	1.43
Painsdale	798	3.26	123.80	3.19	1.43
Painsdale	798	2.77	123.70	3.05	1.42
Painsdale	798	2.30	123.69	3.05	1.19
Painsdale	796	4.54	123.94	3.43	2.01
Painsdale	796	3.98	123.84	3.29	1.96
Painsdale	796	3.26	123.70	3.10	1.88
Painsdale	796	2.77	123.60	2.97	1.82
Painsdale	796	2.30	123.64	3.03	1.42
Painsdale	794	4.54	123.94		
Painsdale	794	3.98	123.84		
Painsdale	794	3.26	123.70		
Painsdale	794	2.77	123.60		
Painsdale	794	2.30	123.64		
Painsdale	793	5.14	123.45	2.85	3.44
Painsdale	793	4.49	123.41	2.79	3.24
Painsdale	793	3.68	123.53	2.95	2.48
Painsdale	793	3.10	123.48	2.88	2.27
Painsdale	793	2.60	123.43	2.81	2.07
Painsdale	788	5.14	123.54	3.08	2.54
Painsdale	788	4.49	123.48	3.00	2.45
Painsdale	788	3.68	123.39	2.89	2.33
Painsdale	788	3.10	123.33	2.80	2.22
Painsdale	788	2.60	123.27	2.72	2.11
Painsdale	449	5.14	118.36	33.11	0.21
Painsdale	449	4.49	118.13	33.11	0.25
Painsdale	449	3.68	117.87	33.11	0.33
Painsdale	449	3.10	117.72	9.72	0.37
Painsdale	449	2.60	117.58	9.50	0.37
Painsdale	447	5.14	118.21	33.11	1.63
Painsdale	447	4.49	117.97	33.11	1.68

HEC-RAS Plan: DEVELOPED 9/10/97 (continued)

Reach	River Sta.	Q Total	W.S. Elev.	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Painsdale	447	3.68	117.71	9.70	1.72
Painsdale	447	3.10	117.57	9.47	1.67
Painsdale	447	2.60	117.44	9.26	1.62
Painsdale	440	5.14			
Painsdale	440	4.49			
Painsdale	440	3.68			
Painsdale	440	3.10			
Painsdale	440	2.60			
Painsdale	347	5.14	116.98	7.54	2.94
Painsdale	347	4.49	116.91	7.36	2.80
Painsdale	347	3.68	116.81	7.10	2.63
Painsdale	347	3.10	116.73	6.89	2.49
Painsdale	347	2.60	116.66	6.72	2.34
Painsdale	342	5.14	116.62	6.60	2.06
Painsdale	342	4.49	116.58	6.51	1.97
Painsdale	342	3.68	116.53	6.39	1.83
Painsdale	342	3.10	116.49	6.28	1.76
Painsdale	342	2.60	116.45	5.95	1.69
Painsdale	126	5.14	115.53	105.10	0.08
Painsdale	126	4.49	115.45	104.55	0.07
Painsdale	126	3.68	115.35	98.61	0.07
Painsdale	126	3.10	115.37	102.63	0.06
Painsdale	126	2.60	115.34	96.37	0.05
Painsdale	1	5.14	115.53	174.35	0.02
Painsdale	1	4.49	115.45	171.53	0.02
Painsdale	1	3.68	115.35	168.04	0.02
Painsdale	1	3.10	115.37	168.56	0.02
Painsdale	1	2.60	115.34	167.75	0.01
Tipalt1	5713	32.72	130.71	7.78	6.46
Tipalt1	5713	29.08	130.66	7.63	6.21
Tipalt1	5713	24.46	130.59	7.41	5.87
Tipalt1	5713	21.60	130.55	7.27	5.64
Tipalt1	5713	17.79	130.48	7.07	5.29
Tipalt1	5224	44.12	129.47	127.46	0.63
Tipalt1	5224	39.05	129.36	118.07	0.64
Tipalt1	5224	32.63	129.21	105.52	0.64
Tipalt1	5224	28.15	129.10	96.24	0.64
Tipalt1	5224	23.56	128.97	85.58	0.64

HEC-RAS Plan: DEVELOPED 9/10/97 (continued)

Reach	River Sta	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Tipalt1	5126	44.12	129.33	24.24	1.15
Tipalt1	5126	39.05	129.22	24.20	1.09
Tipalt1	5126	32.63	129.07	23.91	1.01
Tipalt1	5126	28.15	128.97	23.60	0.95
Tipalt1	5126	23.56	128.84	23.11	0.88
Tipalt1	5124	44.12	129.33	24.24	1.16
Tipalt1	5124	39.05	129.22	24.20	1.10
Tipalt1	5124	32.63	129.07	23.90	1.02
Tipalt1	5124	28.15	128.96	23.59	0.95
Tipalt1	5124	23.56	128.84	23.10	0.88
Tipalt1	5120	44.12	129.33		
Tipalt1	5120	39.05	129.22		
Tipalt1	5120	32.63	129.07		
Tipalt1	5120	28.15	128.96		
Tipalt1	5120	23.56	128.84		
Tipalt1	5118	45.47	129.26	24.22	1.24
Tipalt1	5118	40.24	129.16	24.16	1.18
Tipalt1	5118	33.62	129.02	23.76	1.08
Tipalt1	5118	29.00	128.92	23.46	1.01
Tipalt1	5118	24.26	128.80	22.86	0.94
Tipalt1	5113	45.47	129.25	24.21	1.24
Tipalt1	5113	40.24	129.15	24.13	1.18
Tipalt1	5113	33.62	129.01	23.73	1.09
Tipalt1	5113	29.00	128.91	23.43	1.02
Tipalt1	5113	24.26	128.79	22.81	0.95
Tipalt1	5024	45.47	128.67	18.86	2.19
Tipalt1	5024	40.24	128.59	18.68	2.09
Tipalt1	5024	33.62	128.51	18.49	1.89
Tipalt1	5024	29.00	128.47	18.37	1.71
Tipalt1	5024	24.26	128.38	18.16	1.59
Tipalt1	4898	45.47	128.35	46.75	1.11
Tipalt1	4898	40.24	128.19	45.18	1.14
Tipalt1	4898	33.62	127.94	37.06	1.23
Tipalt1	4898	29.00	127.74	30.60	1.30
Tipalt1	4898	24.26	127.56	19.33	1.35
Tipalt1	4895	45.47	128.36	78.71	1.05
Tipalt1	4895	40.24	128.20	73.60	1.13
Tipalt1	4895	33.62	127.85	10.12	1.69

HEC-RAS Plan: DEVELOPED 9/10/97 (continued)

Reach	River Sta	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Tipalt1	4895	29.00	127.69	9.54	1.58
Tipalt1	4895	24.26	127.53	9.50	1.43
Tipalt1	4893	45.47	128.17	61.58	2.02
Tipalt1	4893	40.24	128.05	55.46	1.88
Tipalt1	4893	33.62	127.83	9.99	1.73
Tipalt1	4893	29.00	127.67	9.54	1.62
Tipalt1	4893	24.26	127.52	9.50	1.46
Tipalt1	4891	45.47	128.17		
Tipalt1	4891	40.24	128.05		
Tipalt1	4891	33.62	127.83		
Tipalt1	4891	29.00	127.67		
Tipalt1	4891	24.26	127.52		
Tipalt1	4889	47.17	127.89	10.50	2.37
Tipalt1	4889	41.74	127.84	10.10	2.14
Tipalt1	4889	34.86	127.77	9.67	1.85
Tipalt1	4889	30.06	127.65	9.53	1.69
Tipalt1	4889	25.14	127.51	9.49	1.53
Tipalt1	4884	47.17	127.85	10.18	2.36
Tipalt1	4884	41.74	127.82	9.90	2.13
Tipalt1	4884	34.86	127.75	9.57	1.83
Tipalt1	4884	30.06	127.63	9.53	1.68
Tipalt1	4884	25.14	127.49	9.49	1.52
Tipalt1	4860	47.17	127.80	41.05	1.85
Tipalt1	4860	41.74	127.76	39.76	1.71
Tipalt1	4860	34.86	127.70	37.54	1.53
Tipalt1	4860	30.06	127.56	31.74	1.54
Tipalt1	4860	25.14	127.38	12.23	1.57
Tipalt1	3932	47.17	124.73	41.63	1.18
Tipalt1	3932	41.74	124.60	40.19	1.18
Tipalt1	3932	34.86	124.41	39.22	1.20
Tipalt1	3932	30.06	124.12	17.60	1.35
Tipalt1	3932	25.14	123.93	15.77	1.32
Tipalt1	3930	47.17	124.61	40.31	1.86
Tipalt1	3930	41.74	124.50	39.40	1.73
Tipalt1	3930	34.86	124.35	37.10	1.56
Tipalt1	3930	30.06	124.08	17.19	1.57
Tipalt1	3930	25.14	123.90	15.47	1.47
Tipalt1	3928	47.17	124.61		

HEC-RAS Plan: DEVELOPED 9/10/97 (continued)

Reach	River Sta	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Tipalt1	3928	41.74	124.50		
Tipalt1	3928	34.86	124.35		
Tipalt1	3928	30.06	124.08		
Tipalt1	3928	25.14	123.90		
Tipalt1	3926	48.18	124.48	39.36	2.02
Tipalt1	3926	42.63	124.42	39.23	1.84
Tipalt1	3926	35.60	124.31	26.70	1.63
Tipalt1	3926	30.70	124.03	16.73	1.65
Tipalt1	3926	25.66	123.86	15.04	1.55
Tipalt1	3921	48.18	124.51	39.72	1.43
Tipalt1	3921	42.63	124.44	39.35	1.37
Tipalt1	3921	35.60	124.32	38.53	1.30
Tipalt1	3921	30.70	124.03	17.09	1.44
Tipalt1	3921	25.66	123.85	15.34	1.39
Tipalt1	3489	49.24	122.94	32.71	1.48
Tipalt1	3489	43.57	122.79	25.36	1.45
Tipalt1	3489	36.39	122.53	17.96	1.45
Tipalt1	3489	31.38	122.32	15.53	1.44
Tipalt1	3489	26.24	122.14	14.54	1.37
Tipalt1	2623	49.24	120.19	14.77	1.67
Tipalt1	2623	43.57	120.10	14.63	1.55
Tipalt1	2623	36.39	119.99	14.47	1.38
Tipalt1	2623	31.38	119.85	14.06	1.29
Tipalt1	2623	26.24	119.61	13.35	1.24
Tipalt1	2621	49.24	120.18	14.76	1.73
Tipalt1	2621	43.57	120.09	14.63	1.60
Tipalt1	2621	36.39	119.98	14.47	1.41
Tipalt1	2621	31.38	119.84	14.06	1.31
Tipalt1	2621	26.24	119.61	13.36	1.25
Tipalt1	2620	49.24	120.18		
Tipalt1	2620	43.57	120.09		
Tipalt1	2620	36.39	119.98		
Tipalt1	2620	31.38	119.84		
Tipalt1	2620	26.24	119.61		
Tipalt1	2616	50.57	120.15	14.73	1.79
Tipalt1	2616	44.75	120.06	14.61	1.65
Tipalt1	2616	37.38	119.96	14.45	1.46
Tipalt1	2616	32.24	119.82	14.03	1.35
Tipalt1	2616	26.97	119.59	13.33	1.29

HEC-RAS Plan: DEVELOPED 9/10/97 (continued)

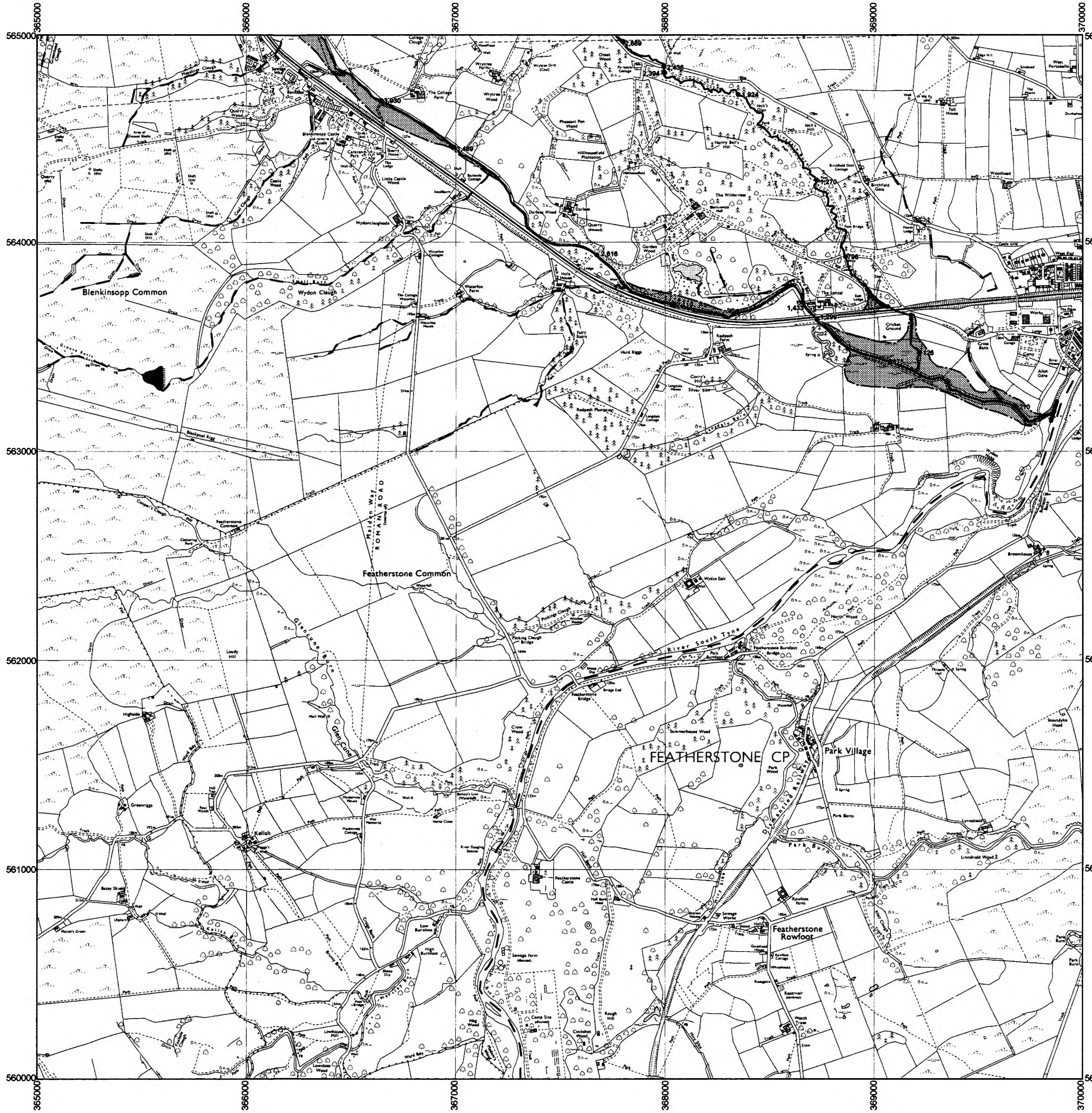
Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Tipalt1	2611	50.57	120.13	14.71	1.75
Tipalt1	2611	44.75	120.05	14.59	1.62
Tipalt1	2611	37.38	119.95	14.42	1.43
Tipalt1	2611	32.24	119.81	14.00	1.34
Tipalt1	2611	26.97	119.58	13.30	1.29
Tipalt1	2119	50.57	118.80	53.48	1.24
Tipalt1	2119	44.75	118.68	53.21	1.26
Tipalt1	2119	37.38	118.53	29.61	1.33
Tipalt1	2119	32.24	118.39	28.28	1.30
Tipalt1	2119	26.97	118.14	16.68	1.40
Tipalt1	1435	50.57	117.20	15.66	1.48
Tipalt1	1435	44.75	117.05	15.10	1.40
Tipalt1	1435	37.38	116.88	14.72	1.27
Tipalt1	1435	32.24	116.64	14.17	1.24
Tipalt1	1435	26.97	116.41	13.65	1.18
Tipalt1	1433	50.57	117.13	15.27	1.83
Tipalt1	1433	44.75	116.99	14.97	1.70
Tipalt1	1433	37.38	116.84	14.62	1.52
Tipalt1	1433	32.24	116.60	14.09	1.45
Tipalt1	1433	26.97	116.38	13.59	1.36
Tipalt1	1430	50.57	117.13		
Tipalt1	1430	44.75	116.99		
Tipalt1	1430	37.38	116.84		
Tipalt1	1430	32.24	116.60		
Tipalt1	1430	26.97	116.38		
Tipalt1	1428	51.36	117.09	15.18	1.88
Tipalt1	1428	45.45	116.96	14.90	1.75
Tipalt1	1428	37.97	116.82	14.57	1.55
Tipalt1	1428	32.75	116.58	14.05	1.49
Tipalt1	1428	27.40	116.36	13.55	1.39
Tipalt1	1423	51.36	117.10	15.22	1.56
Tipalt1	1423	45.45	116.97	14.93	1.47
Tipalt1	1423	37.97	116.82	14.59	1.32
Tipalt1	1423	32.75	116.59	14.06	1.30
Tipalt1	1423	27.40	116.36	13.56	1.23
Tipalt1	1351	51.36	116.87	12.60	1.69
Tipalt1	1351	45.45	116.77	12.58	1.56
Tipalt1	1351	37.97	116.66	12.55	1.37

HEC-RAS Plan: DEVELOPED 9/10/97 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Tipalt1	1351	32.75	116.41	12.50	1.33
Tipalt1	1351	27.40	116.19	12.45	1.25
Tipalt1	1349	51.36	116.87	12.62	1.62
Tipalt1	1349	45.45	116.77	12.60	1.49
Tipalt1	1349	37.97	116.66	12.58	1.31
Tipalt1	1349	32.75	116.42	12.52	1.26
Tipalt1	1349	27.40	116.19	12.48	1.18
Tipalt1	1340	51.36	116.87		
Tipalt1	1340	45.45	116.77		
Tipalt1	1340	37.97	116.66		
Tipalt1	1340	32.75	116.42		
Tipalt1	1340	27.40	116.19		
Tipalt1	1334	51.36	116.55	12.55	1.86
Tipalt1	1334	45.45	116.45	12.53	1.72
Tipalt1	1334	37.97	116.45	12.53	1.44
Tipalt1	1334	32.75	116.28	12.49	1.35
Tipalt1	1334	27.40	116.10	12.45	1.25
Tipalt1	1324	51.36	116.50	12.55	1.87
Tipalt1	1324	45.45	116.41	12.53	1.73
Tipalt1	1324	37.97	116.42	12.53	1.44
Tipalt1	1324	32.75	116.25	12.49	1.35
Tipalt1	1324	27.40	116.07	12.46	1.24
Tipalt1	1314	51.36	116.45	12.54	1.92
Tipalt1	1314	45.45	116.36	12.52	1.77
Tipalt1	1314	37.97	116.39	12.52	1.46
Tipalt1	1314	32.75	116.22	12.49	1.37
Tipalt1	1314	27.40	116.05	12.45	1.26
Tipalt1	1300	51.36	116.45		
Tipalt1	1300	45.45	116.36		
Tipalt1	1300	37.97	116.39		
Tipalt1	1300	32.75	116.22		
Tipalt1	1300	27.40	116.05		
Tipalt1	1299	51.36	116.33	12.52	2.01
Tipalt1	1299	45.45	116.25	12.50	1.85
Tipalt1	1299	37.97	116.31	12.51	1.49
Tipalt1	1299	32.75	116.15	12.48	1.40
Tipalt1	1299	27.40	115.97	12.44	1.29
Tipalt1	1294	51.36	116.30	12.51	2.02

HEC-RAS Plan: DEVELOPED 9/10/97 (continued)

Reach	River Sta.	Q Total	W.S. Elev	Top Width	Vel Chnl
		(m3/s)	(m)	(m)	(m/s)
Tipalt1	1294	45.45	116.22	12.50	1.85
Tipalt1	1294	37.97	116.30	12.51	1.49
Tipalt1	1294	32.75	116.13	12.48	1.40
Tipalt1	1294	27.40	115.96	12.44	1.29
Tipalt1	875	51.36	115.58	112.42	0.90
Tipalt1	875	45.45	115.50	112.42	0.89
Tipalt1	875	37.97	115.41	74.47	1.11
Tipalt1	875	32.75	115.40	74.42	0.96
Tipalt1	875	27.40	115.37	73.96	0.84
Tipalt1	777	56.17	115.50	135.84	0.79
Tipalt1	777	49.23	115.43	134.28	0.77
Tipalt1	777	41.14	115.33	132.39	0.74
Tipalt1	777	35.49	115.35	132.79	0.62
Tipalt1	777	29.69	115.33	132.41	0.53
Tipalt2	775	56.17	115.50	201.85	0.77
Tipalt2	775	49.23	115.42	201.85	0.77
Tipalt2	775	41.14	115.33	182.79	0.76
Tipalt2	775	35.49	115.35	188.50	0.63
Tipalt2	775	29.69	115.33	183.65	0.54
Tipalt2	210	56.17	115.04	96.06	0.96
Tipalt2	210	49.23	114.91	93.53	1.00
Tipalt2	210	41.14	114.75	90.46	1.04
Tipalt2	210	35.49	114.70	89.45	0.97
Tipalt2	210	29.69	114.61	36.40	1.23
Tipalt2	0	56.17	113.66	9.41	3.89
Tipalt2	0	49.23	113.48	8.51	3.85
Tipalt2	0	41.14	113.27	7.96	3.72
Tipalt2	0	35.49	113.11	7.55	3.60
Tipalt2	0	29.69	112.93	7.07	3.47



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

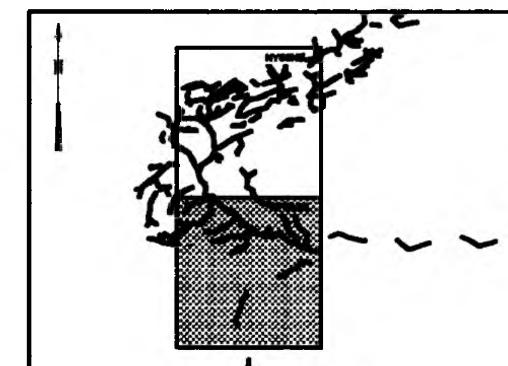
Note :- for clarity only indicative model node points have been included on this plan. For full listing please refer to model output

List of revisions

ENVIRONMENT AGENCY
NORTH EAST REGION

PROJECT TITLE

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



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.
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.

DRAWING TITLE

NORTHUMBRIA AREA
TIPALT AND
PAINSDALE BURN
SHEET 1 OF 2

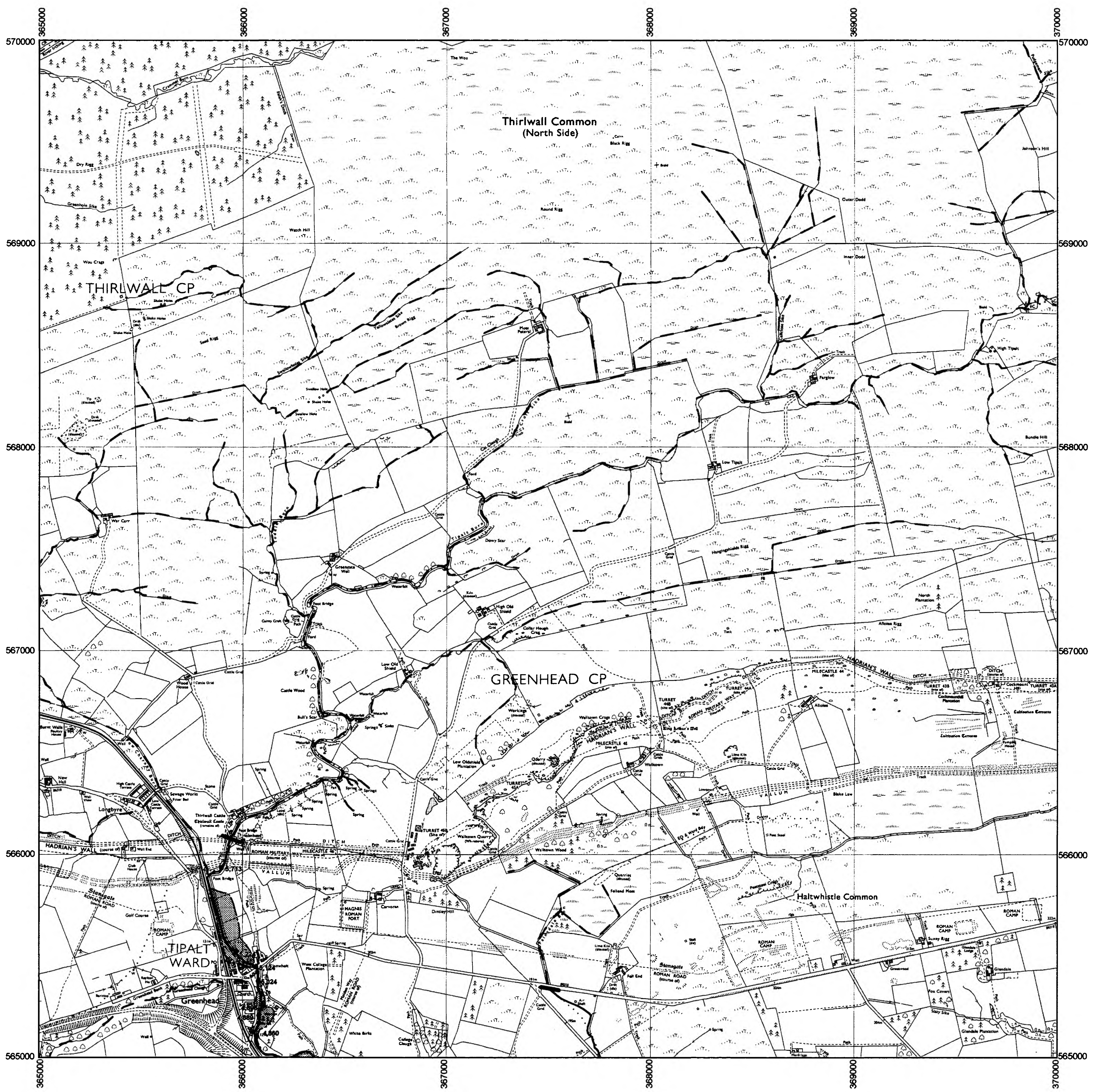
ORIGINATED BY	DRAWN BY	CHECKED BY	APPROVED BY
SPT	TH-R	TJS	
DATE	DATE	DATE	DATE

SCALE 1:10,000

PROJECT NO. / DRAWING NO. / REV
C1395/FPM/01/040

POSFORD DUVIVIER

26-03-98



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

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

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.
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.

DRAWING TITLE

NORTHUMBRIA AREA
TIPALT AND
PAINSDALE BURN
SHEET 2 OF 2

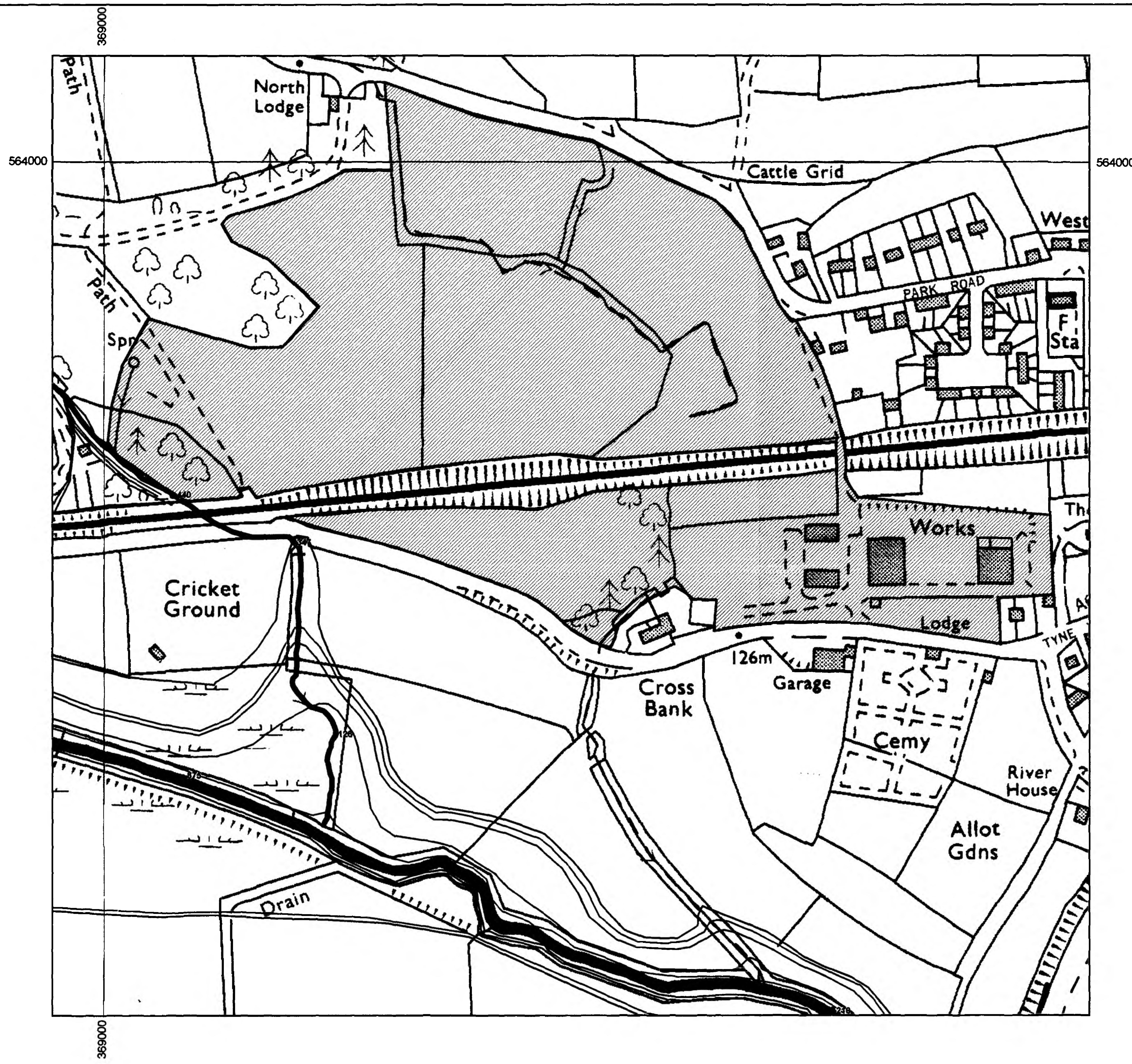
ORIGINATED BY	DRAWN BY	CHECKED BY	APPROVED BY
SPT	TH-R	TJS	
DATE	DATE	DATE	DATE

SCALE
1:10,000

PROJECT NO. / DRAWING NO. / REV
C1395/FPM/01/041

POSFORD DUVIVIER

19-05-98

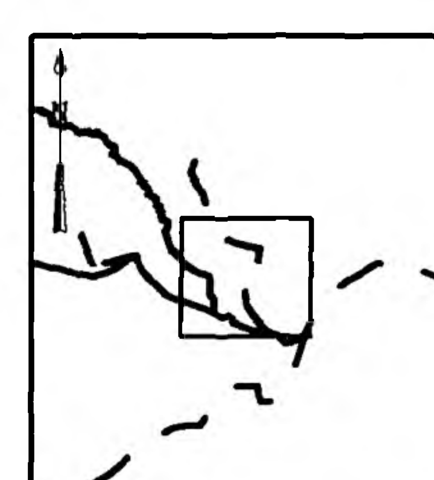


KEY:

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



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 TIPALT BURN PAINSDALE BURN NEAR HALTWHISTLE SHEET 1 OF 1

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/01/040

POSFORD DUVIVIER

07/10/1997