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River Leith Fluvial Audit

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Study of hydrodynamics and sediment in fluvial, coastal and lacustrine environments

FINAL PROJECT REPORT

RIVER LEITH GEOMORPHOLOGICAL/ RHS DATA COLLECTION

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EXECUTIVE SUMMARY

The River Leith is a highly sinuous river meandering across its narrow floodplain between high river terraces with frequent outcrops of red sandstone. The morphology of the channel is characterised in its lower reaches by vegetated point and side bars and fewer than expected riffles. The upper reaches are steeper and have some riffles but the bed morphology is largely step pool. There has been extensive channelisation within the catchment, which may be causing incision in the downstream reach.

Freeze cores extracted from the upper and lower ends of the study reach illustrate that the bed is highly compacted in the downstream reach. Fine material is locally derived from bedrock at depths of only 32 cms into the bed and in one core fine material is 66% of the extracted core. Levels of fines that are believed to be detrimental to fish are put at 20 to 30%.

Reduced flow and stream power from water abstraction may lead to a greater infiltration of fine material if gravels are not regularly flushed through with flood flows. Infiltration of fine material can lead to river bed compaction and concretion. A small abstraction may have no effect on the morphology of a river if the reduced discharge is within the normal range of flows experienced. However if the impact on flows is small it is still possible that fine sediment problems will develop progressively and the effects may not be noticed for several years.

SECTION 1. GEOMORPHOLOGICAL SURVEYS

A set of geomorphological maps (Maps 1 to 8) have been produced that identify key erosional and depositional features at the scale of 1:2500 for the River Leith between Waterfalls bridge and the confluence with the River Lyvennet. The map extends through the channel and incorporates the floodplain and adjacent river terraces, a key for all the maps is given at the end of this section, definitions of features are based on the Environment Agency's River Habitat Survey.

The River Leith, in most locations, meanders across its narrow floodplain constrained by the high terraces on either side. The terraces may be seen on any topographic map and are only included in this survey where they are directly affecting the planform of the channel. The recent floods (October 1998) have resulted in considerable geomorphological work in the river. Banks have been modified and large blocks of bank material can be observed lying in the channel, much of it still with turf at the time of this survey, a meander bend has been cutoff (map 4) and flood debris accumulated.

There appears to be considerable local interest in fencing river banks against stock, the geomorphological survey has picked up very little evidence of accelerated bank erosion from the effects of grazing animals. However this may be largely due to the floods that passed through the river immediately prior to this survey. Considerable recent, natural erosion was observed in many locations, resulting in newly cut banks with extensive turf blocks lying in the channel. The floods may have removed any slumped material from previous erosion and re-cut composite bank profiles associated with overgrazing. In many cases banks were not classified as eroding where they had been undercut and turf was protecting the bank face. To assess the extent of grazing related bank erosion it would be advisable to undertake an erosion survey during a prolonged period of low flow.

The Leith is a dynamic actively meandering, and in many locations, highly sinuous river. As a result of the sinuosity there are a number of point bars and some side bars, these are almost all vegetated. Vegetation on bars can suggest that they are relatively inactive sedimentary features; often this is the case in summer. During flood events vegetated bars may well be reactivated and the sediment reworked. Some fine sediment deposition was observed on a few of these point bars following the recent floods. However it was notable that the channel contained fewer bed features (particularly riffles) than might be expected for this kind of channel planform, in its lower reaches, most notably from Melkinthorpe to the confluence with the Lyvennet. The upstream reach may have a steeper valley slope (hence the step pool morphology) but it appears to be more stable. The study reach is divided into sections here for the purpose of qualitative discussion.

Section1
The lower section of the River Leith between Cliburn town bridge and the confluence with the Lyvennet (Maps 1 and 2), has a deep channel with very little diversity in terms of its bed morphology and generally vertical bank profiles. There are a number of vegetated point bars, which despite the recent large floods have new sediment deposits only on the waters edge side; the bed is highly compacted. A vegetated berm was also noted. Extensive revetments suggest that bank erosion has been a problem. This section in contrast to the upstream natural sections appears unusual. The evidence suggests that the channel may be incised.

Section2
The section immediately upstream to the next road bridge (GR 35765248) is generally wider and shallower with a greater diversity of bed features and a greater variety of bank profiles; steep, vertical and gentle. Recent stock fencing has been erected.

Section 3
The channel in Leith Plantation upstream of the road bridge (Map 4) is highly active with one complete and one partial cutoff having occurred recently. Old channels still held water at the time of this survey and patches of wetland vegetation associated with Carr features were noted. This section has a narrow flood plain, which may account for the greater degree of activity, as stream power will be increased during floodplain floods. In addition there is relatively little 'management' in terms of bank revetments.

Section 4
From the upstream side of Leith Plantation to the confluence with the tributary (GR NY356900, 525400) the channel has regularly spaced riffles, and a variety of bank profiles, extensively gentle.

Section 5
From the confluence to Melkinthorpe, the channel has been realigned; it is overdeep with resectioned banks. The river is showing some signs of attempting to re-establish meander bends. This is apparent at several sites where a cut in the bank is followed by

a riffle immediately downstream (Map 5). However the physical habitat in this reach is severely degraded.

Section 6
From Melkinthorpe to Waterfalls Bridge the channel is much more diverse in terms of bed morphology and depositional features. The final, approximately 500 m, of this section is a densely wooded gorge with outcrops of bedrock and a step pool bed morphology

MAP KEY

IG Improved grazing
TL Tilled land
BL Broadleaf or mixed woodland
TH Tall herbs
SC Scrub vegetation
RP Rough pasture
(T) Isolated tree

XS Locations for cross-section surveys
UF Unfenced river banks

Riffle
Step feature
(associated with step/pool morphology)
VS Vegetated side bar
SB Side bar
PB Point bar
VP Vegetated point bar
MB Mid channel bar

▼▼▼▼ Bedrock bank material

RI Reinforced bank
RS Resectioned bank
RR Rip rap
BR Bricklaid stone
TP Tipped material on bank
ER Eroding bank
EC Eroding cliff
PC Poached bank
CP Composite bank profile
SC Stable cliff
BE Bedrock

SECTION 2 CROSS SECTION SITES

Twenty sites have been identified for cross section surveys; the locations are shown on Map 9 with notes for surveyors on finding the sites and orientation of the section. All sections were marked in the field by small wooden pegs hammered into the bank on one side with approximately 20 cms of peg exposed. An effort was made to place these markers out of the way of any farm traffic etc. The cross section locations are also noted on the geomorphological maps (Maps 1 to 8) at a scale of 1:2500 for more accurate location.

SECTION 3 FREEZE CORE SAMPLING

3.1 SITES

Two sites were chosen for sediment sampling with three cores being taken at each site, three cores in one location will give a more accurate assessment of the sediment characteristics at a site. Site one was upstream of the abstraction point, site 2 downstream, shown in Map 9.

3.2 METHODOLOGY

Sediment samples were extracted by using a copper standpipe inserted into the river bed, liquid nitrogen was used to freeze the standpipe and the surrounding interstitial water in the gravels, the pipe was then extracted from the bed complete with an undisturbed sample of gravel using a winch. Details of the equipment are given in Carling and Crompton (1988). Cores were then divided into sections according to the bed stratigraphy.

Samples were dried at room temperature and sieved mechanically using a Fritsch Analysette. Sieving time was 15 minutes using an intermittent mode of amplitude sufficient to mobilise the coarsest fractions. As grain size distributions approach a logarithmic distribution, samples were sieved at 1 phi (ø) intervals in the range <0ø (<1 mm) to –7.0ø (129 mm). The use of the phi scale is common practice in sedimentological investigations and the relationship to the mm scale is shown in Table 1.0. However for convenience in this report all sizes are expressed in mm.

3.3 RESULTS

Where cores penetrate into the strata underlying the river sediments only the layers associated with the fluvial regime are considered in these results unless otherwise stated. All cores from site 1 penetrated into the underlying till whilst at site 2 core 6 penetrated into the underlying sandstone bedrock.

Table 1.

PRINCIPAL PARTICLE SIZE DIVISIONS

Particle Diameter

Units	Diameter	Subdivision	Class	Group
		V Large	Boulders	GRAVEL
-11	2048mm	Large	Boulders	GRAVEL
-10	1024mm	Medium	Boulders	GRAVEL
-9	512mm	Small	Boulders	GRAVEL
-8	256mm	Large	Cobbles	GRAVEL
-7	128mm	Small	Cobbles	GRAVEL
-6	64mm	V Coarse	Pebbles	GRAVEL
-5	32mm	Coarse	Pebbles	GRAVEL
-4	16mm	Medium	Pebbles	GRAVEL
-3	8mm	Fine	Pebbles	GRAVEL
-2	4mm	V Fine	Pebbles	GRAVEL
-1	2mm	V Coarse	Sand	
0	1mm	Coarse	Sand	
+1	500μ	Medium	Sand	
+2	250μ	Fine	Sand	
+3	125μ	V Fine	Sand	
+4	62μ	V Coarse	Silt	MUD
+5	31μ	Coarse	Silt	MUD
+6	16μ	Medium	Silt	MUD
+7	8μ	Fine	Silt	MUD
+8	4μ	V Fine	Silt	MUD
+9	2μ		Clay	MUD

Whole Core Data

Site 1

Core 1 (length & number of sections includes basal layer)

Total length (cm)	49
Number of Sections	3
Total Weight (g)	28087.5
% weight > 0Phi (1mm)	92.6
% weight < 0Phi (1mm)	7.4

Core 2 (length & number of sections includes basal layer)

Total length (cm)	51
Number of Sections	2
Total Weight (g)	7641.5
% weight > 0Phi (1mm)	96.4
% weight < 0Phi (1mm)	3.6

Core 3 (length & number of sections includes basal layer)

Total length (cm)	53
Number of Sections	3
Total Weight (g)	25962.2
% weight > 0Phi (1mm)	94
% weight < 0Phi (1mm)	6

Site 2

Core 4

Total length (cm)	59
Number of Sections	4
Total Weight (g)	11841.6
% weight > 0Phi (1mm)	73.4
% weight < 0Phi (1mm)	26.6

Core 5

Total length (cm)	42
Number of Sections	1
Total Weight (g)	10241.1
% weight > 0Phi (1mm)	82.2
% weight < 0Phi (1mm)	17.8

Core 6 (length & number of sections includes basal layer)

Total length (cm)	32
Number of Sections	2
Total Weight (g)	10826.1
% weight > 0Phi (1mm)	86.9
% weight < 0Phi (1mm)	13.1

Individual Section Data

Site 1: Core 1

	Level 1	Level 2	Level 3
Section Length (cm)	8	12	39
Phi Unit	Weight (g)	Weight (g)	Weight (g)
-7		10748.5	Underlying Till
-6	6362.3	888.6	"
-5	1420.5	1446.9	"
-4	792.8	747.4	"
-3	434.2	665.2	"
-2	316.2	401.7	"
-1	329.5	509.5	"
0	476.1	464.7	"
<1	890.1	1193.3	"
Total weight (g)	11021.7	17065.8	
% > 0Phi (1mm)	91.9	93.3	
%< 0Phi (1mm)	8.1	6.7	

Site 1: Core 2

	Level 1	Level 2
Section Length (cm)	11	30
Phi Unit	Weight (g)	Weight (g)
-7		Underlying Till
-6	5137.2	"
-5	1001.3	"
-4	452.7	"
-3	325.1	"
-2	193.1	"
-1	151.9	"
0	108.2	"
<1	272.0	"
Total weight (g)	7641.5	
% > 0Phi (1mm)	96.4	
%< 0Phi (1mm)	3.6	

Site 1: Core 3

	Level 1	Level 2	Level 3
Section Length (cm)	16	31	6
Phi Unit	Weight (g)	Weight (g)	Weight (g)
-7			Underlying Till
-6	2351.9	7300.5	"
-5	2470.6	3678.3	"
-4	376.1	2538.8	"
-3	334.2	1882.9	"
-2	300.7	1149.1	"
-1	266.7	932.5	"
0	202.3	631.4	"
<1	508.8	1037.4	"
Total weight (g)	6811.3	19150.9	
% > 0Phi (1mm)	92.5	94.6	
%< 0Phi (1mm)	7.5	5.4	

Site 2: Core 4

	Level 1	Level 2	Level 3	Level 4
Section Length (cm)	5	12	30	12
Phi Unit	Weight (g)	Weight (g)	Weight (g)	Weight (g)
-7				
-6			1575.2	1129.3
-5	236.8		696.5	581.9
-4	127.4	105.4	830.5	803.2
-3	71.9	94.2	514.7	478.3
-2	37.1	59.9	268.6	228.6
-1	17.6	47.7	193.5	167.8
0	27.1	61.9	195.8	143.1
<1	296.2	722.4	1421.7	707.3
Total weight (g)	814.1	1091.5	5696.5	4239.5
% > 0Phi (1mm)	63.6	33.8	75.0	83.3
%< 0Phi (1mm)	36.4	66.2	25.0	16.7

Site 2: Core 5

	Level 1
Section Length (cm)	42
Phi Unit	Weight (g)
-7	
-6	322.3
-5	3060.2
-4	1898.5
-3	1276.2
-2	879.1
-1	590.7
0	388.9
<1	1825.2
Total weight (g)	10241.1
% > 0Phi (1mm)	82.2
%< 0Phi (1mm)	17.8

Site 2: Core 6

	Level 1	Level 2
Section Length (cm)	28	4
Phi Unit	Weight (g)	Weight (g)
-7		Bedrock
-6	3015.6	"
-5	2787.1	"
-4	1467.2	"
-3	941.3	"
-2	560.1	"
-1	408.7	"
0	224.2	"
<1	1421.9	"
Total weight (g)	10826.1	
% > 0Phi (1mm)	86.9	
%< 0Phi (1mm)	13.1	

Core Descriptions

Core 1: The total core length of 49cm is divided into three sections. The upper two levels representing the fluvial sediments and the final section being underlying till. The upper 8cm (level 1) consisting of cobbles, large pebbles and finer gravels with a population of finer sand and silt. The next 12cm (level 2) contains mainly small gravels, with the exception of one single large cobble, contained within a matrix of fine brown sand and silt. The bottom 39cm (level 3) appears to be a typical unsorted mix of material consistent with the local glacially derived tills.

Core 2: Total core length 41cm divided into two sections, the upper being fluvial sediment lying on top of an underlying till level. The upper 11cm (level 1) containing small pebbles within a matrix of fine brown sand and silt. The lower 30cm of the core (level 2) again is a typical unsorted mix of material consistent with the local glacially derived tills.

Core 3: Total core length 53cm with three distinct layers, two levels of fluvially derived material with a basal level of till. The upper 16cm (level 1) contained a few larger pebbles with a greater number of smaller pebbles contained within a fine matrix of brown sand and clay. The middle section 31 cm (level 2) again contained pebbles of varying size but the finer matrix of sand and silt was redder in colour. The basal layer of 6cm (level 3) once again is a typical unsorted mix of material consistent with the local glacially derived tills.

Core 4: Total core length 59cm with four layers. The upper 5 cm (level 1) contained small gravels within a dense matrix of dark brown sand and silt. The second 12cm (level 2) contained only small gravel within a very dense matrix of red and dark brown sand and silt. The third section 30cm (level 3) again contained smaller gravel along with larger clasts of locally derived sandstone all within a dense matrix of red sand and silt. The lower section 12cm (level 4) contained gravel within a light brown matrix. All levels appear to contain fluvially derived material.

Core 5: Total core length 42cm in one single unit consisting of a mix of fluvially worked gravel and angular sandstone clasts with a matrix of red sand and silt.

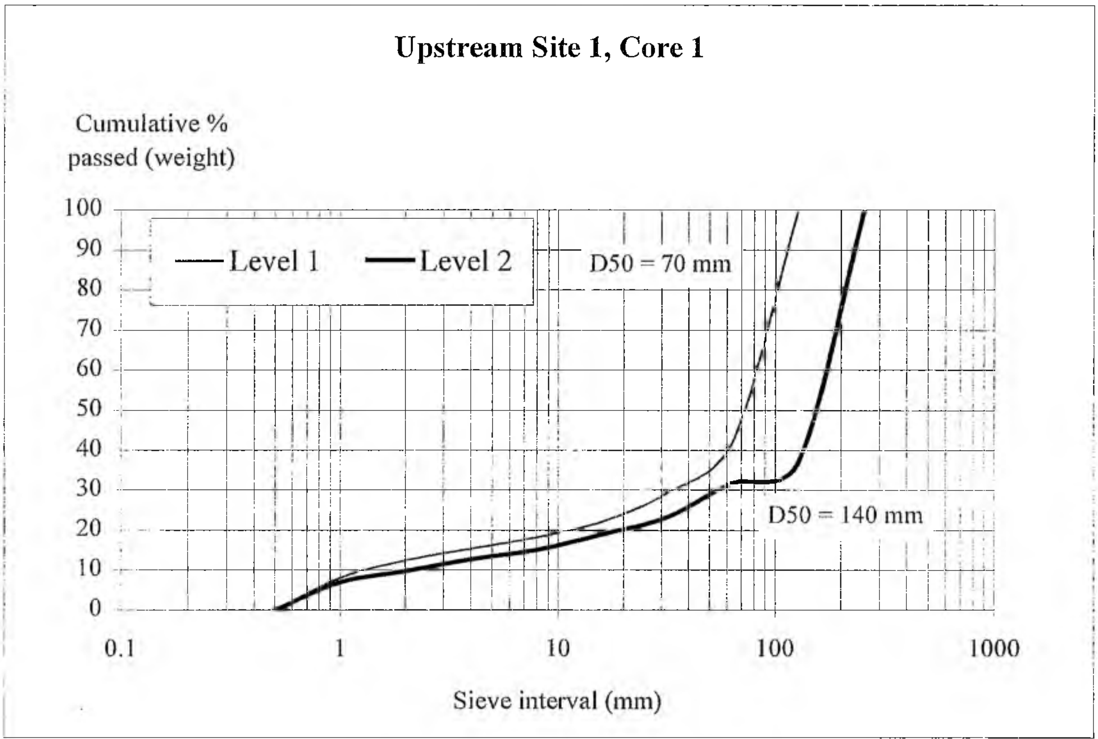
Core 6: Total core length 32cm in two sections. The upper 28cm (level 1) contained fluvially derived material consisting of gravel within a fine matrix of red sand and silt. The basal layer of 4cm (level 2) appears to be sandstone bedrock detached in the freeze coring process.

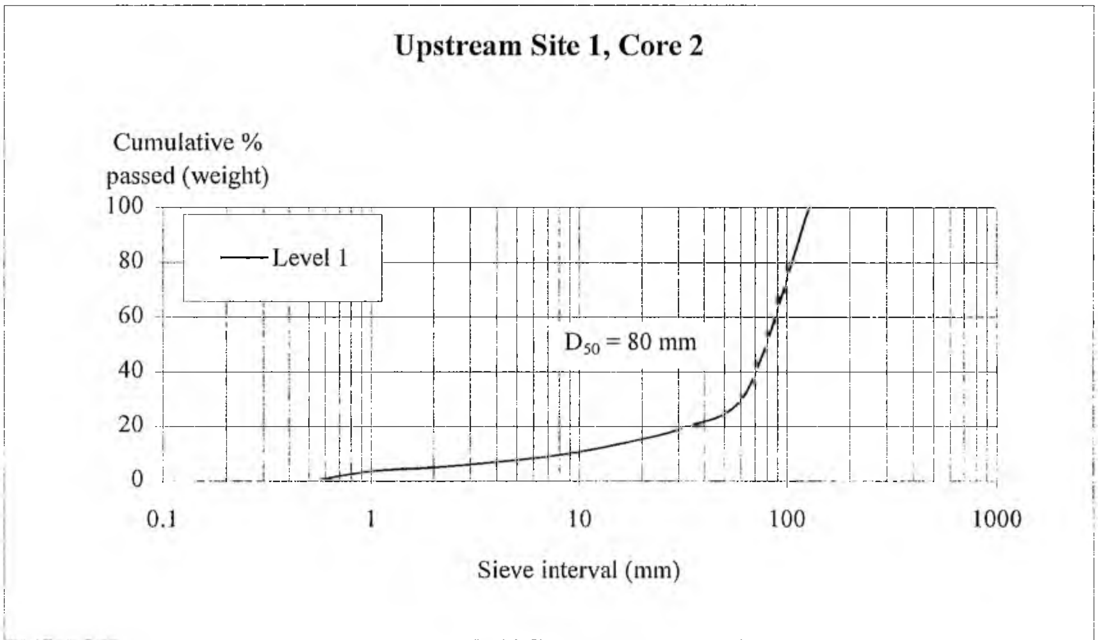
Colour Images of each core are shown in Plates 1 and 2.

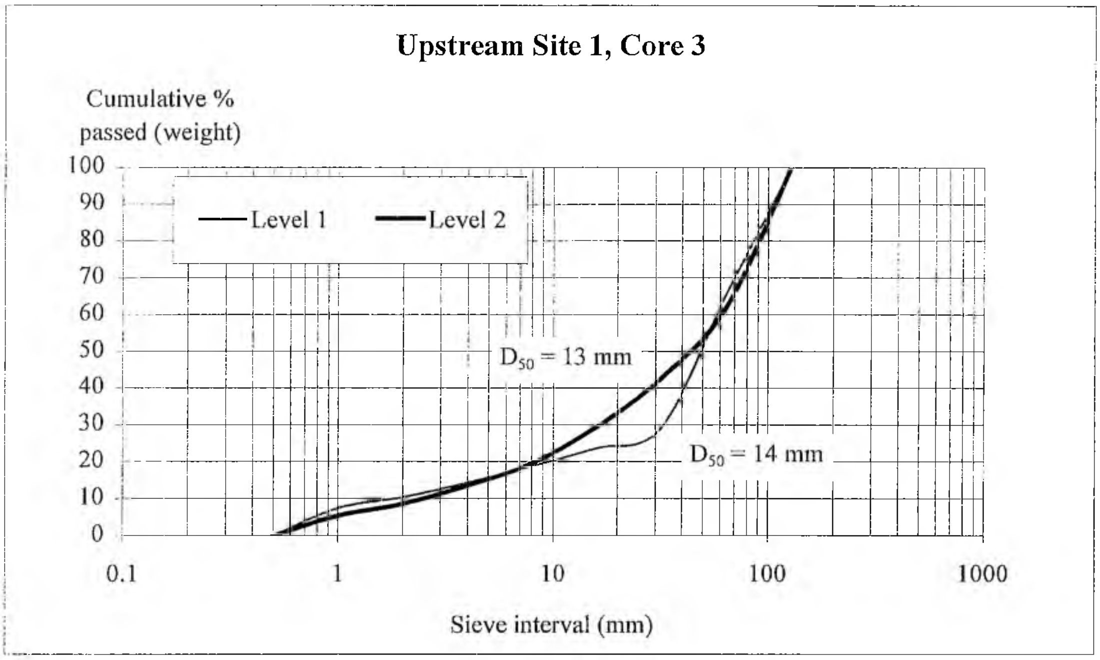
3.4 Interpretation

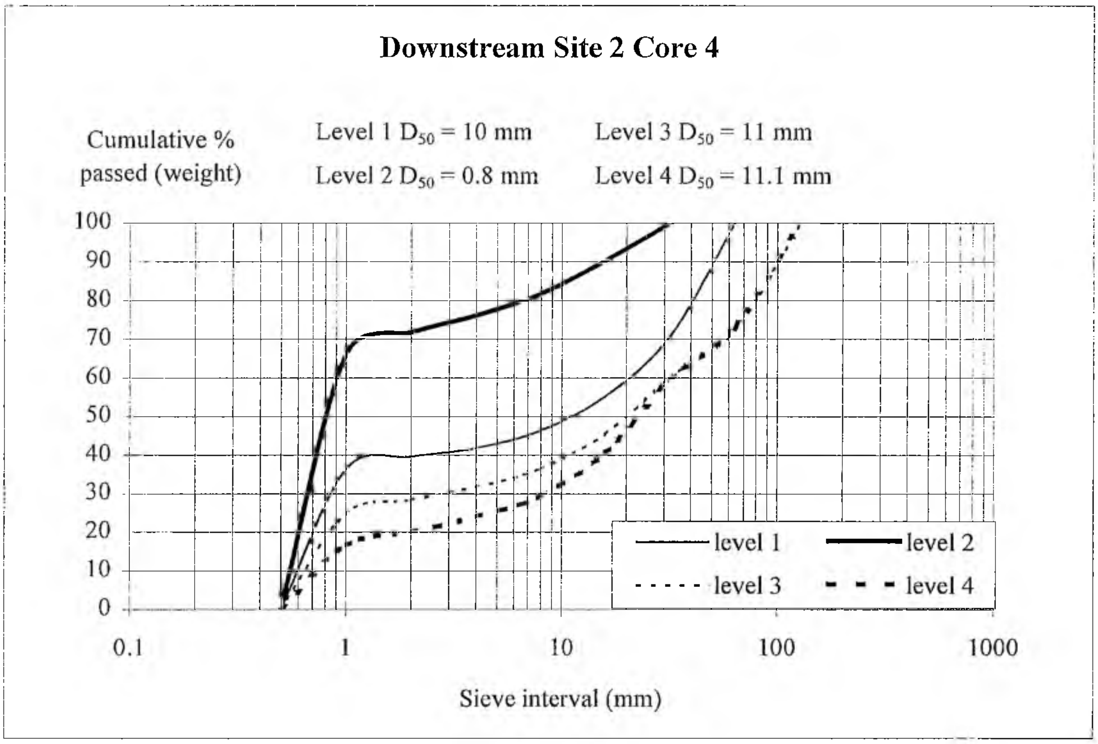
It is usual to sieve sediment samples using the whole range of the sample including the very coarse surface layer which is typically 5 – 15 cm deep and consisting of loose material and very few fines. It was notable on the Leith that this surface layer consisted of a few particles overlaying a very solid base, in some cases the compacted layer was on the surface. Considerable difficulty was experienced in the field, particularly at site 2 because the bed was too compacted to hammer in the sampling tubes. On close examination of the results of the grain size analysis it was clear that the material in Phi size –6 Core 1 was just one cobble.

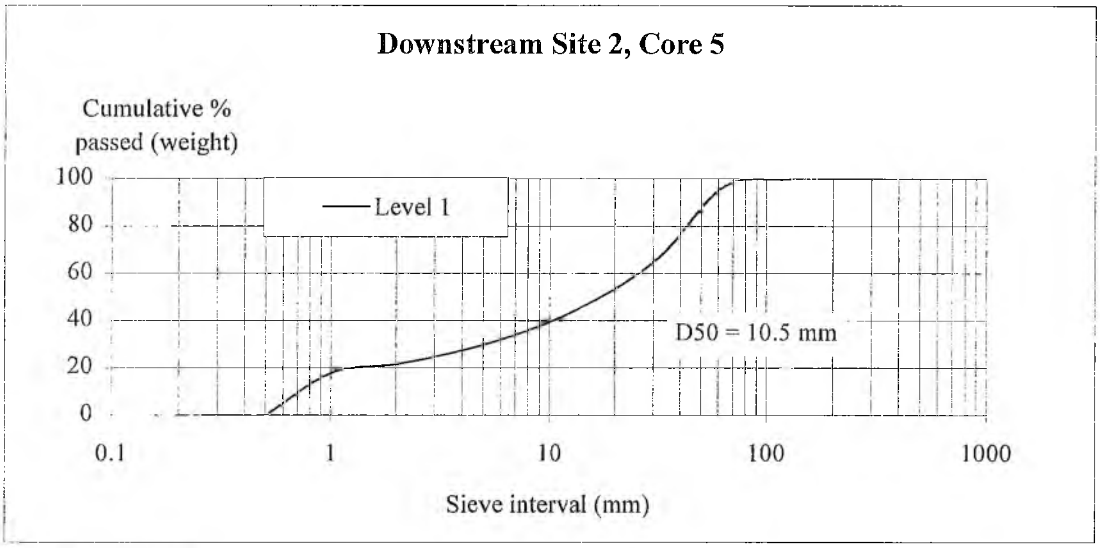
The relative importance of fine material in the gravel matrix can be expressed as a percentage of material less than 1 mm in diameter, known to be detrimental to fish, these figures are listed in the results tables. It is also clear that the fine material dominates in another way as shown in the grain size accumulation curves presented below for all cores from each site.

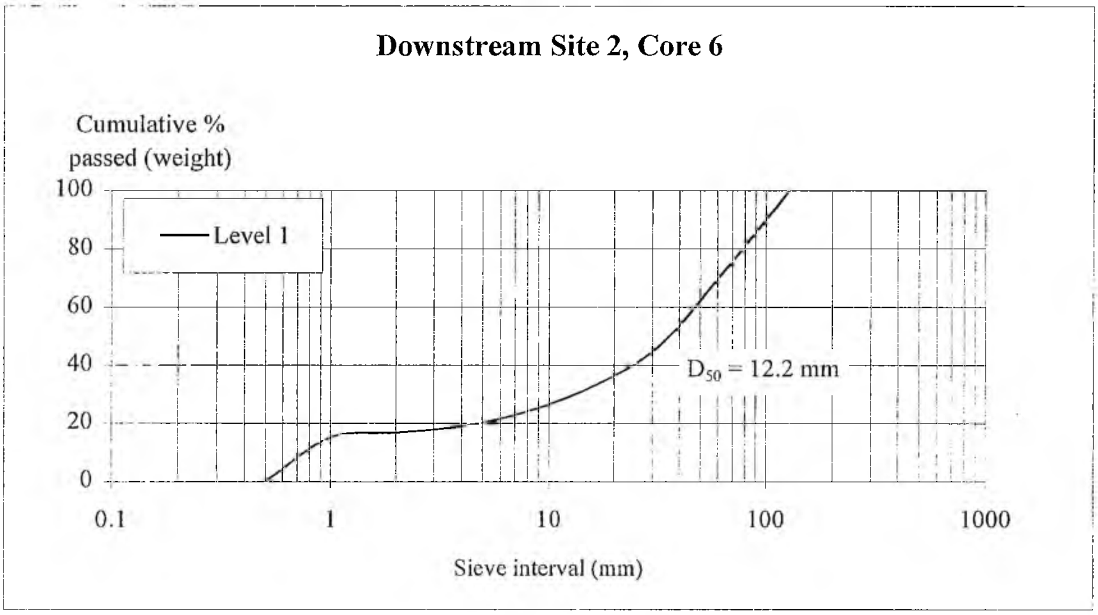





Upstream Site 1, Core 3
Cumulative % passed (weight)
100
90
80
70
60
50
40
30
20
10
0
Level 1
Level 2
D50 = 13 mm
D50 = 14 mm
0.1
1
10
100
1000
Sieve interval (mm)


Downstream Site 2 Core 4
Cumulative % passed (weight)
Level 1 D50 = 10 mm
Level 2 D50 = 0.8 mm
Level 3 D50 = 11 mm
Level 4 D50 = 11.1 mm
100
90
80
70
60
50
40
30
20
10
0
level 1
level 2
level 3
level 4
0.1
1
10
100
1000
Sieve interval (mm)





Grain size accumulation curves can be used to read off values of D50 and D84 etc. for further analysis. Clearly the fine sediment fraction dominates the grain size distribution at site two however the distribution at site one is also slightly bimodal. For further information on grain size distributions see: Carling and Reader (1982), Crisp and Carling (1989) and Kondolf (1992).

For comparative purposes, a table of the percentages of fines (< 1 mm) form other spawning gravels in the UK is presented in Table 2. The River Leith compares well with the Hampshire Chalk rivers which were known to be suffering the impacts of siltation and compaction at the time of the survey.

Table 2

Location		Percentage of fines	
N. E. England		Mean	11.17
		Maximum	39.11
		Minimum	2.40
Dorset		Mean	12.51
		Maximum	32.38
		Minimum	3.90
Hampshire		Mean	27.25
		Maximum	53.00
		Minimum	3.00
River Leith	Site 1	Mean	6.26
		Maximum	8.1
		Minimum	3.6
River Leith	Site 2	Mean	22.33
		Maximum	66.2
		Minimum	13.1

SECTION 4 RIVER HABITAT SURVEYS

A continuous RHS was conducting starting at the downstream end at the confluence between the Leith and the Lyvennet. Sites were numbered consecutively with site 1 at the downstream end and site 13 at the upstream end, at Waterfalls Bridge. Despite early concerns about high flows, the surveys were eventually conducted during moderately low to medium flows where the bed was largely visible. In many cases the bed would not have been visible even at low flow due to the depth of the channel. We are confident that these RHS surveys are suitable for comparison with RHS benchmark sites. However some factors must be taken into consideration regarding the identification of vegetation. Within-channel vegetation may be much more extensive during the summer, by November much of it had died back and been removed by the recent floods. Despite this large quantities of ranunculus were observed, other species were not identifiable. The identification of pest species was believed to be accurate however the identification of alders is less robust since without foliage some trees may have been inadvertently missed.

Where RHS cross sections are measured a note is made of the nature of the bed, whether consolidated or unconsolidated. In many cases the bed appeared to be unconsolidated at least on the surface, however throughout most of its length the River Leith is subject to some degree of compaction. This is discussed more fully in the section of freeze coring. In summary the note on the RHS form should not be used as a definitive guide to the nature of the bed.

The background map-based information at the beginning of the RHS forms was left blank as agreed with the project manager at the outset. Forms are included separately with this report.

SECTION 5 LIKELY IMPACTS OF WATER ABSTRACTION

The most likely impact of a water abstraction will be the reduced discharge and hence stream power that will in turn affect the sediment regime. If the carrying capacity of the river is reduced then deposition of fine sediment will increase. This can lead to infiltration of fine material into the bed causing compaction, with serious consequences for salmonid fish.

'Flushing' of river systems in high flows is important not just from a fine sediment perspective but also in terms of oxygenation and movement of nutrients through the system, this may be particularly important for highly vegetated channels. Water abstraction will very likely reduce the high flow peaks and place extra pressure on in-river ecosystems during low flows.

Following the recent floods, small areas of sand deposition were noted at several locations within the River Leith, particularly in slack water areas and close to the bank. Reduced discharge in the river could mean that these deposits are not effectively removed. Reduced stream power could potentially lead to a reduced risk of bank erosion and hence reduced fine sediment supply however it is likely that fine sediment is supplied through runoff from heavily grazed and tilled land and through locally derived weathered parent material.

Research on gravel bed rivers in Britain has noted that regulated rivers may have sediment-related problems at river confluences. Tributaries supply main rivers with a particular sediment load, a reduced discharge in the main river may mean that the carrying capacity is not sufficient and sediment may accumulate at these junctions. Changes in the bed morphology (e.g. gravel bar development) may lead to geomorphic instability at these sites.

A small abstraction may have no effect on the morphology of a river if the reduced discharge is within the normal range of flows experienced. However if the impact on flows is small it is still possible that fine sediment problems will develop progressively and the effects may not be noticed for several years.

The precise impact of an abstraction will depend on the percentage of water abstracted and the time of abstraction. Predictions cannot be made without some knowledge of the flow regime and the amount of expected abstraction, this would require gauging station data and volumetric measurements of the abstraction. Mitigation measures may include restricting the abstraction to times when the river is at a sufficiently high stage.

The bed of the River Leith is already compacted which may be due to runoff of fine sediment but the extent of exposed and eroding banks are also a major source of fines. The fine sediment found in cores extracted from site 2 at the downstream end is locally derived i.e. from parent rock material. Sediment clasts are angular which suggests that they cannot have been transported far by the river, fluvial processes usually produce rounded sediment particles. If, as suggested by local people, the fishery has declined it is likely to be, at least in part, a response to the levels of compaction. If compaction is relatively recent, and as the fine sediment is locally derived, the channel may be becoming entrenched, i.e. the bed level of the river was previously higher and not in contact with the bedrock. In this case the greatest problem facing the river is the entrenchment. Possible causes of this change are the degree of channelisation shown on maps 5 and 6 which may have lead to instability downstream (see Brookes, 1988). A very brief examination of maps for the River Leith upstream of the study reach suggest that channelisation may also have taken place upstream.

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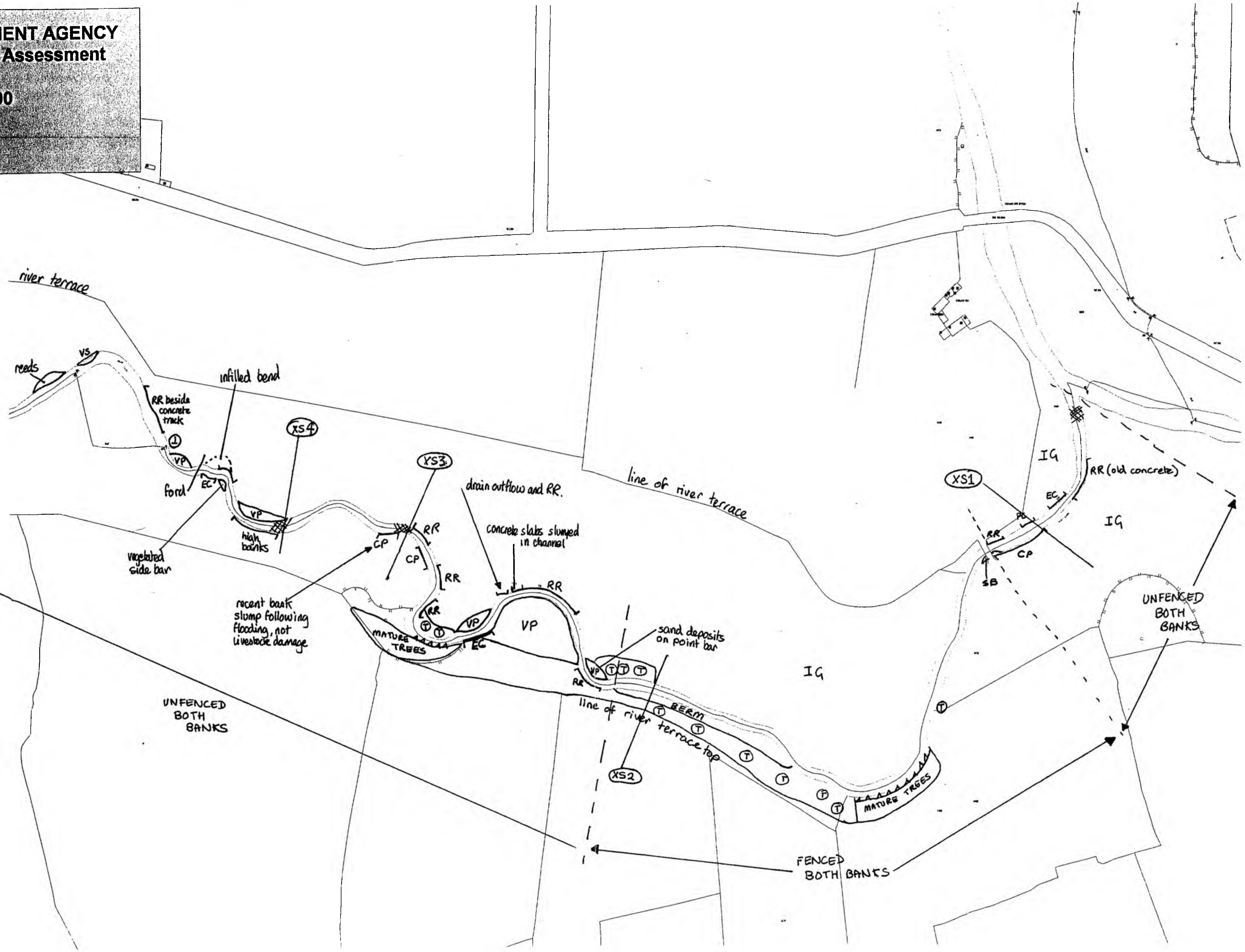
ENVIRONMENT AGENCY
River Leith Assessment

Scale 1:2500

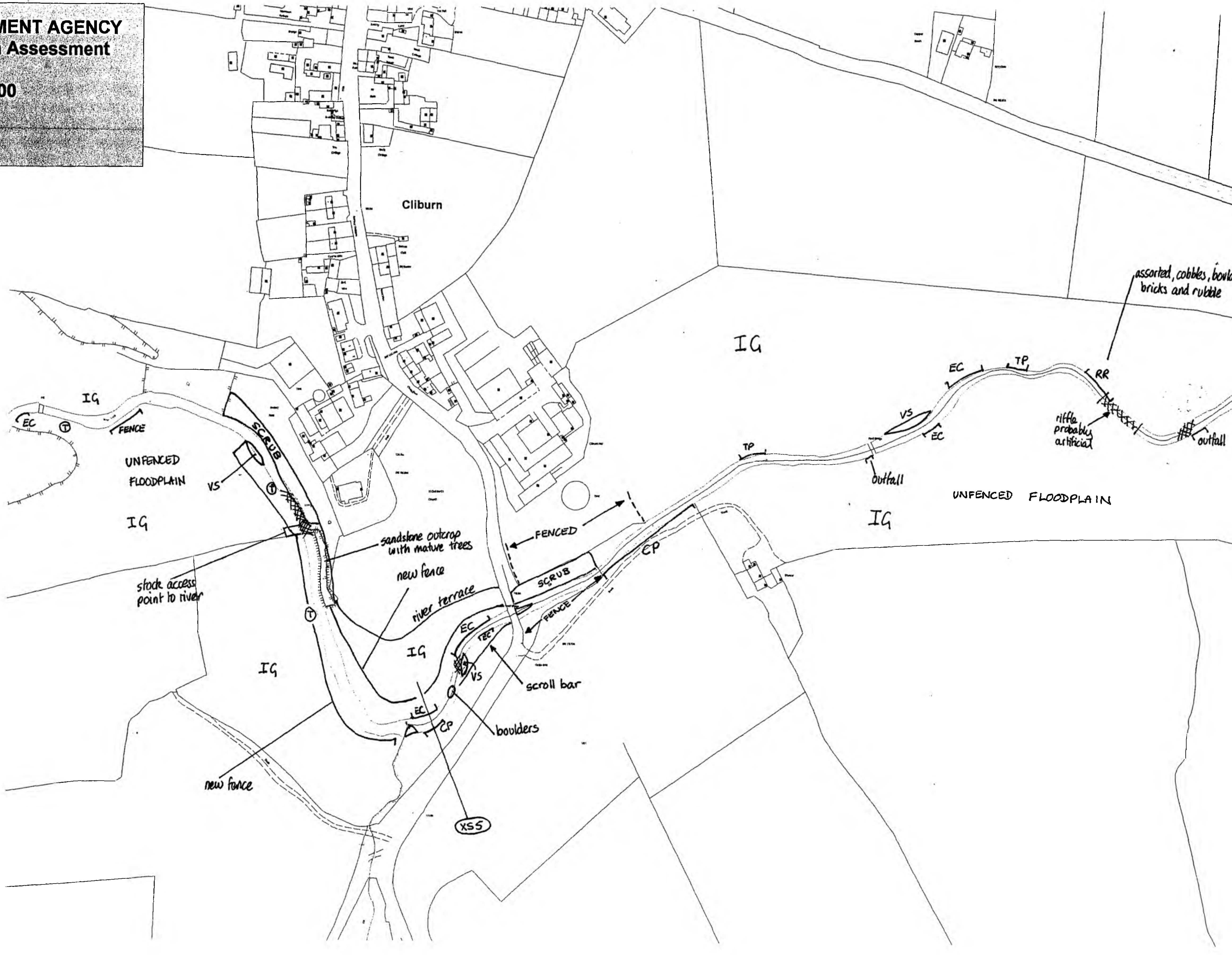
Map 1



ENVIRONMENT AGENCY
River Leith Assessment

Scale 1:2500

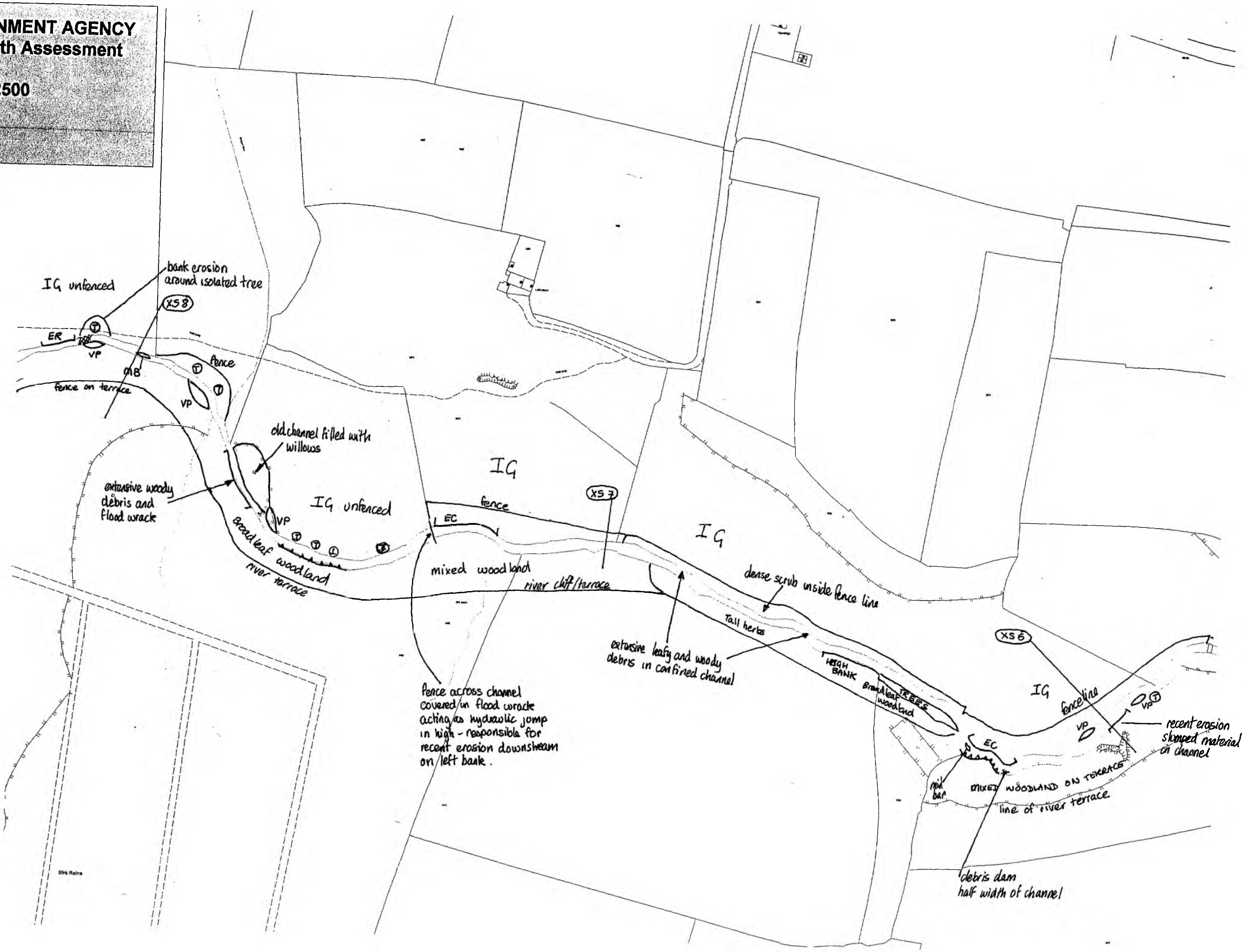
Map 2

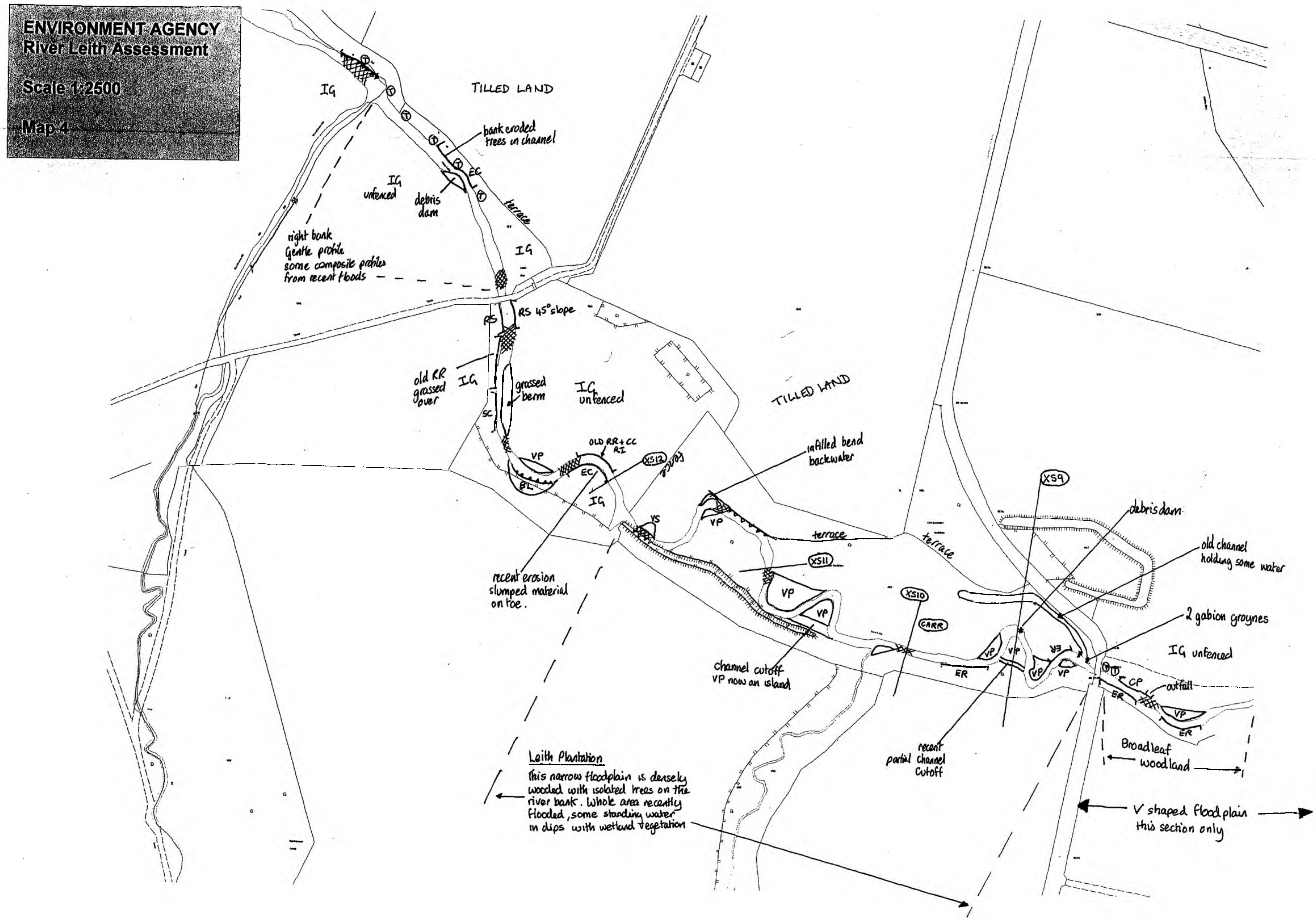


ENVIRONMENT AGENCY
River Leith Assessment

Scale 1:2500

Map 3

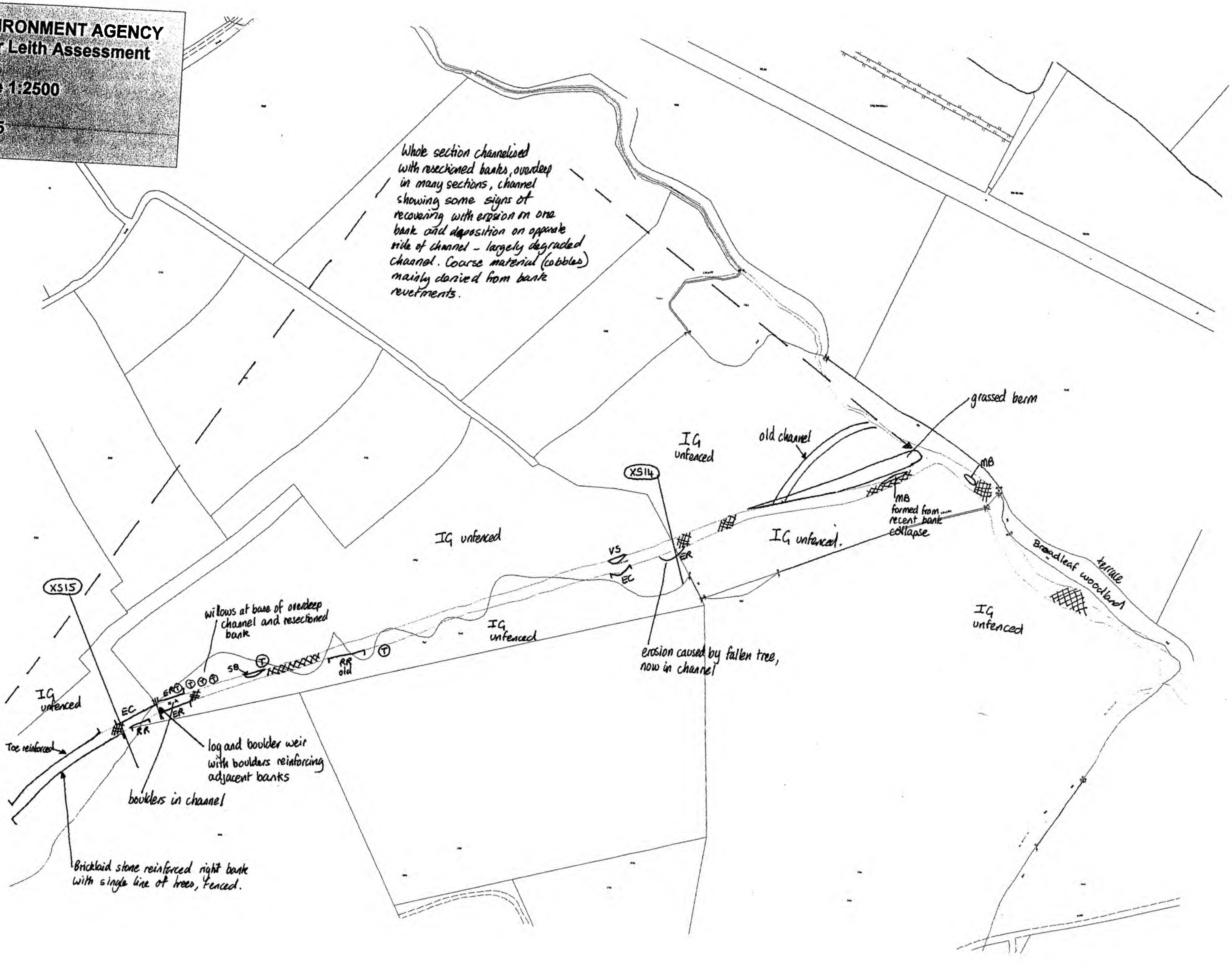


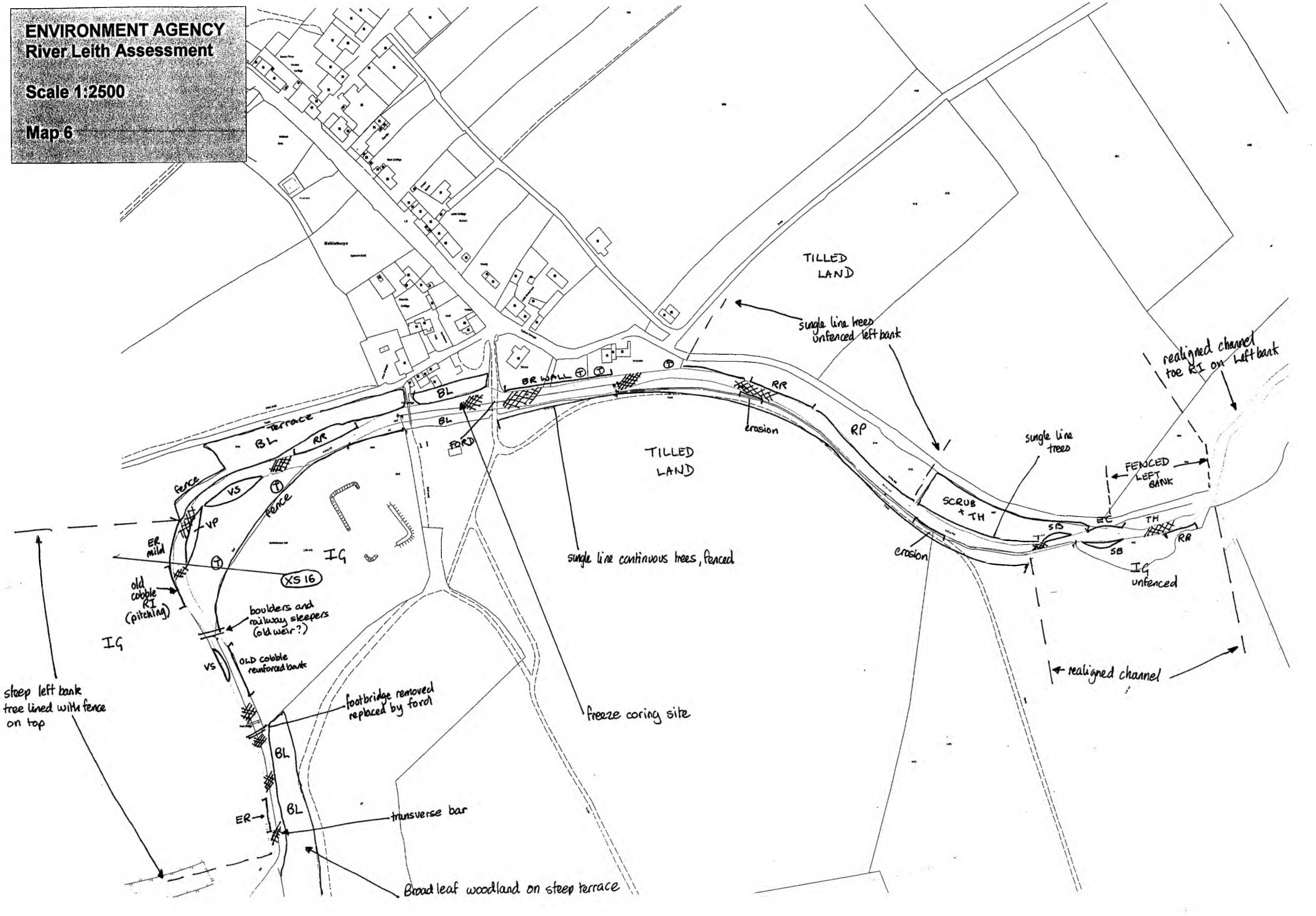

ENVIRONMENT AGENCY
River Leith Assessment
Scale 1:2500
Map 4
TILLED LAND
IG
bank eroded
trees in channel
EC
IG
unfenced
debris
dam
terrace
IG
right bank
Gentle profile
some composite profiles
from recent floods
RS
RS 45° slope
old RR
grassed
over
IG
grassed
berm
IG
unfenced
SC
TILLED LAND
VP
OLD RR+CC
RI
XS12
EC
BL
IG
fence
infilled bend
backwater
YS
VP
terrace
terrace
recent erosion
slumped material
on toe.
XS11
VP
VP
XS10
CARR
XS9
debris dam
old channel
holding some water
2 gabion groynes
IG unfenced
ER
VP
VP
VP
VP
ER
CP
outfall
ER
VP
ER
Channel cutoff
VP now an island
recent
partial channel
cutoff
Broadleaf
woodland
Leith Plantation
This narrow floodplain is densely wooded with isolated trees on the river bank. Whole area recently flooded, some standing water in dips with wetland vegetation
V shaped flood plain
this section only

ENVIRONMENT AGENCY
River Leith Assessment

Scale 1:2500

Map 5

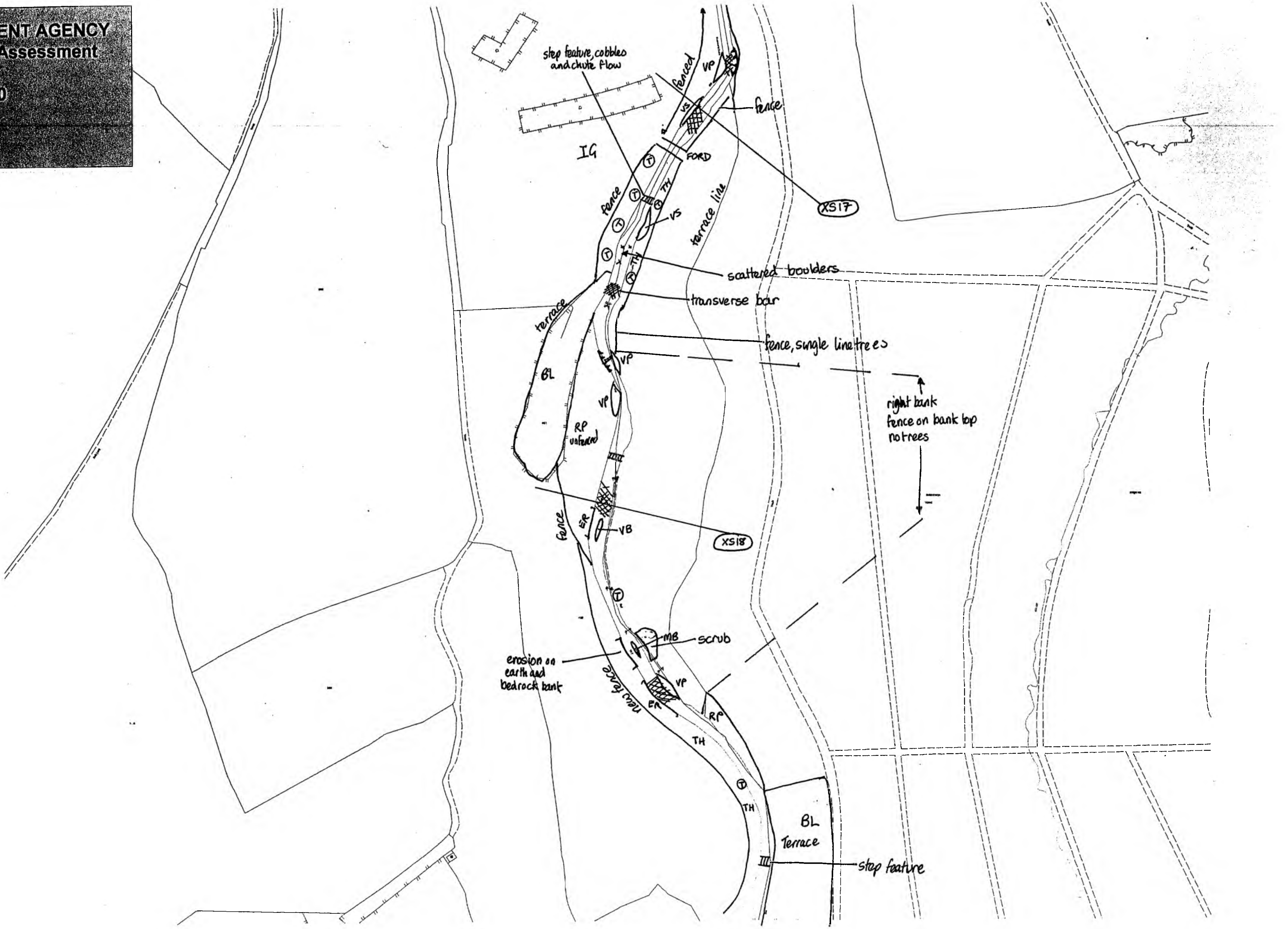



ENVIRONMENT AGENCY
River Leith Assessment
Scale 1:2500
Map 6
TILLED LAND
single line trees unfenced left bank
realigned channel toe RI on left bank
RR
erosion
RP
single line trees
FENCED LEFT BANK
SCRUB + TH
SB
EC
TH
RR
SB
IG unfenced
erosion
BR WALL
BL
BL
FORD
terrace
BL
RR
TILLED LAND
fence
VS
fence
VP
ER mild
IG
XS 16
single line continuous trees, fenced
old cobble RI (pitching)
boulders and railway sleepers (old weir?)
IG
VS
OLD cobble reinforced bank
realigned channel
steep left bank tree lined with fence on top
footbridge removed replaced by ford
freeze coring site
BL
ER
BL
transverse bar
Broad leaf woodland on steep terrace

ENVIRONMENT AGENCY
River Leith Assessment

Scale 1:2500

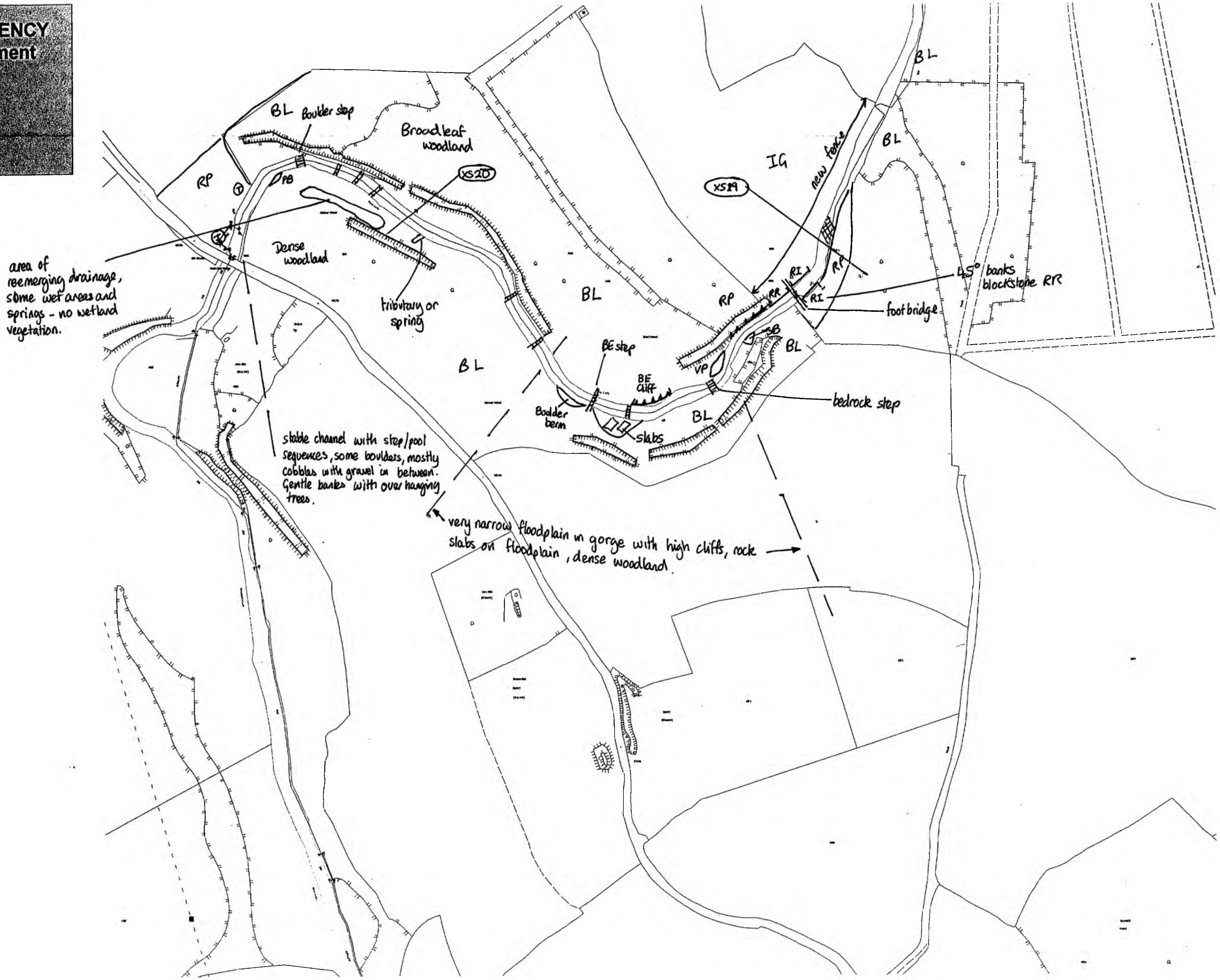
Map 7



ENVIRONMENT AGENCY
River Leith Assessment

Scale 1:2500

Map 8



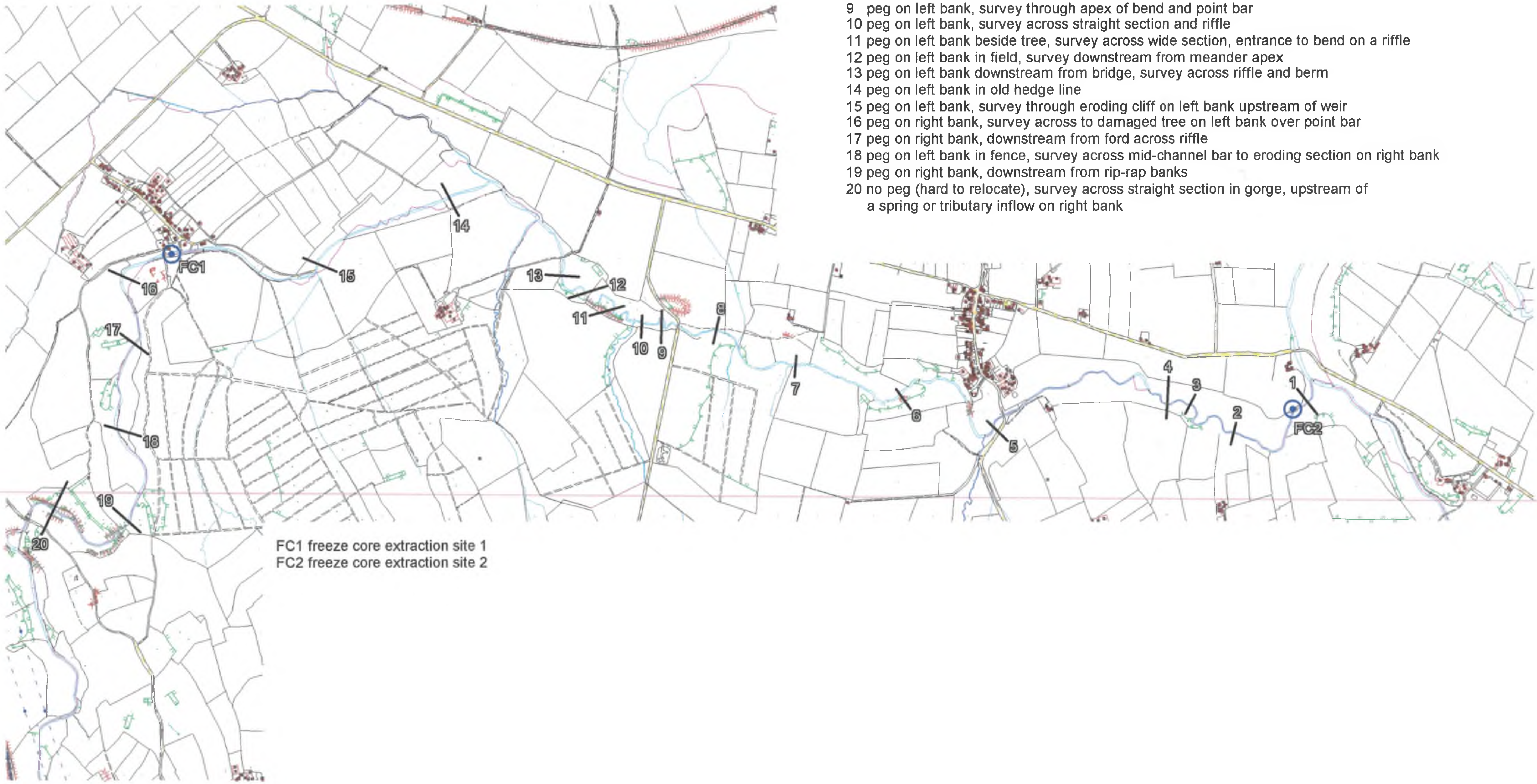
ENVIRONMENT AGENCY
River Leith Assessment

Scale 1:16000

Map 9: Locations for cross-section surveys

Location Notes

1 peg in fence on left bank
2 peg adjacent to mature tree on left bank opposite berm and river cliff
3 peg on left bank of floodplain, survey across collapsed right bank
4 peg on left bank, survey across riffle and point bar opposite high right bank
5 peg on right bank in hedge, survey into eroding cliff
6 peg in new fence on left bank opposite willow on right bank
7 peg in fenceline on left bank at the end of scrub vegetation
8 peg on left bank 20m upstream from stile
9 peg on left bank, survey through apex of bend and point bar
10 peg on left bank, survey across straight section and riffle
11 peg on left bank beside tree, survey across wide section, entrance to bend on a riffle
12 peg on left bank in field, survey downstream from meander apex
13 peg on left bank downstream from bridge, survey across riffle and berm
14 peg on left bank in old hedge line
15 peg on left bank, survey through eroding cliff on left bank upstream of weir
16 peg on right bank, survey across to damaged tree on left bank over point bar
17 peg on right bank, downstream from ford across riffle
18 peg on left bank in fence, survey across mid-channel bar to eroding section on right bank
19 peg on right bank, downstream from rip-rap banks
20 no peg (hard to relocate), survey across straight section in gorge, upstream of a spring or tributary inflow on right bank



FC1 freeze core extraction site 1
FC2 freeze core extraction site 2

Core 1

Core 2

Core 3

Plate 1. Sediment Cores From Site 1

Core 4

Core 5

Core 6

Plate 2. Sediment Cores From Site 2