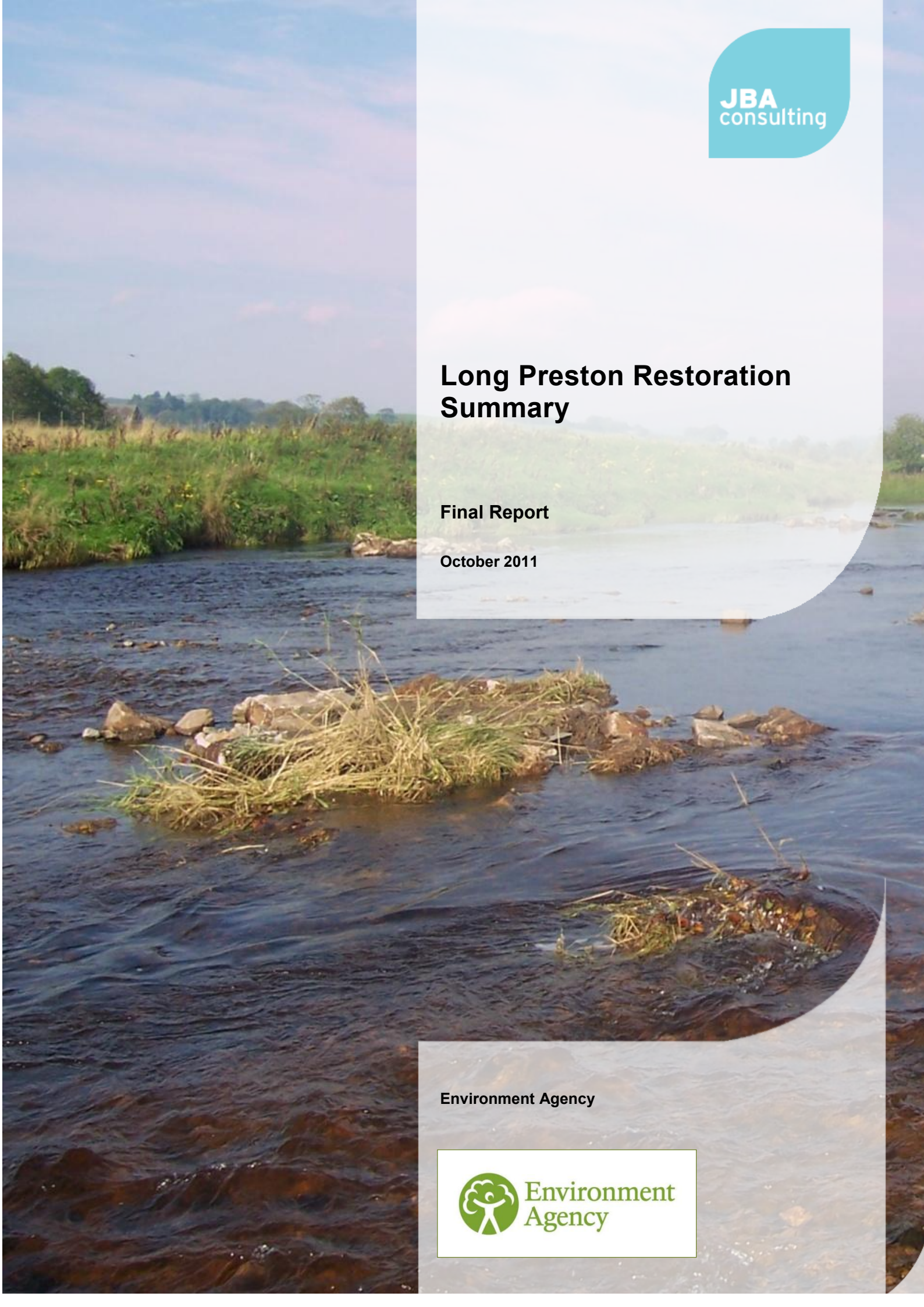

Long Preston Restoration Summary

Final Report

October 2011

Environment Agency

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Revision History

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Contract

This report describes work commissioned by Askam Construction, on behalf of the Environment Agency, by Peter Isherwood (order number C868/JBA/SB01). Seb Bentley and George Heritage of JBA Consulting carried out this work.

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Purpose

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Executive Summary

Introduction and Background

This report documents the restoration works that have been undertaken for a reach of the Long Preston Deeps in September 2011.

The works fall broadly in line with the SSSI River Restoration Plan developed by JBA Consulting for Natural England and the Environment Agency[1]. Deviation from the plan was necessary due to the reduced spatial extent of the works and landowner constraints. However, the broad ethos of the restoration plan was followed promoting natural river restoration practices, restoring natural processes and connections and facilitating channel response.

Restoration Techniques

Several techniques were utilised as part of the restoration works, including:

- Flood bank realignment
- Chute channel creation
- Paleo feature reinstatement
- Revetment removal and boulder cluster creation

These works are detailed in Figure 2-1 in the main report.

Perceived Benefits

The perceived hydromorphological, ecological and wider benefits of each restoration component have also been discussed and are shown in Table a below, and also an indication of the likely response of the system to the restoration works.

Table a: River and floodplain restoration works at Long Preston Deeps

Works	Perceived benefits
Flood bank realignment	Stream power reduction at flows above bankfull, influencing the sediment transport locally (extension of local bar feature) and reduced erosive pressure on right bank. Fine sediment deposition on floodplain reducing deposition in main channel on gravel features. Provides nutrients to the floodplain. The floodplain is to be planted with wet woodland species, therefore increasing the ecological diversity and flow diversity locally. It will allow development of the wandering channel locally, over time forming a more stable channel bounded by wooded riparian vegetation.
Chute creation	Increased flow and hydromorphological diversity for flows at a higher level than the normal annual average level. A greater area for energy dissipation due to a greater flow width. The flood flows through the chute channel will cause winnowing leading to bed armouring. It will provide a greater variation of in-channel habitat and therefore should increase the in-channel ecological diversity.

[1] JBA Consulting (2010). Long Preston Deeps River Restoration Plan. Report to Natural England and the Environment Agency.

Works	Perceived benefits
	Flood flows will be diverted away from the right bank which will reduce the erosion pressure there.
Revetment removal	Removal of the revetments will encourage a more natural flow and sediment regime locally and therefore we are likely to see more natural erosion processes along the channel banks.
Bed sediment alteration (boulder clusters)	Increased flow and hydromorphological diversification local to the boulder clusters. There has already been a change in the sediment size distribution around the clusters, with deposition of larger gravels at the upstream face and general fining of sediments downstream, in the lee of the cluster. It will have a positive impact on the ecological diversity by providing varied in-channel habitat and providing a shelter for fish, and micro-habitat for instream invertebrates.
Palaeo-feature reconnection	General floodplain morphological rejuvenation and flood flow reconnection. Increased flow and hydromorphological diversity for flows at a higher level than the normal annual average level. It will have a positive impact on the ecological diversity within the paleo feature as it will now be wetted more frequently and will receive fine sediment and nutrients from the river. The river will now occupy a feature that it probably would have under natural conditions, providing more natural conditions for the river locally. There could be some diversification in the gravel bed features within the main channel of the Ribble due to the impacts of a proportion of flow now being diverted around the paleo feature.
Exclusion fencing	The fencing programme will help to facilitate natural vegetation reestablishment by limiting access to grazing cattle.

Predicted Reactions to the Restoration

The likely reactions to the restoration are shown in Figure a and Table b below:

Figure a: Predicted channel and floodplain responses in restored section

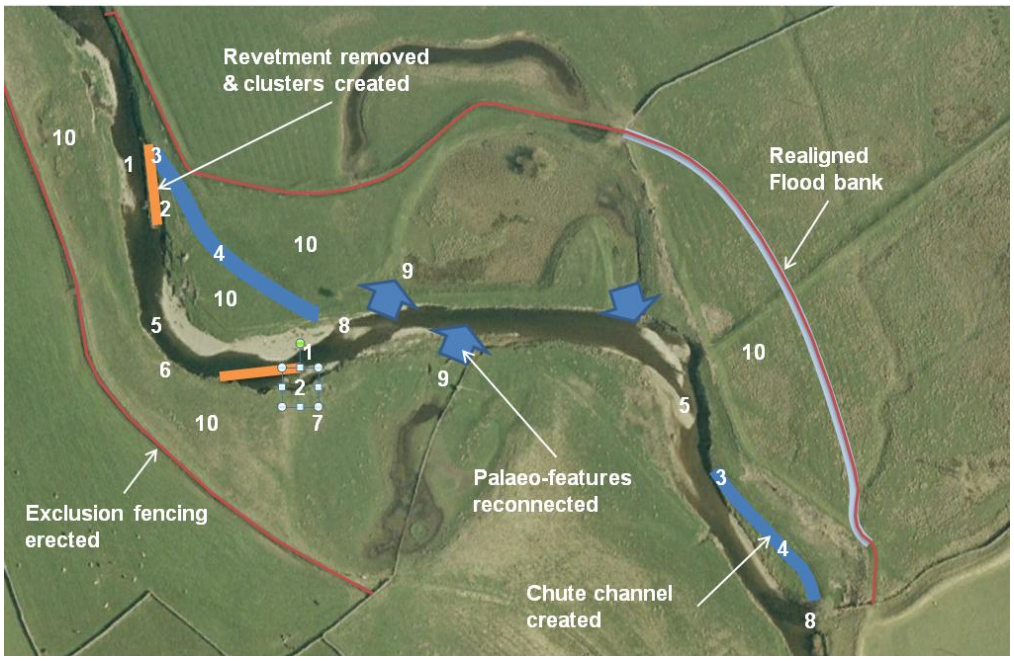

Table b: Predicted channel and floodplain responses in restored section

Feature code (as shown in Figure above)	Linked restoration activity	Short term response	Long term response
1	Cluster creation	Rapid micro-habitat creation Increased flow diversity	Development of vegetated bars Flow channel bifurcation
2	Revetment removal	Bank erosion processes restored	Lateral channel migration mitigated by floodplain woody vegetation
3	Chute channel creation	Stripping of entrance sediments Realignment of chute entrance Coarsening of bed material	General lowering of chute elevation Improved flow connectivity
4	Chute channel creation	Redistribution of chute sediments Micro-habitat creation Chute entrance/exit change	Development of diverse chute morphology and sedimentology
5	Chute channel creation / Flood bank realignment	Increased gravel bed stabilisation	Increased gravel bed stabilisation
6	Chute channel creation	Reduced lateral erosion	Bank stabilisation and vegetative development
7	Palaeo-channel reconnection	Localised natural palaeo-feature reconnection	Rejuvenation of palaeo-meander and associated habitats
8	Chute channel creation	Accumulation of flushed fines	Development of convergence scour pool
9	Chute channel creation	Rapid vegetation development Flow differentiation	Slow silt accumulation Micro-habitat creation
10	Exclusion fencing	Development of ungrazed floodplain vegetation	Planned woody vegetation planting combined with

Feature code (as shown in Figure above)	Linked restoration activity	Short term response	Long term response
			naturalisation of the floodplain herbaceous plants will develop into riparian zone woodland with associated impacts on channel stability

Way Forward

Finally, recommendations have been provided for further restoration works upstream and downstream that will further the successes of the work completed to date. These works will extend the naturalisation of the river along much of the active incipient wandering reach of the river, restoring floodplain connectivity, reducing excessive in-channel hydraulic forces and reactivating floodplain features and processes.

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Abbreviations

JBA	Jeremy Benn Associates
m	Metres
RBMP	River Basin Management Plan
SSSI	Site of Special Scientific Interest
WFD	Water Framework Directive

1 Introduction

1.1 Introduction

JBA Consulting supervised groundworks undertaken by Askam Construction in September 2011 to complete restoration works along the River Ribble, close to Settle. The intention of this summary report is to:

- Provide a diary of the restoration undertaken.
- If/where the restoration works have differed compared to the original design.
- The perceived benefits of the restoration works from a hydromorphological and ecological perspective.
- A predicted reaction of the watercourse to the restoration works.
- How this work links to further restoration works along the River Ribble.

1.2 Water Framework Directive (WFD) targets for the Ribble

The WFD targets identified for the River Ribble in the North West River Basin Management Plan (RBMP) are to reach Good Ecological Status by 2015. It is currently defined as moderate. Proposed actions identified by the RBMP include

- A specific action to implement a restoration plan along the Long Preston Deeps through physical modification.
- A Flood/Coastal Erosion Risk Management Measures for realignment of the flood defence and preserve and enhance ecological value of marginal aquatic habitat, banks and riparian zone.

The restoration works undertaken all contribute to the WFD targets and measures identified, as described in the perceived benefits sections above.

1.3 Background

In 2010 the status of Long Preston Deeps Site of Special Scientific Interest (SSSI) was confirmed overall to be in unfavourable condition. A Government target for SSSIs has required a river restoration plan for Long Preston Deeps SSSI to be adopted by December 2010, contributing to moving the SSSI towards unfavourable recovering condition. The North West River Basin Management Plan (RBMP) has identified the Long Preston Deeps Restoration Plan as an action to be completed as part of the identified measures to help the River Ribble meet Good Ecological Status by 2015.

The Government Report Making Space for Nature[2], now published on Defra's website, stresses that a step-change in nature conservation is needed in England and that, 'we need to embrace a new, restorative approach which rebuilds nature and creates a more resilient natural environment for the benefit of wildlife and ourselves'. A key theme amongst its recommendations is the need to continue progress in improving the management and condition of our SSSI's, including ways that enhance their resilience to climate change.

The previous reports and plans outlined an unconstrained vision of the potential restoration options that are desirable to meet the conservation objectives.

The key aims of the restoration plan were to:

- Work with natural processes to develop a river and floodplain system consistent with its controlling factors
- Restore former functional features such as old channels to create new dynamic and diverse habitats

[2] Lawton, J.H., Brotherton, P.N.M., Brown, V.K., Elphick, C., Fitter, A.H., Forshaw, J., Haddow, R.W., Hilborne, S., Leafe, R.N., Mace, G.M., Southgate, M.P., Sutherland, W.J., Tew, T.E., Varley, J., & Wynne, G.R. (2010) *Making Space for Nature: a review of England's wildlife sites and ecological network*. Report to Defra.

- Improve channel, bank and floodplain morphology
- Restore connectivity between the channel and its floodplain
- Allow the slow/natural migration of the river channel through restored sediment transport processes
- Work closely with stakeholders to develop and implement restoration actions

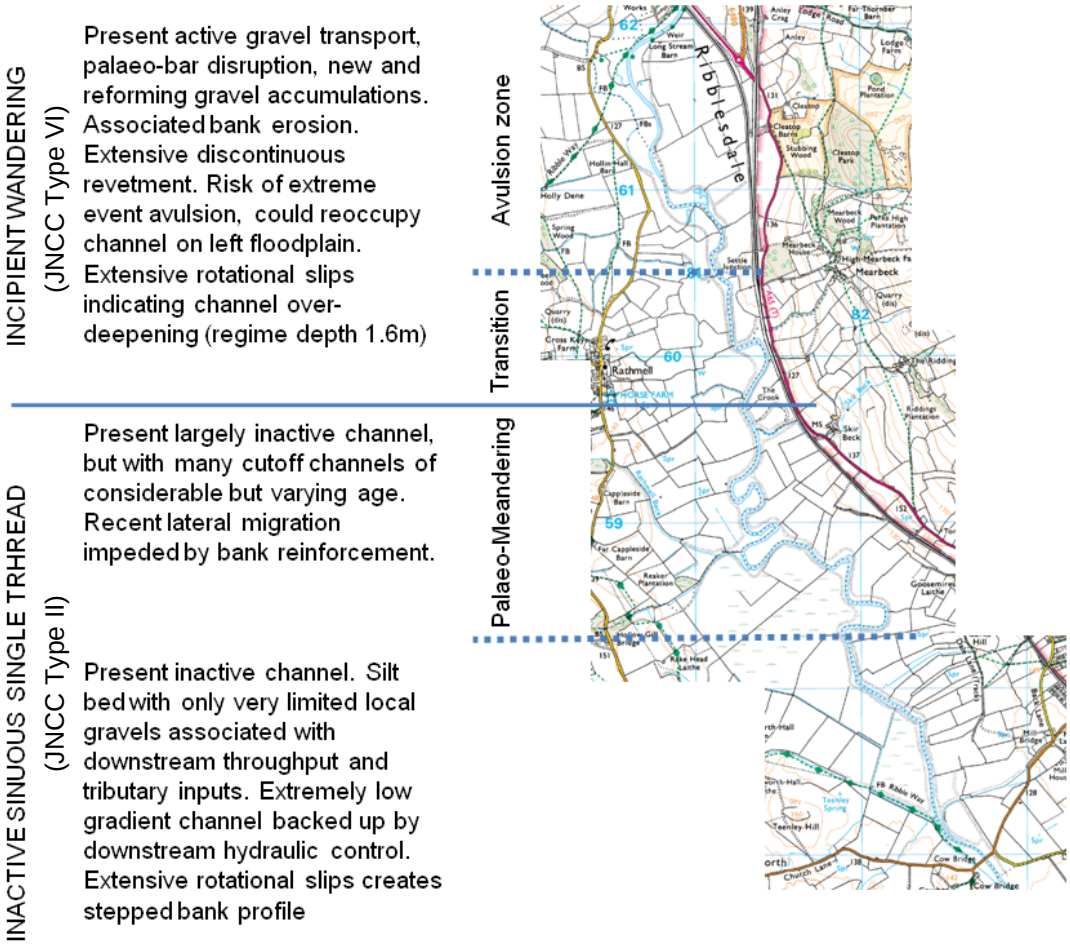
The river and floodplain at Long Preston Deeps has undergone considerable modification over time and is subject to land management pressures. Gross changes to the physical form and function have occurred which in turn have affected the flora and fauna across the entire site. As a result the system is presently degraded and displays few of the functional geomorphological and ecological features expected under more natural conditions. The River Ribble Catchment Flood Management Plan only has one action for Long Preston Deeps which is to promote restoration of the floodplain to attenuate flows in the upper Ribble catchment and reduce flood risk downstream.

Under the present management regime the site will remain in a geomorphologically degraded state and active restoration measures accompanied by altered management regimes are required to improve the current situation. Restoration should re-establish form and function through assisted natural recovery, it should also consider both the river and floodplain as a single functional unit due to the intrinsic process linkages between the two. In this way a system will develop that is controlled by current processes with the barriers to natural development and functioning removed.

The SSSI is characterised by an active gravel bed river with a number of large gravel bars in the northern half of the SSSI area (incipient wandering river reach) gradually changing to a uniform low energy, over-deepened silt bed river (inactive sinuous single thread reach) to the south of the Crook (near the centre of the SSSI). These river characteristics conform with those that could be expected given the local controls on channel form, with steeper gradients characterising the wandering channel and very low gradients characterising the single thread channel as it flows across old lake sediments.

Both river characters presently exhibit modified morphology and ecology due to past and present engineering and management activities (see Figure 1-1). The wandering channel is exhibiting heightened bank erosion, as you would expect. The floodplain is currently almost completely disconnected from the river due to the physical processes operating within the channel which are as a result of the past management measures, leading to significantly reduced levels of floodplain inundation (i.e. online flood banks).

Figure 1-1: Summary character of the River Ribble through Long Preston Deeps highlighting major alterations to the natural river and floodplain dynamics.



The primary causes behind the unnatural watercourse and floodplain at the site include:

Grossly altered flooding regime

Extensive flood banks confine all but the more extreme flows to the main channel and immediate overbank area. This is affecting both in-channel and floodplain morphology and ecology. Elevated in-channel flood flows frequently create energetic conditions sufficient to mobilise gravels and prevent vegetative stabilisation which is important for fisheries as stable gravels provide better spawning habitat.

Historic dredging has also artificially increased channel capacity retaining flood flows in-channel, causing extensive bank collapse and creating a stepped profile along the majority of both banks. It has also destroyed the natural in-channel morphology which is very slow to recover through the low energy single thread reach.

Highly modified channel

The bank protection that is present along considerable stretches of the river (especially the single thread reach) is disrupting natural erosion processes and preventing lateral channel movement, inhibiting bar development and creating local instability where it has been outflanked. This also has impacts downstream where increased bank erosion is experienced on opposing banks (to the protected banks) as the flow direction is made more sinuous through the deflection off the protected banks.

In many places the protection has failed to prevent rotational slips along the banks with the revetment moving into the river as part of the slipped mass.

Managed floodplain

Livestock access to the river is inhibiting vegetative development along stepped banks and is contributing to the development of unnatural fine sediment berms in the main channel.

Floodplain drainage is further disrupting the hydrologic regime of old channel and backswamp areas.

The flora of Long Preston Deeps SSSI has responded negatively to the altered morphology and dynamics of the reach. In particular, the aquatic environment is poor in water-crowfoot, water-starwort and pondweed species and the grazed banks support a highly modified assemblage dominated by creeping bent grass. Bankside woody vegetation is almost completely absent save for a few scattered sycamore, young alder and crack willow.

Further background information can be found in the previous background report to the restoration plan[3].

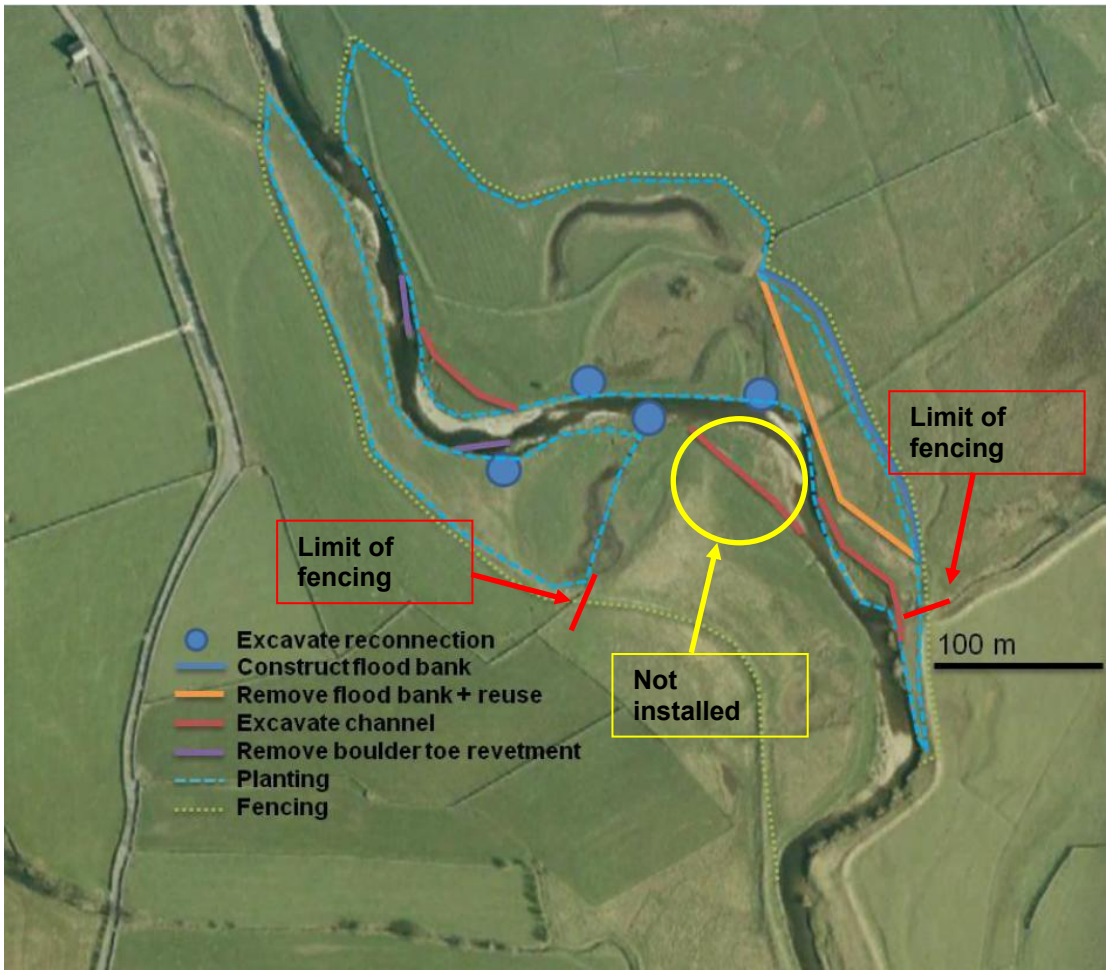
[3] JBA Consulting (2010). Long Preston Deeps River Restoration Plan. Report to Natural England and the Environment Agency.

2 Restoration Works and Perceived Benefits

2.1 Overall plan of works

The original restoration plan devised for the Long Preston Deeps has changed following consultation with landowners. Figure 2-1 below shows the original plans for this phase of the restoration works and further plans are provided as Appendix A.

Figure 2-1: Original restoration plan



The significant change from this plan is that the right bank chute channel could not be excavated as landowner consent was not given. The fencing on the right bank does not stretch as far as shown above, it is now stopped at the edge of the marked planting section. Similarly over the left bank, the fencing stops at the end of the downstream chute channel.

2.2 Planned silt mitigation during site works

During the planning process, three activities were identified as creating a potential for silt and fine sediment production within the channel. These were:

1. Silt production associated with plant crossing - Plant will be making a single traverse of the river onto and off of site at a riffle site. The bed composition at this site is dominated by coarse gravels with an infill of finer gravel, sands and some silt. Minor disruption of the bed is anticipated releasing limited fine sediment into suspension. Tracking up the bank side will cause local erosion of fine deposits, this level of loss is seen all along the banks of both sides of the river. This will quickly be dissipated across the flow and will be for a very short period of time. Overall the volume of released sediment will be well within normal transport limits for this river during elevated flows and no methods to reduce releases are recommended.

2. Silt production associated with palaeo-channel reconnection - Floodplain sedimentological evidence suggests that the palaeo-channel excavation will expose previous river gravels in the bed. This material will have a high level of fines which will be released when the channels are rejoined. As such excavation should be of the central portion first followed by downstream reconnection and finally upstream reconnection. Sediments should be employed at the palaeo-channel exits to catch released sediment.
3. Silt production associated with revetment removal - Short lengths of masonry blockwork should be removed from the main channel. This will be completed from the bank wherever possible but some plant access to the channel may be required. The bed material around the revetment is dominated by coarse gravels with an infill of finer gravel, sands and some silt. Minor disruption of the bed is anticipated releasing limited fine sediment into suspension. The volume of released sediment will be well within normal transport limits for this river during elevated flows and no methods to reduce releases are recommended. Impact on downstream gravel units will be undetectable.

During the site works it was evident that the predicted low level impact on fine sediment production above was accurate. Minimal fine sediment/silt was produced when plant crossed the river at the riffle site. Very little fine sediment entered the channel during excavation works associated to connection of the paleo-channel. Minor amounts were released during the revetment removal and cluster installation works. Downstream monitoring was undertaken during these works to ensure significant amounts were not being released.

2.3 Setting back the flood bank

Restoration works began on site on 14 September 2011, due to a delay the previous week caused by a significant flood event along the River Ribble that resulted in extensive flooding across the site. Due to the high water levels on 14 September, the restoration works initially focused on setting back the flood embankment on the left bank where a breach had previously occurred in the existing embankment. The final location of the embankment has changed compared to the plans due to a request on site by the land owner that it not be set back as far as indicated on the plan. Therefore, it is now located approximately half way between the left bank of the Ribble and the ditch running through the field in the floodplain, shown below in Figure 2-2, photograph a). However, this has still opened up approximately 7,500m^2 of floodplain.

Figure 2-2: Set back flood embankment photos

a) Set back flood embankment during construction, looking upstream. Note the flood embankment has been set at a slightly higher level to the original embankment to allow for settlement.

b) View of flood embankment from floodplain side. Seeding was undertaken during the

construction phase and before the embankment was 'smoothed' to minimise seed being moved by the wind.

c) View of left hand floodplain where embankment has now been set back. The area where the embankment has been removed from has also been seeded.

d) Restored floodplain area. Time was spent smoothing this floodplain area post completion

of the flood embankment.

2.3.1 Perceived benefits and likely reaction to setting back the flood bank

The Ribble has now been reconnected to a part of it's floodplain by setting back the flood bank at this location. Whilst this is only a small area compared to the remaining length of flood bank that is tight to the banks, the perceived benefits include:

- Setting back the flood bank will have reduced the stream power at flows above bankfull which will influence the sediment transport characteristics locally. This could result in an extension to the gravel bar feature at this location, as well as a reduced erosive pressure on the opposite bank and further downstream. This is because the flood flow will now be spread over a greater area locally, resulting in a dissipation of energy compared to the previous situation when the flow is contained between the original flood embankments.
- Finer sediment transported in flood flows can now be deposited within this section of floodplain rather than transported further downstream (increasing the nutrient content on the floodplain) and deposited within the channel, which reduces the hydromorphological diversification within the river. This may help to improve the gravel bed features further downstream. Some fine sediment may infill gravel features however, this is not anticipated to be excessive and the gravels will not be smothered.
- The floodplain is to be planted with wet woodland species, therefore increasing the ecological diversity and flow diversity locally.
- Extra flood storage is now being provided on the floodplain here, which may reduce flood water levels downstream (the extent of this could only be defined using a hydraulic model although it is thought this will not be significant).
- It will allow development of the wandering channel locally, over time forming a more stable channel bounded by wooded riparian vegetation.

The flood embankment has been constructed slightly above the previous embankment level to allow for settlement over time. It is also wider than previously constructed to allow easier access to the crest, with acceptable slope gradients. The flood embankment and area where the flood embankment was moved from has been seeded with grass.

It is likely that erosion will be experienced on the left bank of the Ribble where the flood bank has been set back as it now does not have to cut through the embankment. Current erosive patterns on this bank certainly indicate that continued erosion is likely to occur (with significant flow turbulence and eddies at the foot of the bank, meaning undercutting of the banks is likely to occur), however this should not be seen as a negative, instability is natural and the idea of this restoration scheme is to reinstate some 'naturalness' to the watercourse and the floodplain.

2.4 Downstream chute channel

A chute channel approximately 30-40m long and 5-7m wide (top of bank width) has been cut into a left bank paleo bar feature adjacent to where the flood embankment has been set back, shown in Figure 2-3 below. Gravels were encountered at the downstream end of the chute channel but not at the upstream end. This feature was installed shortly after completion of setting back the flood embankment. The material produced from this feature was used for setting back the flood embankment. The idea of this feature is to provide flow and hydromorphological diversification during higher flows.

Figure 2-3: Downstream chute channel photographs

a) View of chute channel looking downstream. Note the water level marks on the right bank of the chute channel showing level of recent flood.

b) Downstream end of chute channel showing gravels exposed during excavation.

c) Chute channel activated at higher flow, looking upstream. Some sediment deposition was evident after this event.

d) Bed composition of exposed gravel section at downstream end of chute channel.

e) Photograph showing some areas of bank likely to be eroded through natural processes.

2.4.1 Perceived benefits and likely reaction to the chute channel

The perceived benefits include:

- Increased flow and hydromorphological diversity for flows at a higher level than the normal annual average level.
- A greater area for energy dissipation due to a greater flow width.
- The flood flows through the chute channel will cause winnowing leading to bed armouring.
- It will provide a greater variation of in-channel habitat and therefore should increase the in-channel ecological diversity.

As described above, once the chute has been active for a significant period of time, we should begin to see the bed armouring, through mainly winnowing of the bed leaving coarser gravels, and through gravels deposited from upstream. The bed of the chute channel is likely also be eroded to the gravel layer that is approximately 0.3-0.5m below the current engineered bed level with fine sediment stripping occurring downstream from the chute entrance.

It is likely there will be some natural modification to the bank immediately upstream of the chute channel (there is a section of bank shown in Figure 2-3, photograph e)**Error! Reference source not found.** which is likely to be eroded at higher flows). The island that has been created by the engineering of the chute channel is also likely to be modified during higher flow events, particularly the upstream end which will be susceptible to erosion. Again, erosion is a natural process so this should not be considered as a negative reaction by the river and will promote seral vegetation community development.

Other likely reactions include:

- Flood flows will be diverted away from the right bank which will reduce the erosion pressure there.
- It will create secondary wet/damp habitats with greater water table connection.

- It will also create stable gravel habitat.
- It is likely to create a deeper convergence pool at the exit back into the main river providing deep, low energy pool habitat during low flows.
- It isolates the stable bar area in mid-channel reducing grazing pressure and promoting seral vegetation development.

2.5 Reconnection of paleo feature over left bank

Work on this feature began on the 26 September. A paleo meander bend has been reconnected to the Ribble main channel by cutting through the flood embankment at what would have been the entrance to this feature, shown in Figure 2-4 below. The entrance has been connected at a level where flow should begin to enter the feature at approximately the same time as the downstream and upstream chute channels (i.e. above annual average flows). Gravels were found at this level, indicating an appropriate bed level for the entrance to this feature. The width of the cut through the embankment is approximately 10m from top of bank. General clearance work was also undertaken where the paleo features reconnects to the main channel downstream. In the past, this feature was only inundated during significant flood events where it filled from the downstream end, or in extreme events where it overtopped the flood embankments.

Figure 2-4: Paleo feature photographs

a) Paleo feature that has now been reconnected. This view is looking upstream towards the inlet.

b) Inlet to paleo feature during construction showing exposed gravels at the bed level.

c) View from inlet into the paleo feature showing that the level of the inlet is set at approximately the same bed level as the paleo feature.

2.5.1 Perceived benefits and likely reaction to reconnection of the paleo feature reconnection

The perceived benefits include:

- General floodplain morphological rejuvenation and flood flow reconnection.
- Increased flow and hydromorphological diversity for flows at a higher level than the normal annual average level.
- It will have a positive impact on the ecological diversity within the paleo feature as it will now be wetted more frequently and will receive fine sediment and nutrients from the river.
- The river will now occupy a feature that it probably would have under natural conditions (i.e. with no flood embankment in place) therefore, we are providing more natural conditions for the river locally.
- There could be some diversification in the gravel bed features within the main channel of the Ribble due to the impacts of a proportion of flow now being diverted around the paleo feature. This is not considered a negative impact from a hydromorphological perspective as it is encouraging a more natural sediment regime.
- The feature will be providing flood storage which could result in lower downstream water levels, however, this is deemed to be relatively insignificant.

Once this feature has been active for a significant period of time, we are likely to see some modification to the inlet to the paleo feature. This may be in the form of widening, erosion of the inlet bed and/or deposition of gravels on the bed of the inlet and within the paleo feature. There could be impacts on the gravel bed features at the downstream exit from the paleo feature, the existing gravels could become winnowed over time due to more frequent flows through the reconnected feature. However, these are likely to be distributed locally further downstream, potentially on existing gravel bar features, and eventually further downstream where gravel supply appears to be low.

2.6 Upstream chute channel

A chute channel approximately 50-60m long and 10m wide (top of bank width) has been cut into a left bank paleo bar feature. Gravels were encountered at the downstream end of the chute channel but not the upstream end. This feature was installed towards the end of the site works in September. The material produced by installing this feature has been redistributed along the flood bank local to the feature, ensuring that the height has not been increased (i.e. it is now a slightly wider feature). The idea of this feature is to provide flow and hydromorphological diversification during higher flows.

Figure 2-5: Upstream chute channel photographs

a) Upstream chute channel during construction looking downstream showing fine sediment on bed.

b) Upstream inlet to chute channel (note - entrance angle has now been smoothed off

following this photograph).

2.6.1 Perceived benefits and likely reaction to the chute channel

The perceived benefits are very similar to the downstream chute channel described in section 2.4.1.

Again, the bed of the chute channel should become armoured over time through stripping of the fine sediment on the bed at the upstream end.

2.7 Boulder clusters and general bed coarsening

The boulder revetments along the right and left banks of the upstream section of this reach have been removed where they had become separated from the channel banks and therefore were no longer protecting the banks for erosion. The boulders have been redistributed in the channel to form irregular clusters through the main channel of the upstream section of the restored reach. These mimic natural coarser areas seen across cobble and gravels riffles and generate local variation in bed sedimentology and flow energy. The general distribution achieved is shown below in Figure 2-6, photograph a) and b). These have mainly been installed on the long riffle feature adjacent to where the left bank revetment was removed but also further downstream on the riffle feature close to where the right bank revetment boulders were removed.

Figure 2-6: Boulder cluster photographs

a) Some of installed boulder clusters and general coarsening of the bed towards the left bank

b) Boulder cluster network and bed coarsening looking downstream (note flow variation improving the diversity across the uniform glide).

c) Boulder cluster composition showing diversity in material size and distribution.

2.7.1 Perceived benefits and likely reaction to the boulder clusters

The perceived benefits include:

- Increased flow and hydromorphological diversification local to the boulder clusters.
- There has already been a change in the sediment size distribution around the clusters, with deposition of larger gravels at the upstream face and general fining of sediments downstream, in the lee of the cluster.
- It will have a positive impact on the ecological diversity by providing varied in-channel habitat and providing a shelter for fish, and micro-habitat for instream invertebrates.
- Removal of the revetments will encourage a more natural flow and sediment regime locally and therefore we are likely to see more natural erosion processes along the channel banks.

It is likely that some of the boulder clusters will be modified and redistributed during significant flood events as these are now considered to be mobile sediments where as previously these were fixed by fine sediments to the banks.

Larger boulders may lead to some of the clusters becoming fixed features over time and therefore could become naturally vegetated.

2.8 Grip de-silting

The grip that connects the wetland/pond feature over the right bank of the Ribble has been partially reconnected by removing/clearing deposited silt from the downstream section of the grip. This has been undertaken sensitively to ensure the pond feature does not drain down into the Ribble. However, enough material has been removed to encourage more frequent wetting of this feature.

2.8.1 Perceived benefits and likely reaction to the grip de-silting

The perceived benefits include:

- More frequent wetting of the pond feature is likely to improve the habitat for existing species and potentially provide a more varied habitat to increase the existing ecological diversity.
- Providing a more natural connection between the feature and the Ribble.

2.9 Fencing

The fencing programme will help to facilitate natural vegetation reestablishment by limiting access to grazing cattle.

2.10 Other minor works

Other works have mainly consisted of repairs to small holes in low level embankments highlighted by the landowners whilst on site.

2.11 Summary

The restoration of the Ribble at the Long Preston Deeps has been undertaken to restore the form and function of the river and floodplain by providing assistance to the 'natural' recovery of the system locally. The works and associated benefits are summarised in Table 2-1.

Table 2-1: River and floodplain restoration works at Long Preston Deeps

Works	Perceived benefits
Flood bank realignment	Stream power reduction at flows above bankfull, influencing the sediment transport locally (extension of local bar feature) and reduced erosive pressure on right bank. Fine sediment deposition on floodplain reducing deposition in main channel on gravel features. Provides nutrients to the

Works	Perceived benefits
	floodplain. The floodplain is to be planted with wet woodland species, therefore increasing the ecological diversity and flow diversity locally. It will allow development of the wandering channel locally, over time forming a more stable channel bounded by wooded riparian vegetation.
Chute creation	Increased flow and hydromorphological diversity for flows at a higher level than the normal annual average level. A greater area for energy dissipation due to a greater flow width. The flood flows through the chute channel will cause winnowing leading to bed armouring. It will provide a greater variation of in-channel habitat and therefore should increase the in-channel ecological diversity. Flood flows will be diverted away from the right bank which will reduce the erosion pressure there.
Revetment removal	Removal of the revetments will encourage a more natural flow and sediment regime locally and therefore we are likely to see more natural erosion processes along the channel banks.
Bed sediment alteration (boulder clusters)	Increased flow and hydromorphological diversification local to the boulder clusters. There has already been a change in the sediment size distribution around the clusters, with deposition of larger gravels at the upstream face and general fining of sediments downstream, in the lee of the cluster. It will have a positive impact on the ecological diversity by providing varied in-channel habitat and providing a shelter for fish, and micro-habitat for instream invertebrates.
Palaeo-feature reconnection	General floodplain morphological rejuvenation and flood flow reconnection. Increased flow and hydromorphological diversity for flows at a higher level than the normal annual average level. It will have a positive impact on the ecological diversity within the paleo feature as it will now be wetted more frequently and will receive fine sediment and nutrients from the river. The river will now occupy a feature that it probably would have under natural conditions, providing more natural conditions for the river locally. There could be some diversification in the gravel bed features within the main channel of the Ribble due to the impacts of a proportion of flow now being diverted around the paleo feature.
Exclusion fencing	The fencing programme will help to facilitate natural vegetation reestablishment by limiting access to grazing cattle.

A summary of the likely responses to the restoration works are given below in Figure 2-7 and Table 2-2.

Figure 2-7: Predicted channel and floodplain responses in restored section

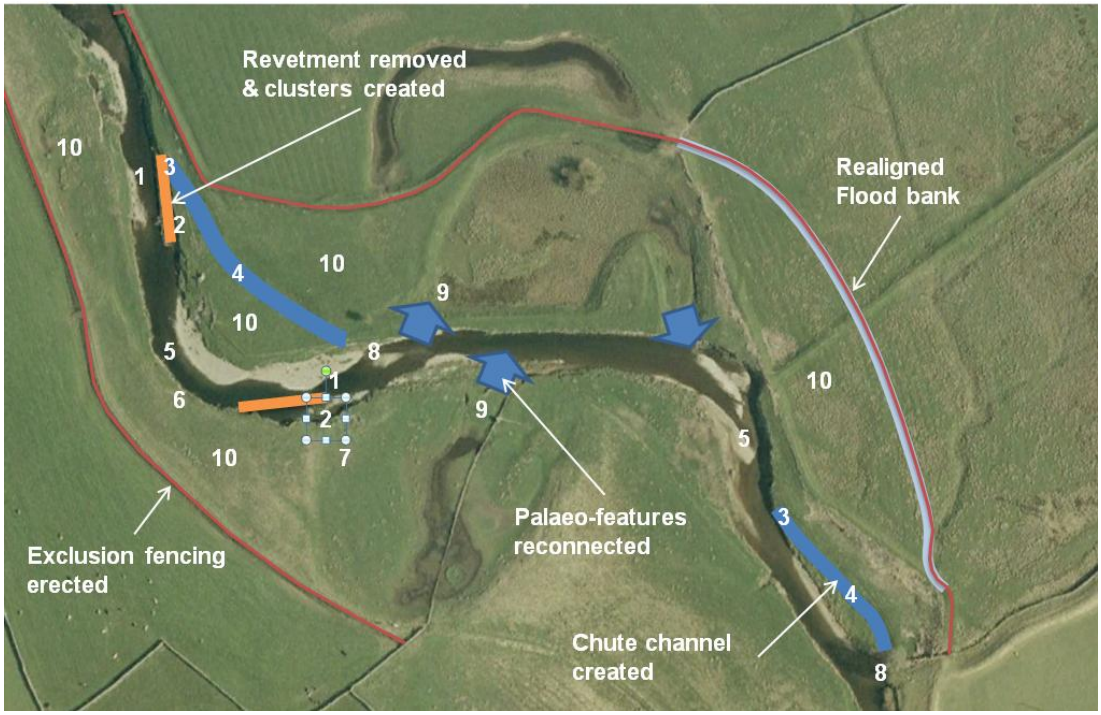


Table 2-2: Predicted channel and floodplain responses in restored section

Feature code (as shown in Figure 2-7)	Linked restoration activity	Short term response	Long term response
1	Cluster creation	Rapid micro-habitat creation Increased flow diversity	Development of vegetated bars Flow channel bifurcation
2	Revetment removal	Bank erosion processes restored	Lateral channel migration mitigated by floodplain woody vegetation
3	Chute channel creation	Stripping of entrance sediments Realignment of chute entrance Coarsening of bed material	General lowering of chute elevation Improved flow connectivity
4	Chute channel creation	Redistribution of chute sediments Micro-habitat creation Chute entrance/exit change	Development of diverse chute morphology and sedimentology
5	Chute channel creation / Flood bank realignment	Increased gravel bed stabilisation	Increased gravel bed stabilisation
6	Chute channel creation	Reduced lateral erosion	Bank stabilisation and vegetative development
7	Palaeo-channel reconnection	Localised natural palaeo-feature reconnection	Rejuvenation of palaeo-meander and associated habitats
8	Chute	Accumulation of flushed fines	Development of convergence

Feature code (as shown in Figure 2-7)	Linked restoration activity	Short term response	Long term response
	channel creation		scour pool
9	Chute channel creation	Rapid vegetation development Flow differentiation	Slow silt accumulation Micro-habitat creation
10	Exclusion fencing	Development of ungrazed floodplain vegetation	Planned woody vegetation planting combined with naturalisation of the floodplain herbaceous plants will develop into riparian zone woodland with associated impacts on channel stability

It has improved the connection of the river and floodplain locally, which should be regarded as a single functional unit rather than separate units.

The completed restoration measures may also improve the overall dynamic 'stability' of the reach locally by reducing pressures on channel erosion during extreme floods.

The restoration will also lead to an improvement in the ecology of the SSSI, by providing more varied habitat, leading to increases in numbers of species and hopefully the return of species that are currently absent from the site.

The reaction of the channel to the restoration may be slow but the emphasis has been to restore naturalness to the system. Whilst we have attempted to predict some of the likely responses following the restoration works, it is important to remember that a natural system can be unpredictable and therefore those suggested in this report should not be treated as an exhaustive list.

The success of this project is also dependant on a commitment to further restoration works along the Long Preston Deeps, upstream and downstream of the works completed to date. For the system to function successfully, and to satisfy fully targets specified in the WFD, the suggestions in section 3 of this report should be considered as the proposed next stage to the Long Preston Deeps Restoration Scheme.

3 Future Restoration Works

3.1 Restoration Vision for the Long Preston Deeps

As described in section 2.11, it is considered vitally important that attentions are now turned to the scope of further restoration works upstream and downstream of the restoration undertaken to date along the Long Preston Deeps. This is considered as fundamental for achieving the restoration vision to recreate a more dynamic system, optimising channel and floodplain form and function to processes operating locally and within the wider catchment. Restoration upstream and downstream will further enhance the success of the restoration works undertaken to date.

3.2 Proposed Phase 2 Restoration Upstream

Figure 3-1: Proposed upstream restoration works

The outline restoration works for the reach upstream of the completed restoration section are shown above in Figure 3-1. The perceived benefits are:

- Weir removal at Long Stream Barn (downstream of Settle Railway Bridge) - complete removal will increase the gradient locally encouraging riffle development, partial removal would lead to flow concentration and the development of a deeper channel comprised of coarser winnowed material and sediment deposition and bar formation in lower energy areas. The potential for lateral erosion would be enhanced locally creating steep river cliffs. This may also lead to the re-exposure of old masonry protection and threaten a dry stone wall running along the left bank of the channel.
- Floodplain scrapes - the degradation of the channel bed of the Ribble over time has significantly divorced the channel from the floodplain in several locations. There is little scope for creating chute channel in the scrape areas due to the significant depth of the floodplain in these locations. Therefore, to restore some connectivity between the channel and floodplain in these areas, it is proposed to scrape some floodplain material to create a secondary lower level floodplain.
- Paleo-channel regeneration - it is particularly evident from aerial imagery and the site walkover that there are numerous paleo channels with the floodplain in this upstream section that could be reconnected similar to the feature recently reconnected in the completed restoration works reach. This will recreate the diversity of channel morphologies and habitats seen in more natural examples of this wandering channel type.
- Bar planting - this will provide improve local ecological and flow diversification.
- Chute cutoff/channel - this will create 1) increased flow and hydromorphological diversity for flows at a higher level than the normal annual average level. 2) A greater area for energy dissipation due to a greater flow width. 3) A greater variation of in-channel habitat and therefore should increase the in-channel ecological diversity.

Figure 3-2: Potential chute channel location

- Flood bank removal - there is scope to reconnect and significant area of the floodplain by setting bank a length of flood bank over the left hand bank. The benefits include 1) Finer sediment transported in flood flows could be deposited in the section of restored floodplain rather than transported further downstream and deposited within the channel, which reduces the hydromorphological diversification within the river. This

may help to improve the gravel bed features further downstream. 2) Extra flood storage would be provided, which will reduce flood water levels downstream. 3) It would encourage development of the wandering channel locally.

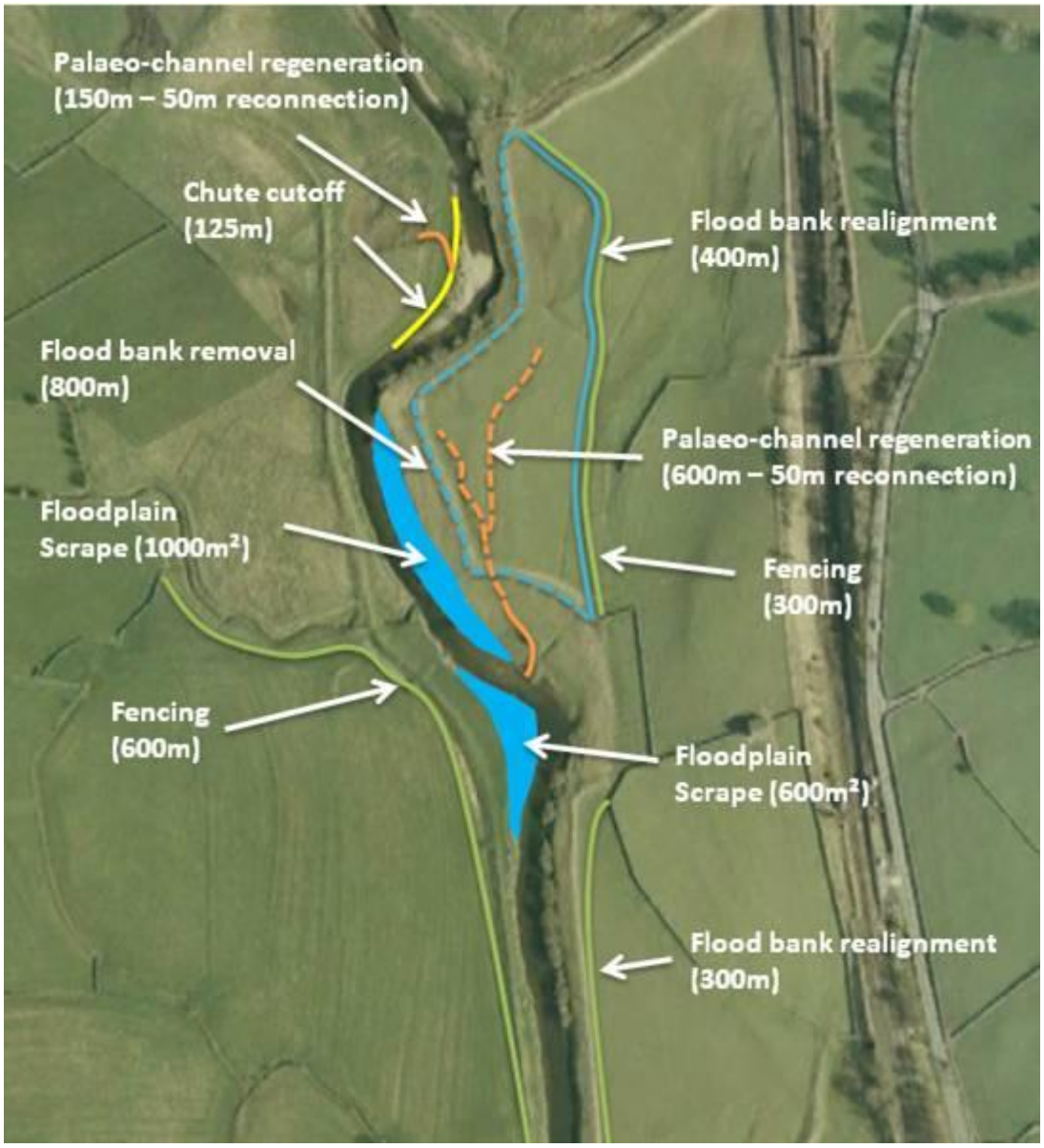
Figure 3-3: Flood embankment that could be set back over left bank

- Revetment removal and cluster creation - similar to the recent clusters created, there is significant scope for similar revetment removal works and cluster creation through this upstream reach. This will create 1) increased flow and hydromorphological diversification local to the boulder clusters. 2) It will have a positive impact on the ecological diversity by providing varied in-channel habitat and providing a shelter for fish. 3) It will encourage a more natural flow and sediment regime locally and therefore we are likely to see more natural erosion processes along the channel banks.

Figure 3-4: Potential revetment removal on right bank

3.3 Proposed Phase 2 Restoration Downstream

Figure 3-5: Proposed downstream restoration works



The outline restoration works for the reach downstream of the completed restoration section are shown above in Figure 3-5. Whilst not as extensive as the potential in the upstream reach, there is considerable scope for restoration in this downstream section. The perceived benefits are very similar to those discussed above for the upstream reach (section 3.2) as the proposed works are of a similar nature.

Appendices

A Restoration Plans

General Notes

1. All dimensions shown are in meters unless otherwise stated and levels in metres to Ordnance Datum.
2. Do not scale from this drawing. All dimensions must be checked/verified on site.
3. This drawing is to be read in conjunction with accompanying detailed drawings. Any discrepancies noted on site are to be reported to the Engineer immediately.
4. All works in watercourses will be carried out with care to minimise the risk of pollution and adhere to Pollution Prevention Guidelines.
5. All works affecting flood defences, main watercourses and/or ordinary watercourses will be subject to Consent for Permanent and Temporary Works under the Land Drainage Act 1991.
6. The locations of any known services shown on drawing are approximate and for guidance only. The Contractor will confirm the location of any services prior to the commencement of any works.
7. The electronic model of this drawing is not to be used for setting out.

Merge proposed floodbank with existing levels

Potential Scrape Site

Post and wire fence to follow proposed floodbank

Area B

Chute 1

Re-A

Re-B

Re-C

Relocate floodbank at a level of 126.5mAOD

Straining Wire Break in Fence

Remove existing floodbank to a level of 125.5mAOD

Overhead Powerlines

Area A

Any excess spoil from scraping on Mr Bradleys land to be used to raise existing floodbank. Evenly distribute along existing levels and grass seed

Chute 2

Merge proposed floodbank with existing levels

Historic Drainage Feature.
Still Functional and Draining East of Railway.
Exact Location and Depth Unknown.
Contractor to Locate with Supervising Officer and Mark Alignment Prior to any Work in this Area.
Working Within 10m of Alignment to be Agreed with Supervising Officer.

Planting

Area A = 13,933 m²
Area B = 35,010 m²

Planting: Alder *Alnus glutinosa (40%)*, Birch *Betula Pubescens(30%)* & Willow *Salix ssp(30%)* to be planted at the equivalent of 3m centres, located in random groups at 1m - 3m centre groupings as opposed to even spacing.
Trees to be planted as whips (60%) and Feathered Whips (40%)with appropriate rabbit protection.

All newly formed and disturbed land to be grass seeded at 8.00 g/m²

N

0 50m 100m

Key

- Indicative water level & direction of flow
- Remove existing floodbank (See Floodbank drawings Drg No: 2011s5277-02)
- Reinstate Floodbank (See Floodbank drawings Drg No: 2011s5277-02)
- Remove boulder toe revetment
- Excavate Chute channels 1 & 2 (See Chute channels drawings Drg No: 2011s5277-03.1/03.2)
- Re-B — Excavate reconnections A, B & C (See Reconnections Drawings Drg No: 2011s5277-04.1/04.2)
- Post & wire fencing (See Fence Detail Drg No: 2011s5277-05)
- Indicates Straining Wire break in fence sections
- Potential scrape site
- Potential fill site
- Area A — Wet Woodland Planting Area A (13,933m2)
- Area B — Wet Woodland Planting Area B (35,010m2)
- Overhead powerlines

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Amendment to Fence Detail	30/09/2011	M.Dodd	G.Heritage	G.Heritage	S.Maslen

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for

Environment Agency

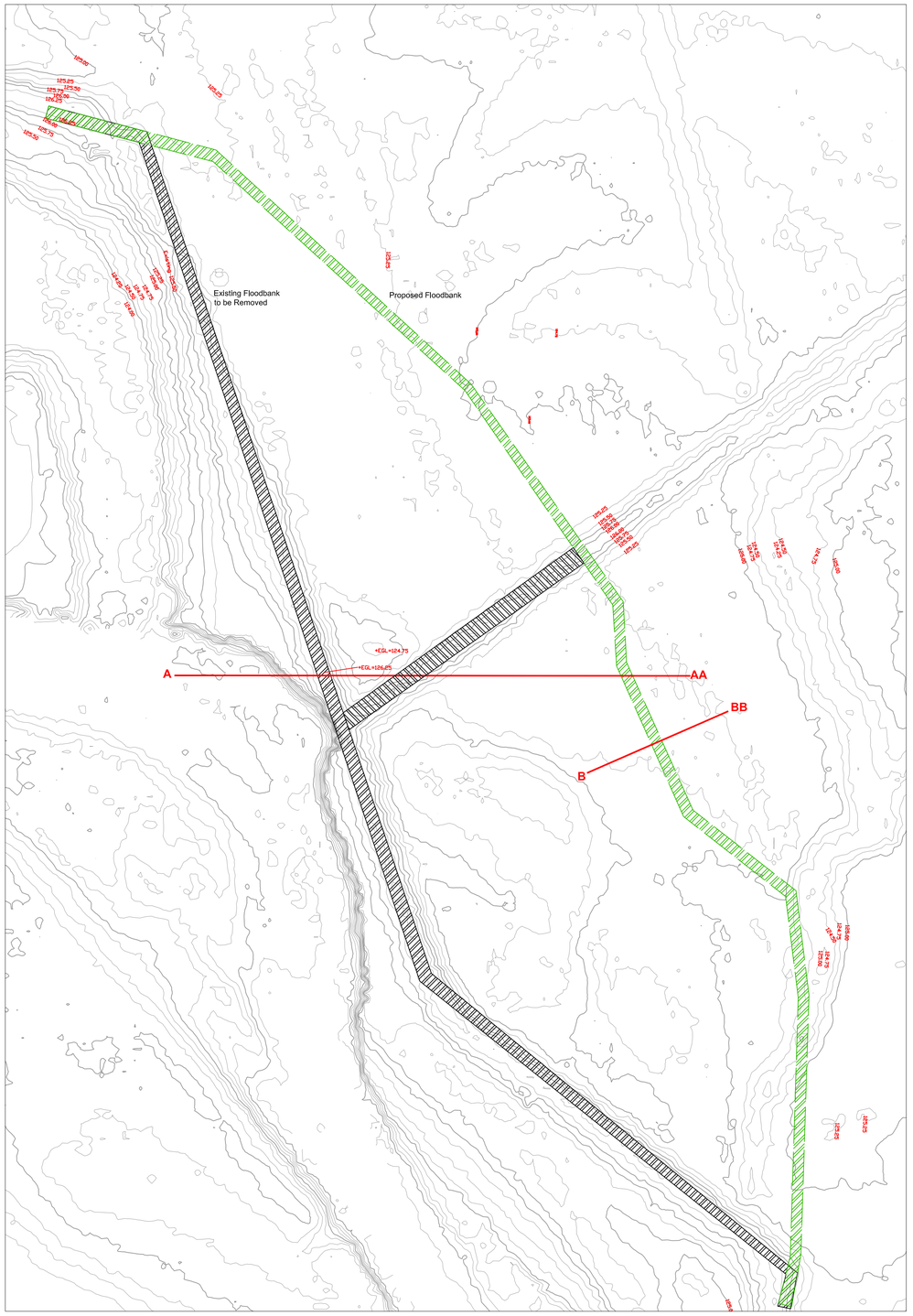
Long Preston
River Ribble Breach Restoration
Location Masterplan

Scale: 1:1000 @ A1	Drawn:	C Hughes	12-8-11
	Designed:	G.Heritage	10-8-11
	Checked:	J. Santa-Clara	31-8-11
	Approved:	S. Maslen	31-8-11

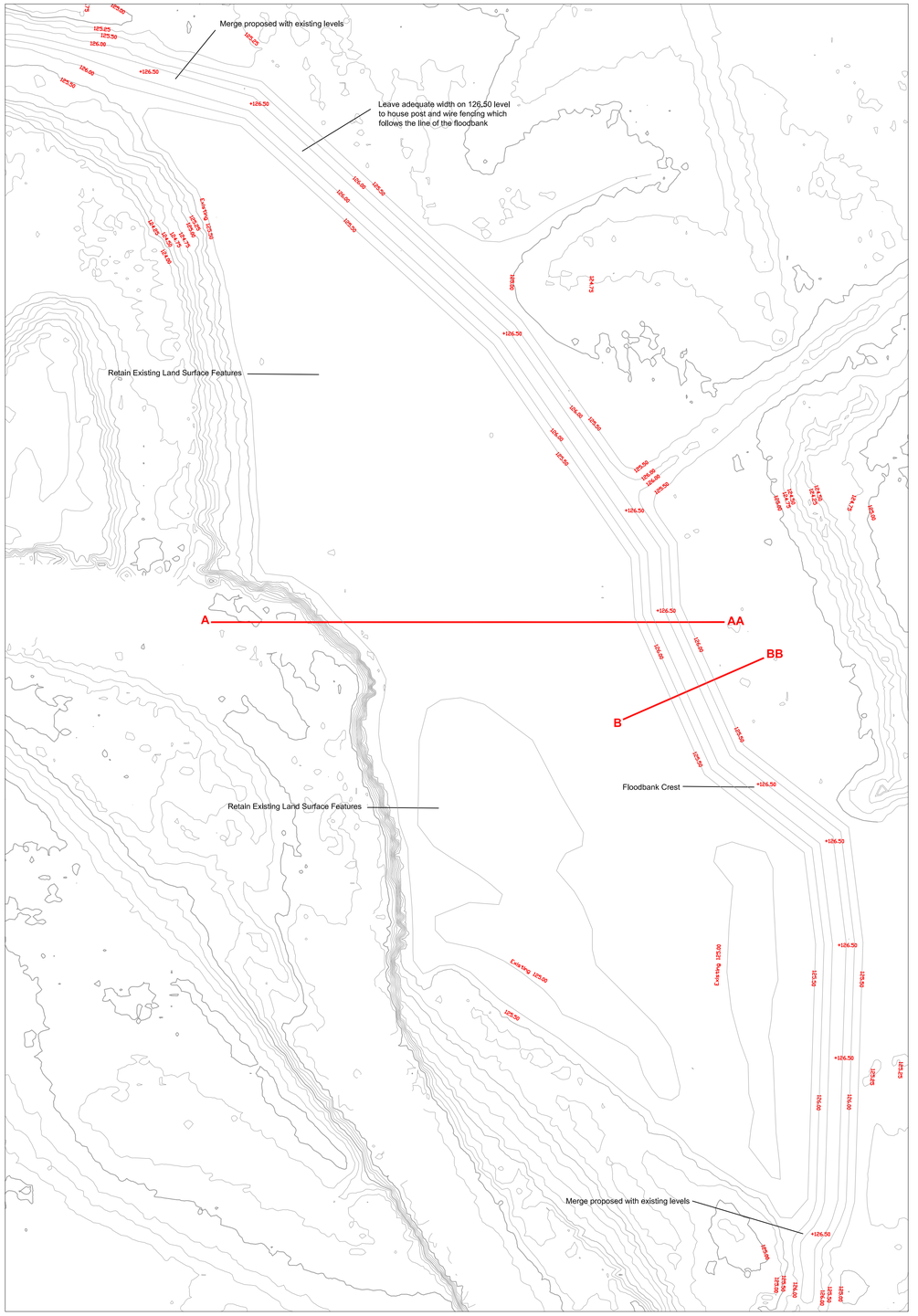
Digital File Name:

Drawing Number:	Rev.:	Sheet No.:	Status:
2011s5277-01	A	1 OF 1	For Construction

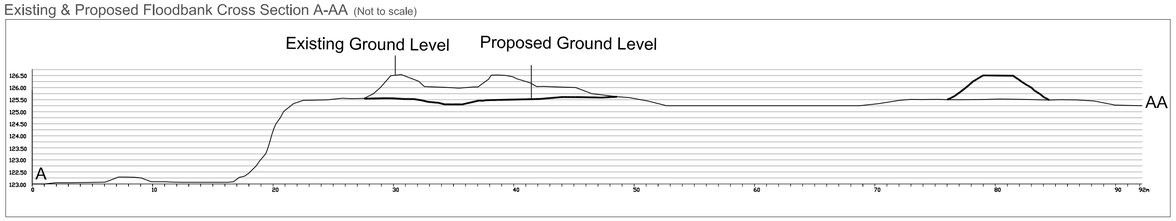
Existing & Proposed Floodbank Outline Plan



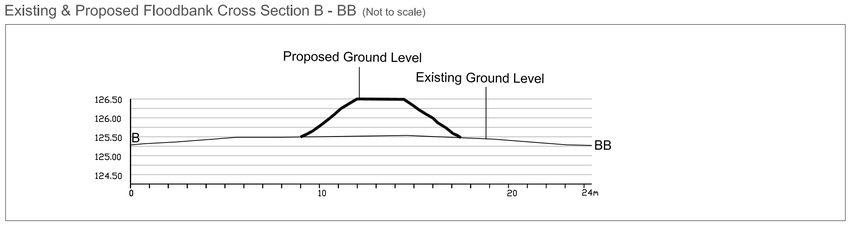
Proposed Floodbank Plan Detail



Existing & Proposed Floodbank Cross Section A-AA (Not to scale)



Existing & Proposed Floodbank Cross Section B - BB (Not to scale)



General Notes

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2. Do not scale from this drawing. All dimensions must be checked/verified on site.
3. This drawing is to be read in conjunction with drg 2011s5277 - 01
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8. The electronic model of this drawing is not to be used for setting out.

Excavation Notes

All top soil from excavation to be stockpiled and reused in the making good of proposed floodbank and reconnections All Sub soil to be stockpiled and reused in the contruction of the proposed floodbank. Floodbank to be grass seeded.

Any surplus materials to be assigned to designated 'potential fill site' as highlighted on drg 2011s5277 - 01

Construction Notes:

All sub soil to be compacted using on site machinery to site supervisors satisfaction. Top soil to spread evenly at 150mm and grass seeded at 8g per m².

New floodbank sideslopes and changes in direction to be trimmed and feathered into existing adjacent land form to create a more naturalised appearance.

Existing Floodbank

Approx Length: 263m

Average Crest Width: 3m

Proposed Floodbank

Approx Length: 280m

Average Crest Width: 3m

Crest Level: 126.5mAOD

Sideslopes: No Steeper than 1:3

KEY

Existing Ground Level Spot Level + EGL 123.75

Proposed Ground Level Spot Level + PGL 123.00

N

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Floodbank plan and cross sections redrawn	01-09-11	M.Dodd			

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for

Environment Agency

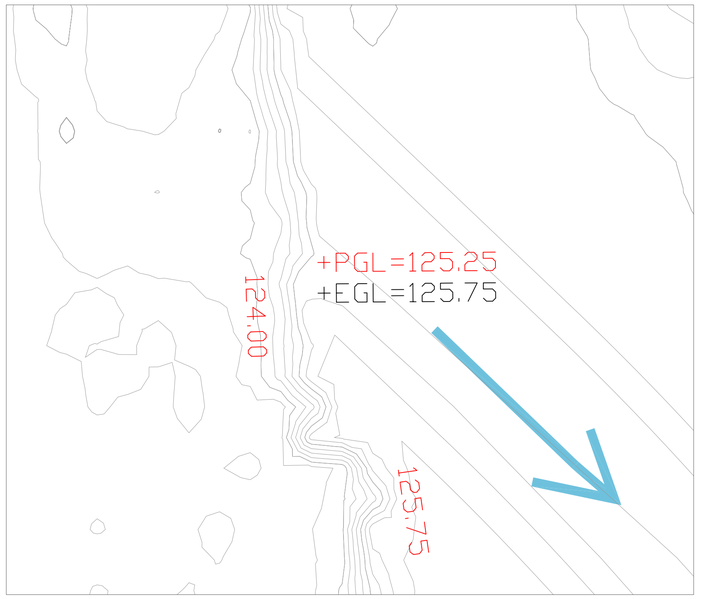
Long Preston
River Ribble Breach Restoration
Flood Bank Removal / Reinstatement

Scale: 1:500 @ A1	Drawn:	C.Hughes	18-8-11
	Designed:	G.Heritage	15-8-11
	Checked:	J.Santa-Clara	31-8-11
	Approved:	S.Maslen	31-8-11

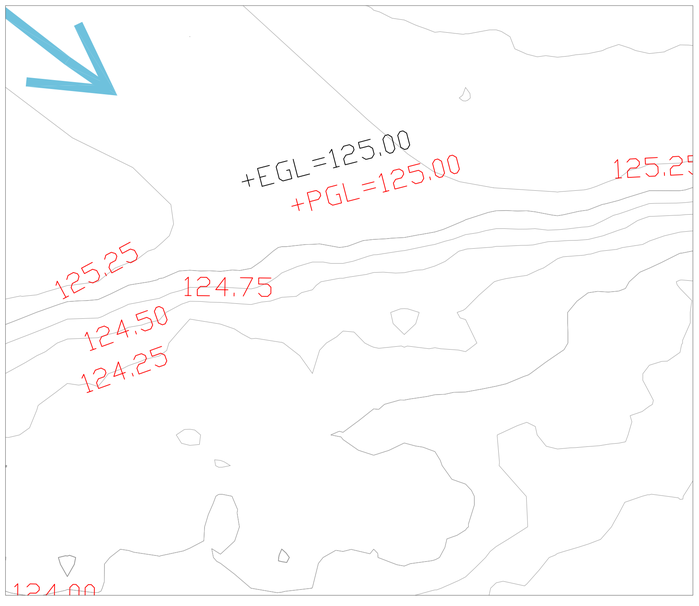
Digital File Name:

Drawing Number:	Rev.:	Sheet No.:	Status:
2011s5277 - 02	A	1 OF 1	For Construction

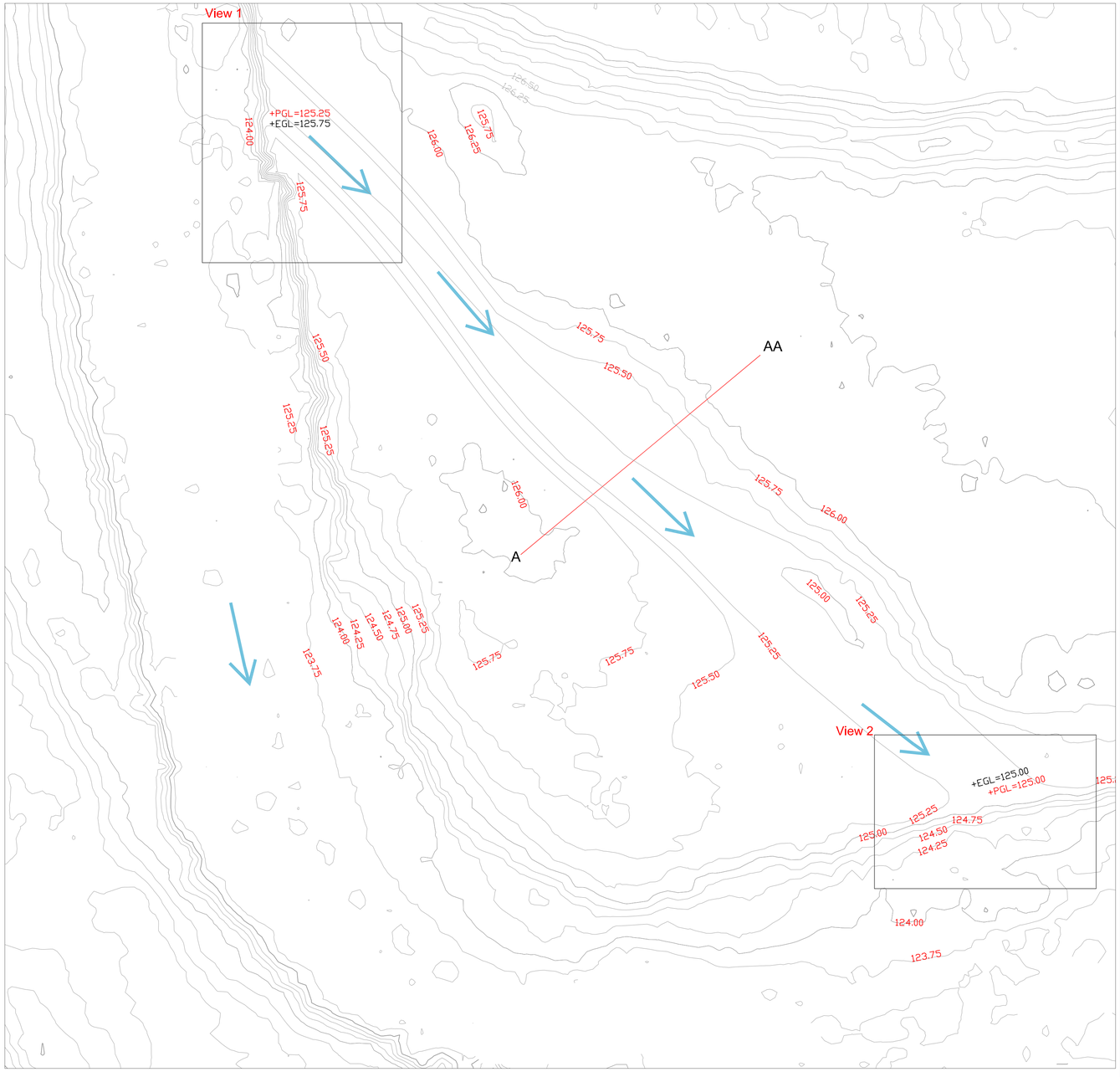
View 1 - Scale 1: 100



View 2 - Scale 1: 100

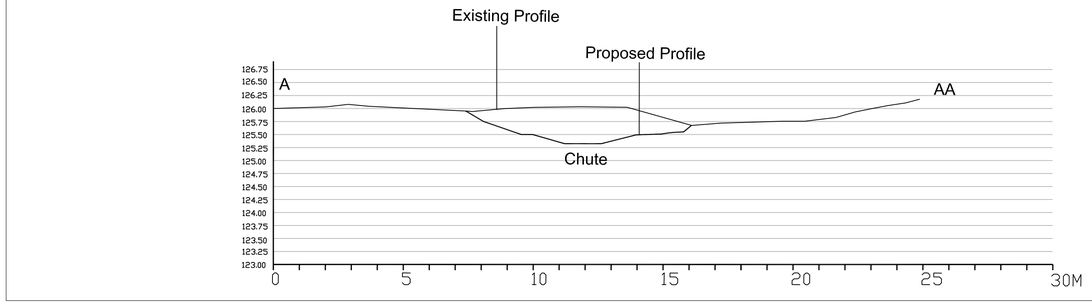


Chute 1 - Proposed Plan View - Scale 1:250



Chute 1- Length & Cut / Fill Volumes

Approx Length: 100m
Approx Width: 5m
Max Cut Depth: 750mm



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Excavation Notes

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Any surplus materials to be assigned to designated 'potential fill site' as highlighted on drg 2011s5277 - 01

Construction Notes:
All sub soil to be compacted using on site machinery to site supervisors satisfaction. Top soil to spread evenly at 150mm and grass seeded at 8g per m².

Sideslopes no steeper than 1:2.

KEY

Existing Ground Level Spot Level	+ EGL 123.75
Proposed Ground Level Spot Level	+ PGL 123.00

N

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Chute topography and sideslopes amended	01-09-11	M.Dodd			

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for

Environment Agency

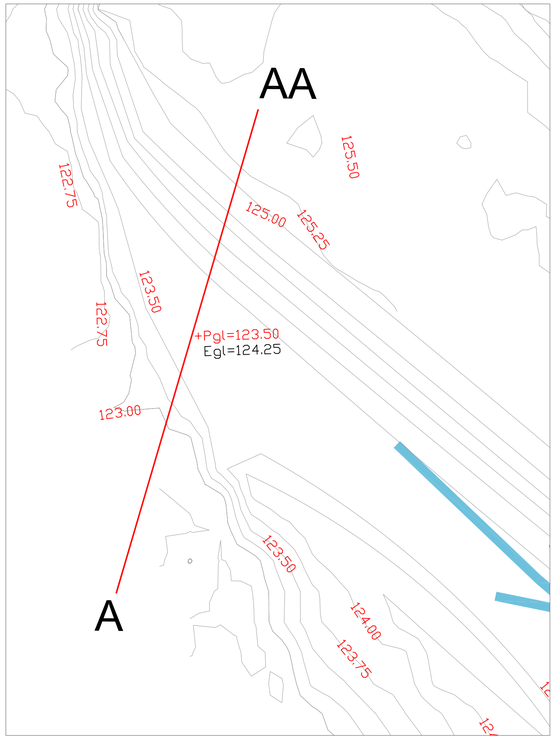
Long Preston
River Ribble Breach Restoration
Chute 1 - Plan View & Section

Scale: Varied scales @ A1	Drawn:	C Hughes	18-8-11
	Designed:	G.Heritage	15-8-11
	Checked:	J.Santa-Clara	31-8-11
	Approved:	S.Maslen	31-8-11

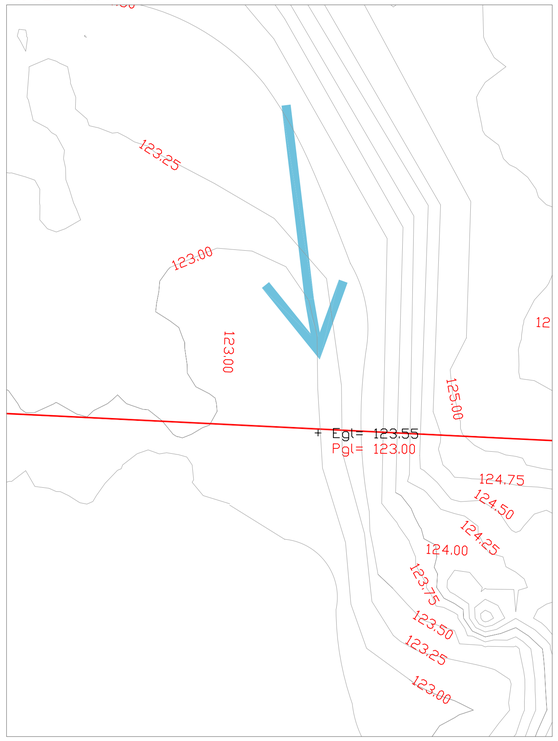
Digital File Name:

Drawing Number:	Rev.:	Sheet No.:	Status:
2011s5277- 03.1		1 OF 1	For Construction

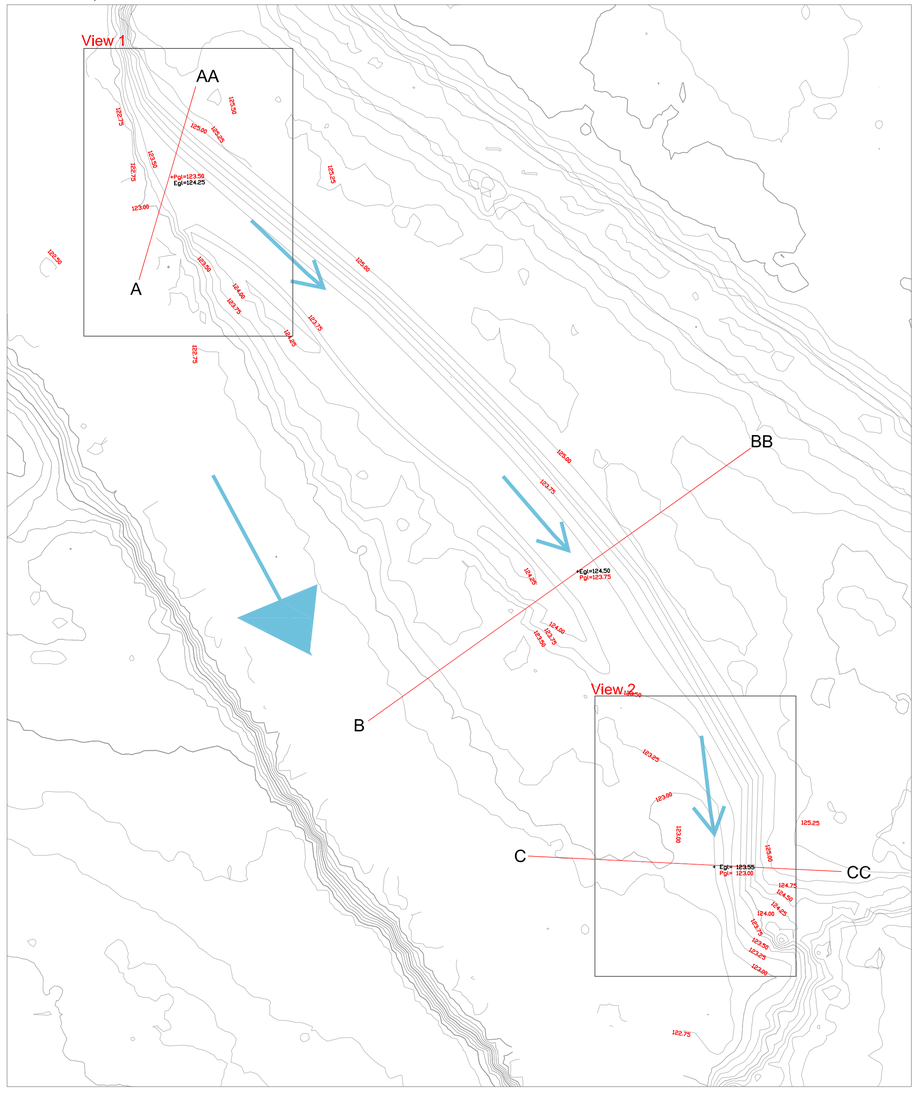
View 1 - Scale 1:100

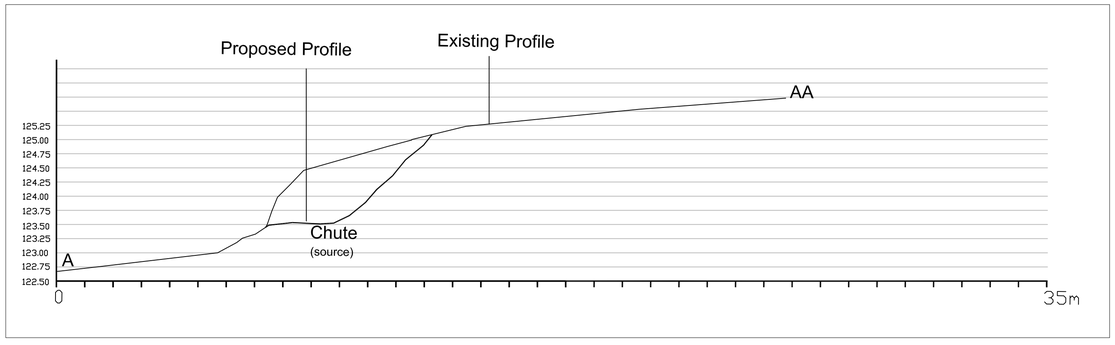


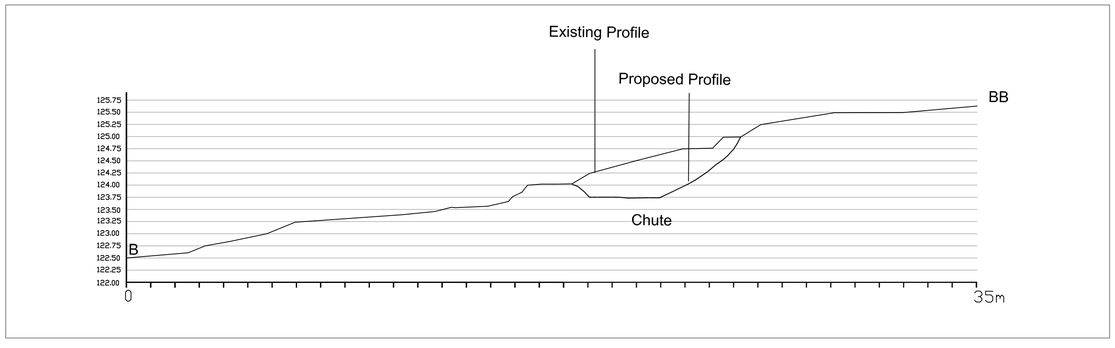
View 2 - Scale 1:100

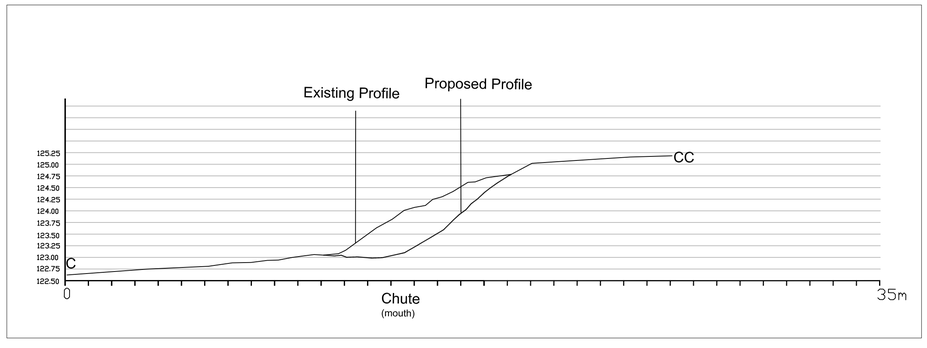


Chute 2 - Proposed Plan View - 1:250









Chute 2- Length & Cut / Fill Volumes

Approx Length: 76m
Approx Width: 5m
Max Cut: 1.5m

General Notes

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Excavation Notes

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Any surplus materials to be assigned to designated 'potential fill site' as highlighted on drg 2011s5277 - 01.
Excavation lines to be sinous and inkeeping with character and sensitive to the forms of the existing surrounding landscape.

Construction Notes:
All sub soil to be compacted using on site machinery to site supervisors satisfaction. Top soil to spread evenly at 150mm and grass seeded at 8g per m².

Sideslopes no steeper than 1:2

KEY

Existing Ground Level Spot Level	+ EGL 123.75
Proposed Ground Level Spot Level	+ PGL 123.00

N

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Chute topography and sideslopes amended.	01-09-11	M.Dodd			

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for

Environment Agency

Long Preston
River Ribble Breach Restoration
Chute 2 - Plan View & Cross Sections

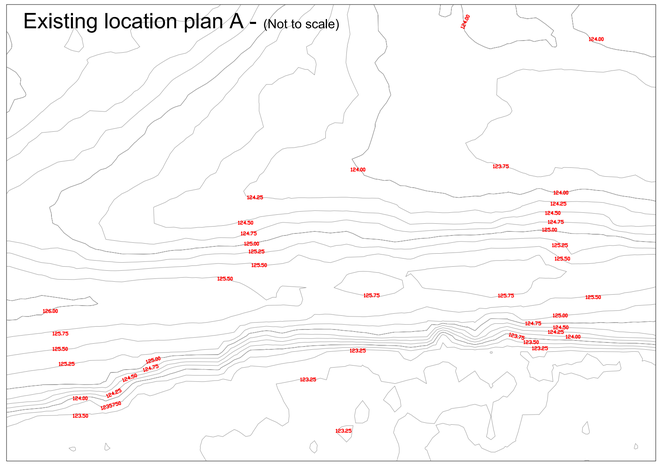
Scale: Varied Scales @ A1	Drawn:	C.Hughes 18-8-11
	Designed:	G.Heritage 15-8-11
	Checked:	J.Santa-Clara 31-8-11
	Approved:	S.Maslen 31-8-11

Digital File Name:

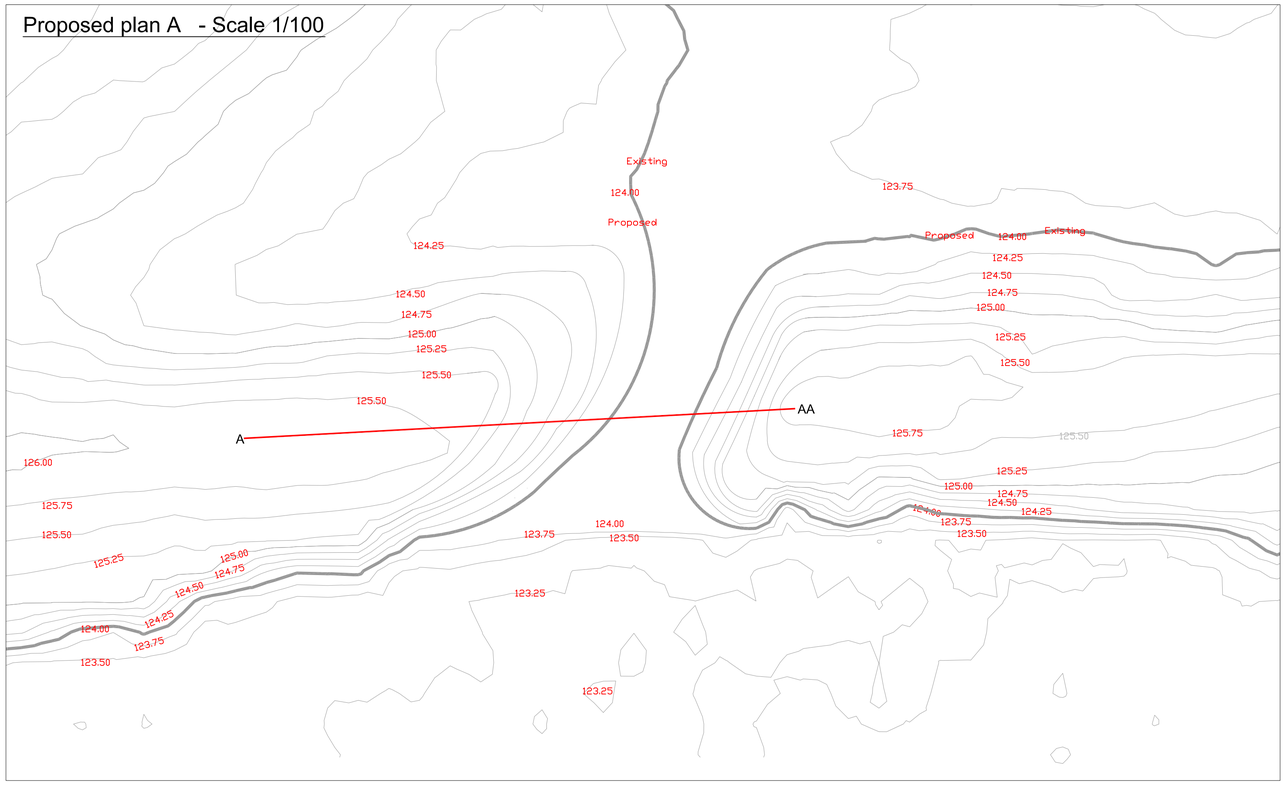
Drawing Number:	Rev.:	Sheet No.:	Status:
2011s5277- 03.2		1 OF 1	For Construction

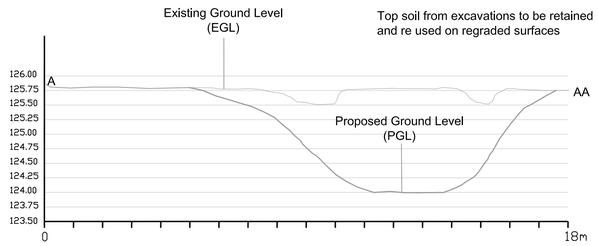
Reconnection A

Existing location plan A - (Not to scale)



Proposed plan A - Scale 1/100

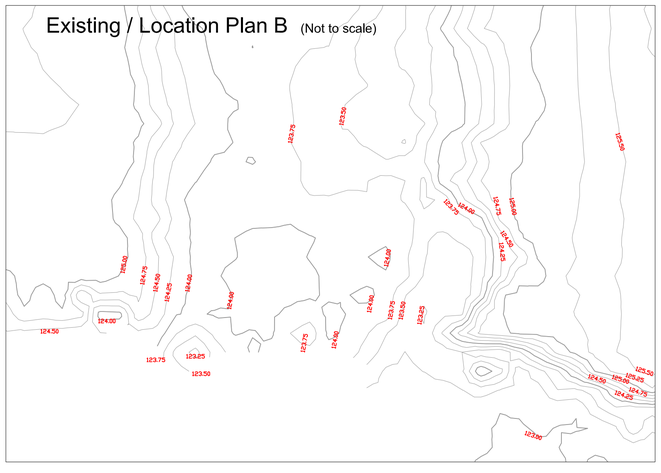




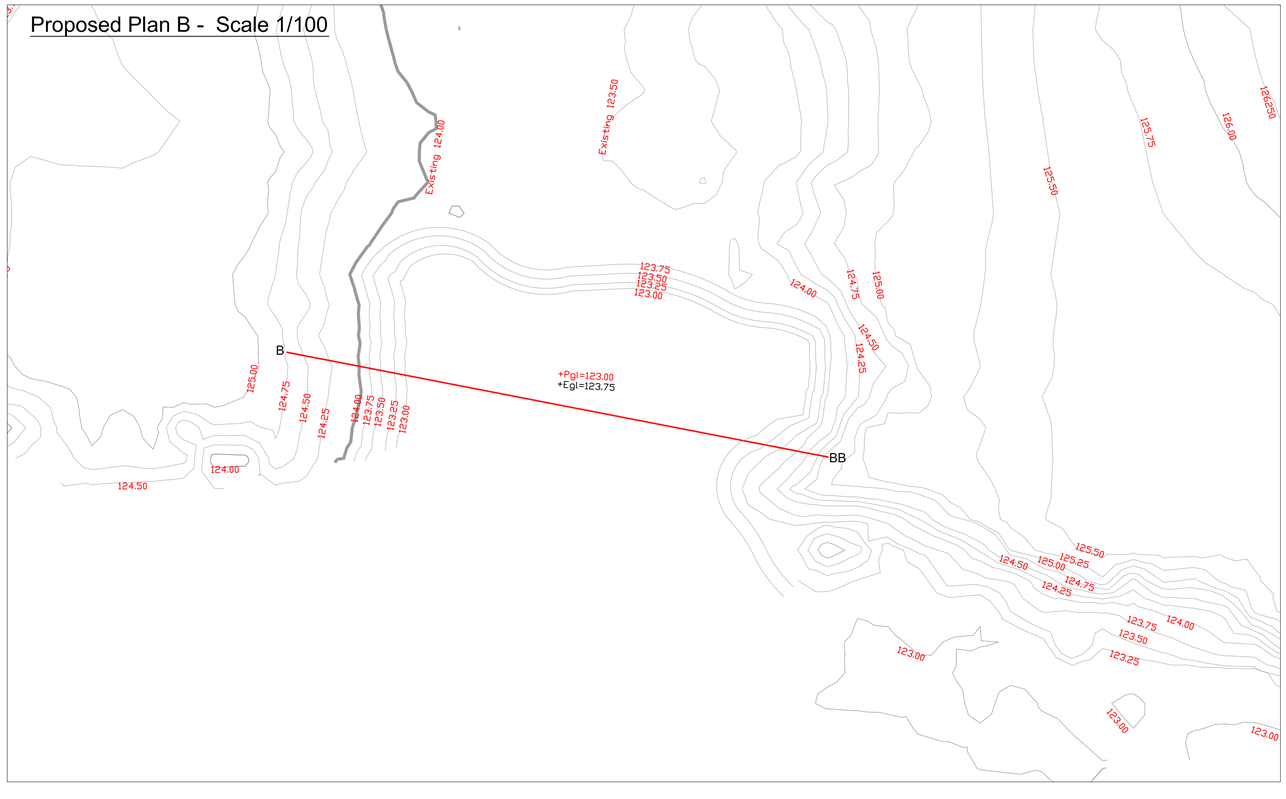
Cross section A-AA

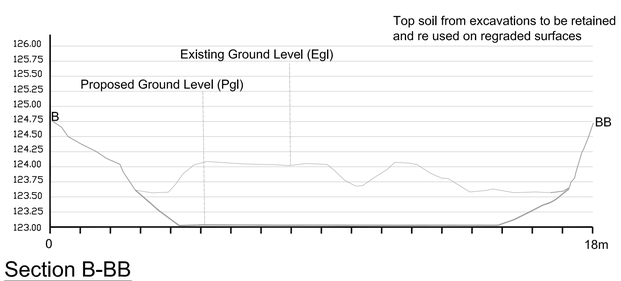
Reconnection B

Existing / Location Plan B (Not to scale)



Proposed Plan B - Scale 1/100





Section B-BB

General Notes

1. All dimensions shown are in meters unless otherwise stated and levels in metres to Ordnance Datum.
2. Do not scale from this drawing. All dimensions must be checked/verified on site.
3. This drawing is to be read in conjunction with drg 2011s5277 - 01.
4. Any discrepancies noted on site are to be reported to the Engineer immediately.
5. All works in watercourses will be carried out with care to minimise the risk of pollution and adhere to Pollution Prevention Guidelines.
6. All works affecting flood defences, main watercourses and/or ordinary watercourses will be subject to Consent for Permanent and Temporary Works under the Land Drainage Act 1991.
7. The locations of any known services shown on drawing are approximate and for guidance only. The Contractor will confirm the location of any services prior to the commencement of any works.
8. The electronic model of this drawing is not to be used for setting out.

Excavation Notes:

All quality top soil to be retained and reused on all regraded reconnection bank surfaces. All sub grade material to be stockpiled and used to re build floodbank. Any surplus materials should be reused in areas marked 'potential fill site' on Masterplan drg 2011s5277 - 01.

Sideslopes to be no steeper than 1:2

KEY

Existing Ground Level Spot Level + EGL 123.75

Proposed Ground Level Spot Level + PGL 123.00

N

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Reconnection topography and sideslopes amended.	01-09-11	M.Dodd			

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for

Environment Agency

Long Preston
River Ribble Breach Restoration
Reconnection Detail A & B (North Bank)

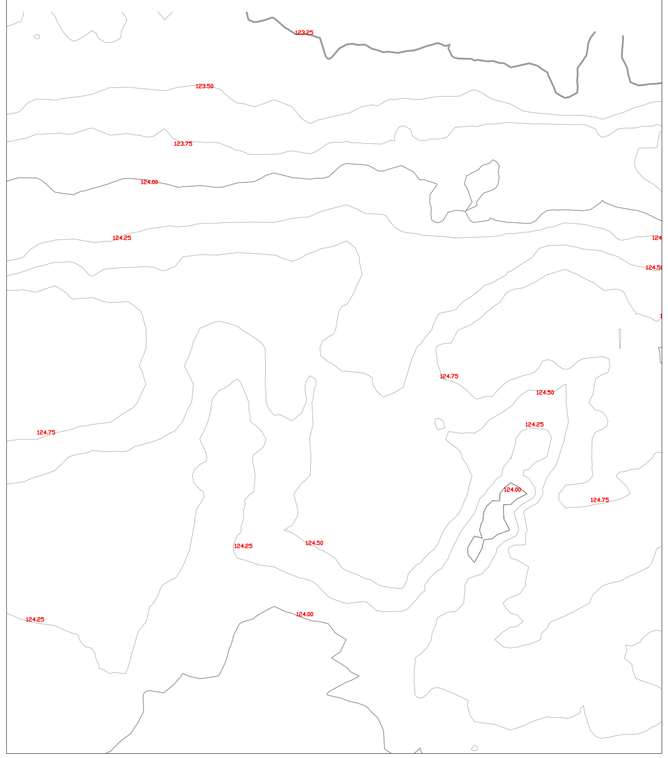
Scale:			
Varied @ A1	Drawn:	C Hughes	15-8-11
	Designed:	G. Heritage	13-8-11
	Checked:	J. Santa-Clara	31-8-11
	Approved:	S.Maslen	31-8-11

Digital File Name:

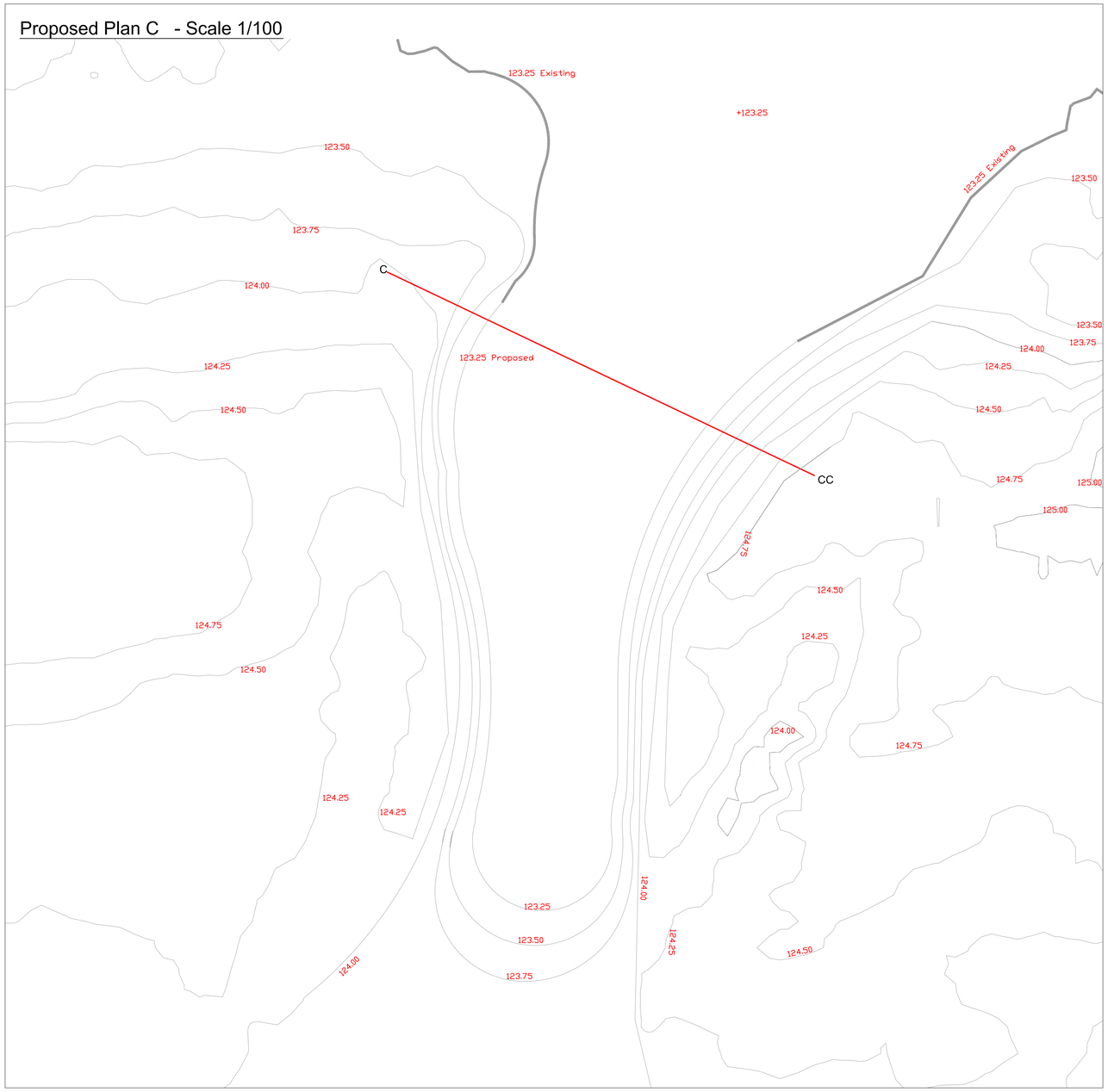
Drawing Number:	Rev.:	Sheet No.:	Status:
2011s5277 - 04.1	A	1 of 1	For Construction

Reconnection C

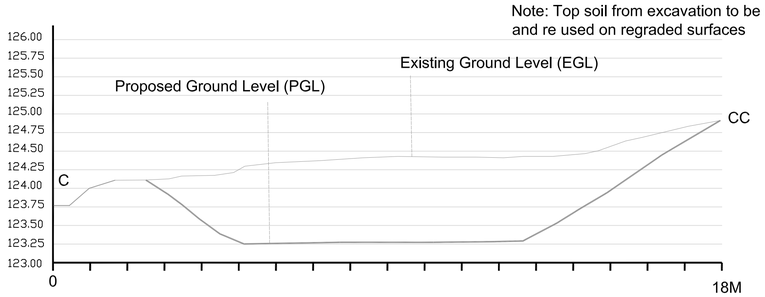
Existing Location Plan C - (Not to scale)



Proposed Plan C - Scale 1/100



Note: Top soil from excavation to be retained and re used on regraded surfaces



Cross section C-CC

General Notes

1. All dimensions shown are in meters unless otherwise stated and levels in metres to Ordnance Datum.
2. Do not scale from this drawing. All dimensions must be checked/verified on site.
3. This drawing is to be read in conjunction with drg 2011s5277-01.
4. Any discrepancies noted on site are to be reported to the Engineer immediately.
5. All works in watercourses will be carried out with care to minimise the risk of pollution and adhere to Pollution Prevention Guidelines.
6. All works affecting flood defences, main watercourses and/or ordinary watercourses will be subject to Consent for Permanent and Temporary Works under the Land Drainage Act 1991.
7. The locations of any known services shown on drawing are approximate and for guidance only. The Contractor will confirm the location of any services prior to the commencement of any works.
8. The electronic model of this drawing is not to be used for setting out.

Excavation Notes:

All quality top soil to be retained and reused on all regraded reconnection bank surfaces. All sub grade material to be stockpiled and used to re build floodbank. Any surplus materials should be reused in areas marked 'potential fill site' on drg 2011s5277 - 01.

Sideslopes to be no greater than 1:2

KEY

Existing Ground Level Spot Level	+ EGL 123.75
Proposed Ground Level Spot Level	+ PGL 123.00

N

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Reconnection topography and sideslopes amended.	01-09-11	M.Dodd			

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for

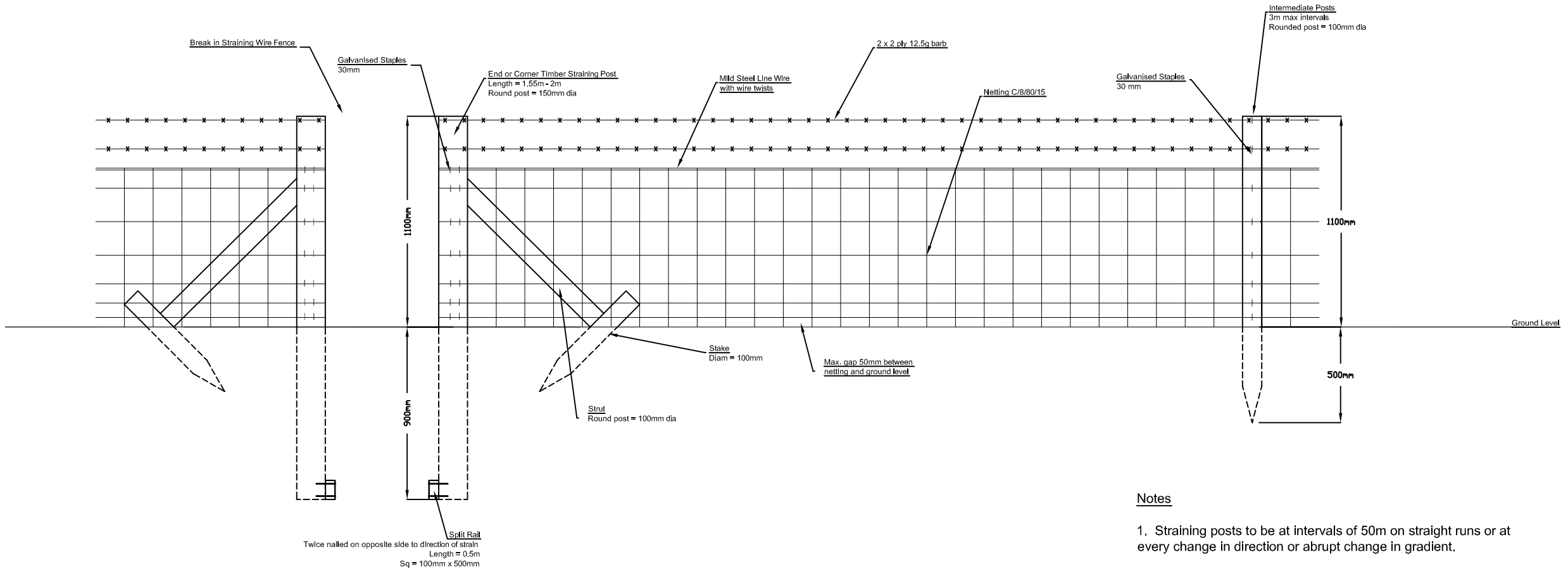
Environment Agency

Long Preston
River Ribble Breach Restoration
Reconnection Detail C (South Bank)

Scale: Varied @ A1	Drawn:	C Hughes	15-8-11
	Designed:	G.Heritage	13-8-11
	Checked:	J.Santa-Clara	31-8-11
	Approved:	S.Maslen	31-8-11

Digital File Name:

Drawing Number:	Rev.:	Sheet No.:	Status:
2011s5277 - 04.2	A	1 of 1	For Construction



General Notes

1. All dimensions shown are in mm unless otherwise stated and levels in metres to Ordnance Datum.
2. Do not scale from this drawing. All dimensions must be checked/verified on site.
3. This drawing is to be read in conjunction with drg 2011s5277 - 01
4. Any discrepancies noted on site are to be reported to the Engineer immediately.
5. All works in watercourses will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
6. All works affecting flood defences, main watercourses and/or ordinary watercourses will be subject to Consent for Permanent and Temporary Works under the Land Drainage Act 1991.
7. The locations of any known services shown on drawing are approximate and for guidance only. The Contractor will confirm the location of any services prior to the commencement of any works.
8. The electronic model of this drawing is not to be used for setting out.

Notes

1. Straining posts to be at intervals of 50m on straight runs or at every change in direction or abrupt change in gradient.

2. Fence to be constructed in 5 pieces as per Masterplan. straining post to be located at each lengths end.

3.Intermediate post to be 1.6m long and at maximum intervals of 3m apart. Longer Intermediate posts may be necessary in soft conditions.

3. Standard Stockproof Fence with netting Type C/8/80/15. Netting to be fixed with a max gap of 50mm between the bottom of the net and the ground. The line wire to be positioned and properly strained 30mm above the top of the netting and clipped to the top wire in at least 2 places between intermediate posts using wire twists or 'Gordian' ring fasteners. 'Top barb wires' to be positioned so that the lower strand is 100mm above netting and the upper strand is 150mm above the lower. Ratchet winders to BS1722.

4. All timber to be softwood and pressure treated with preservative as specified

5. In difficult ground conditions it may be necessary to concrete in straining posts or use a box strainer assembly.

6.All ironmongery to be galvanised to BS729

7. Fence to be fitted with pulse fence energizer connectors in accordance with BS EN 60335-2-76

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Amendments to fence detail	30/09/11	M.Dodd	G.Heritage	G.Heritage	S.Maslen

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for

Environment Agency

Long Preston
Riber Ribble Breach Restoration
Fence Detail

Scale: 1:25 @ A3	Drawn: C.Hughes	22-8-11
	Designed: G. Heritage	16-8-11
	Checked: J.Santa-Clara	31-8-11
	Approved: S.Maslen	31-8-11

Digital File Name:

Drawing Number:	Rev.:	Sheet No.:	Status:
2011s5277-05	A	1 OF 1	For Construction

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