11.2 Clay Lined River

RIVER NITH

LOCATION - WEST OF NEW CUMNOCK, AYRSHIRE NS5412

DATE OF CONSTRUCTION - APRIL – SEPTEMBER 2000

LENGTH – 3km

COST – £3,300,000

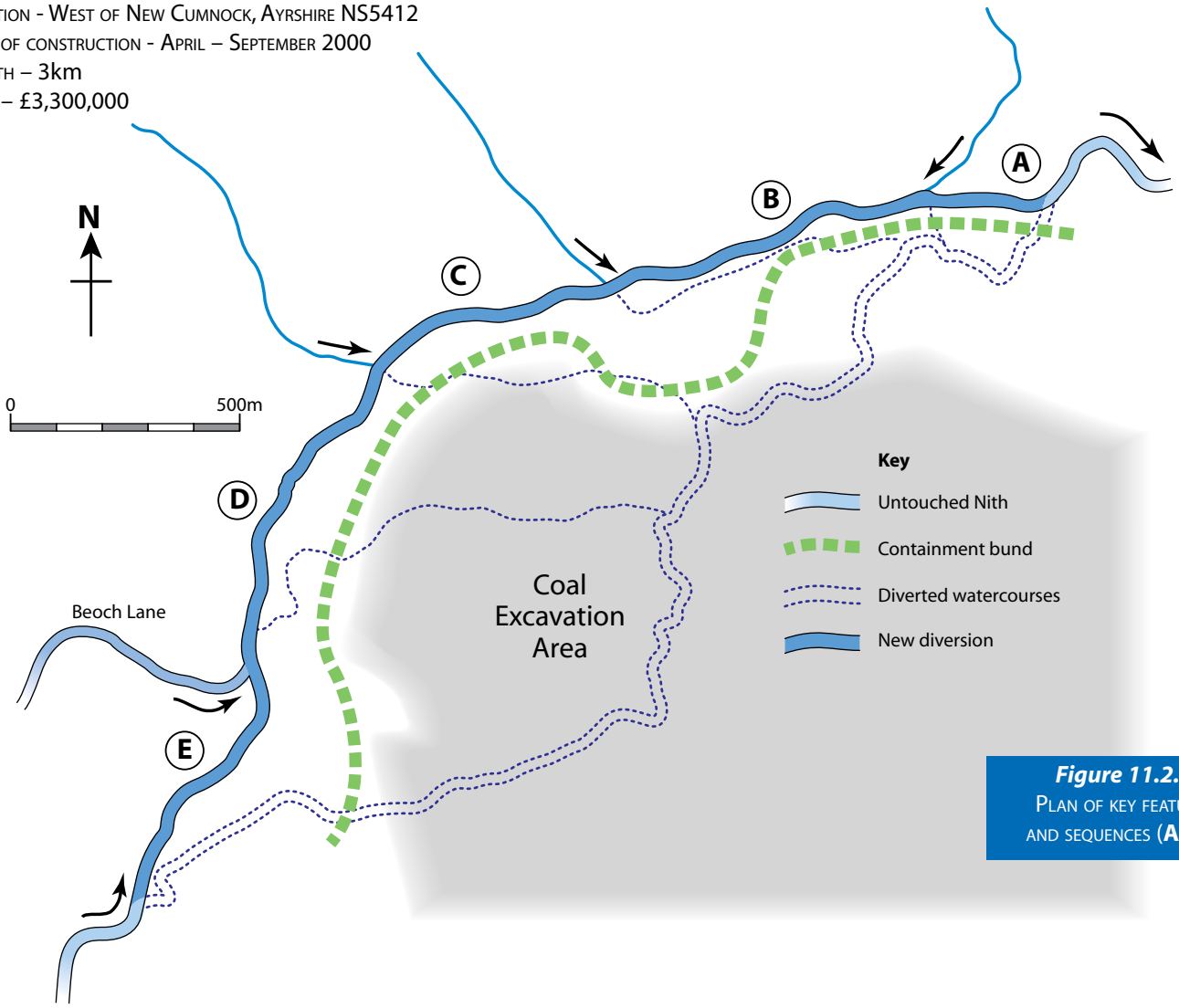


Figure 11.2.1
PLAN OF KEY FEATURES AND SEQUENCES (**A** – **E**)

Description

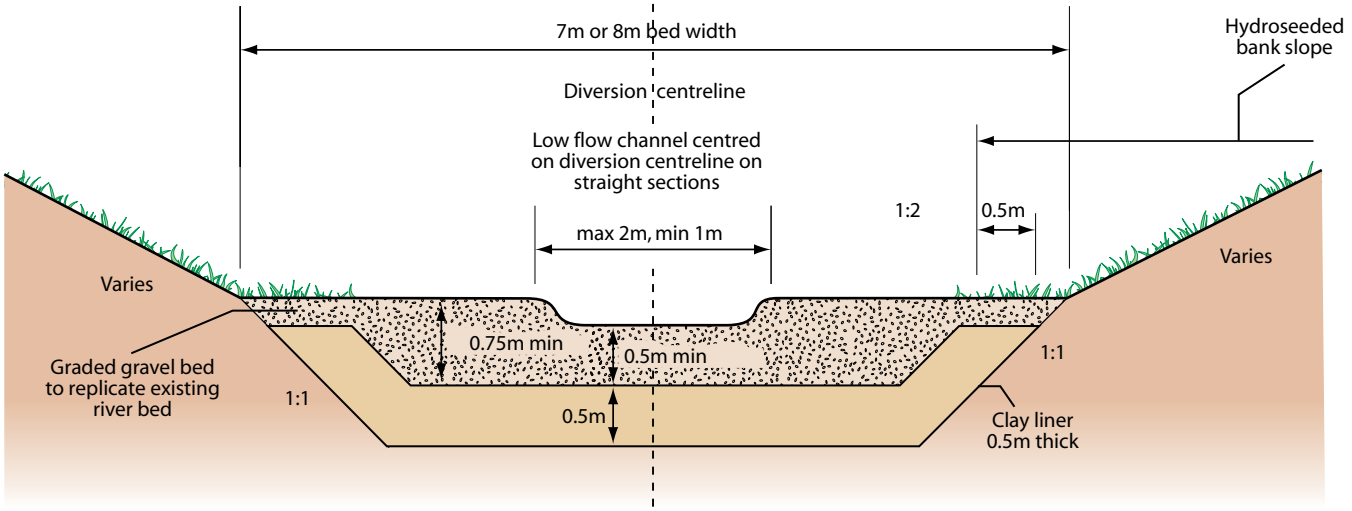
The River Nith rises at around 500m above ordnance datum (AOD) in the uplands of south-west Scotland and is an important salmon and trout fishery. It drops sharply within 7km to meander through a wide grazed valley floor at only 220m AOD. The Nith has a mixed gravel, pebble and boulder bed, with stable and eroding earth cliffs, a common feature of the banks.

In 2000 an existing adjacent open-cast coal site was extended requiring the permanent diversion of a 3km reach of the River Nith, Beoch Lane and three tributaries. The whole floodplain site covers an area of approximately 3km^2.

The route of the diversion was restricted to a narrow corridor through areas of highly permeable strata and previous mine workings. In places the channel would need to be lined to prevent the river flowing below ground. In addition, to stop floodwater and ground water entering the opencast area, a containment bund, with an integral slurry wall constructed down to bedrock, was built between the new river channel and the coal excavation area.

The design flood standards adopted were the Mean Annual Flood for the river channel itself and the 1 in 50 year return period flood for the river corridor. Detailed hydraulic modelling established the diversion channel route and cross sections as well as the extent of flood protection measures required.

Figure 11.2.2
TYPICAL SYMMETRICAL CROSS-SECTION



Description

A clay lined two-stage channel profile was adopted incorporating suitable run-pool-riffle sequences modelled on those in the existing river channel. Construction materials, including the 0.5-1m thick clay liner, river bed gravels and boulders, riffles and bund material, scour protection and in-stream features all came from the adjacent opencast excavations. It was anticipated that the new channel could match the length of the old one, but ultimately a reduction of 10% was necessary.

Figure 11.2.1 shows the diversion channel to the north of the floodplain, with the containment bund protecting the opencast area. Works progressed from A to E upstream, enabling the tributaries and burn to be progressively captured by the new channel. These flows were used to wash silt from the new channel, then intercepted by temporary settlement lagoons at the confluence prior to controlled discharge to the Nith. On completion, flow from the River Nith itself was intercepted above point E and allowed to flow through the new channel.

The key components of the design are shown in *Figures 11.2.2 to 11.2.5* and include:

- a channel, between 0.5 and 1m deeper than the required depth, was excavated;
- along 80% of the diversion length a clay liner was compacted to form a barrier between the river flow and the permeable ground below. A very detailed specification was provided to the contractor regarding the quality of material, and the method of compaction;
- overlying the clay the new bed was formed from mixed cobbles, boulders, and gravels. Many thousands of cobbles and boulders, many of them covered in plant growth and harbouring invertebrate life, were carefully transplanted from the existing Nith and the captured tributaries to assist with the colonisation of the new channel;

Shaping the new channel within the clay lining

11 River Diversions

The 'constructed' run-pool-riffle sequence

- a 1-2m wide depression was formed to create the low-flow channel, centrally on straight sections and towards the outside on bends (*Figures 11.2.2 and 11.2.3*);
- precautionary stone rip-rap was placed on meander bends to maintain the designed planform;
- The bare banks were immediately hydroseeded with a grass mix to reflect the grassy moorland surroundings to maximise vegetation cover before the onset of winter.

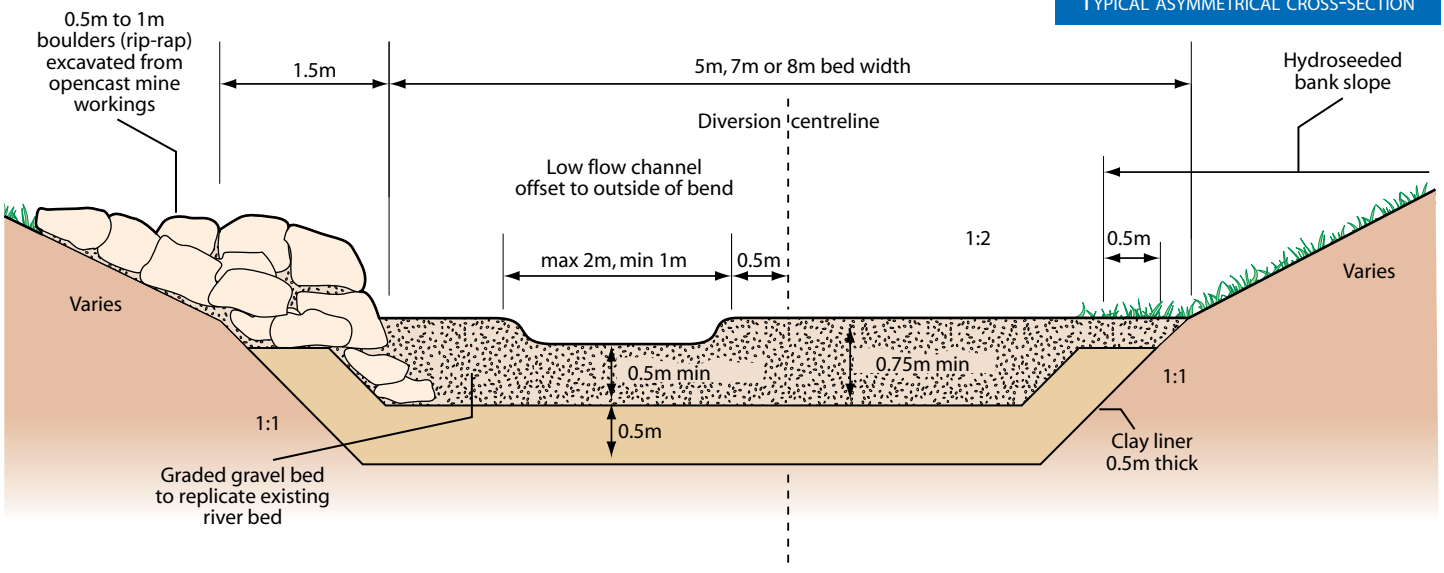
Run-pool-riffle sequences were constructed by over-excavating the ground where the pools would be located. When forming the bed, cobbles and boulders were pushed into the graded gravel upstream of the pool, forming a raised bed and a central faster 'run' of water entering the pool.

Some natural erosion of the riverbank was accepted, though the design aimed to restrict the lateral migration of the river outside the clay liner. To further stabilise the banks planting was undertaken, including reeds and grasses along the water margins, and alder (*Alnus spp.*), ash (*Fraxinus spp.*) and willow (*Salix spp.*) alongside the rip-rap.

An extensive programme of electro-fishing was undertaken to transfer fry, parr and other life stages of fish from the length to be diverted to assist with colonisation of the new channel.

A matrix of wetland and other habitats was established in the new corridor with the intention of creating suitable habitats for a variety of wetland and grassland birds, otters, (*Lutra lutra*) insects and amphibians.

Figure 11.2.3
TYPICAL ASYMMETRICAL CROSS-SECTION



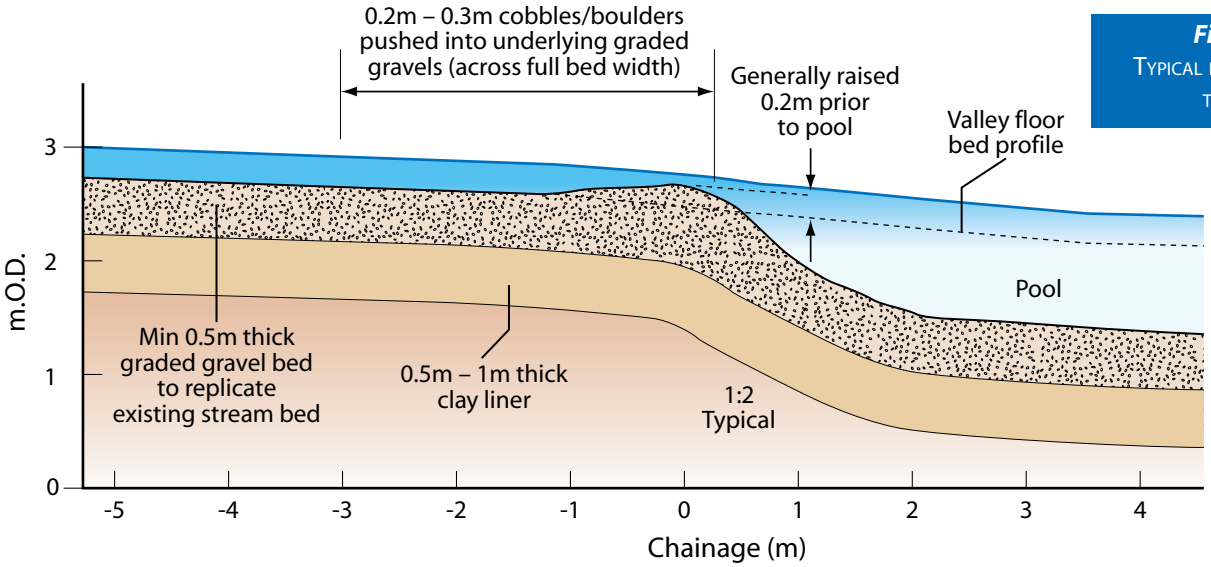


Figure 11.2.4
TYPICAL LONGITUDINAL SECTION THROUGH POOL

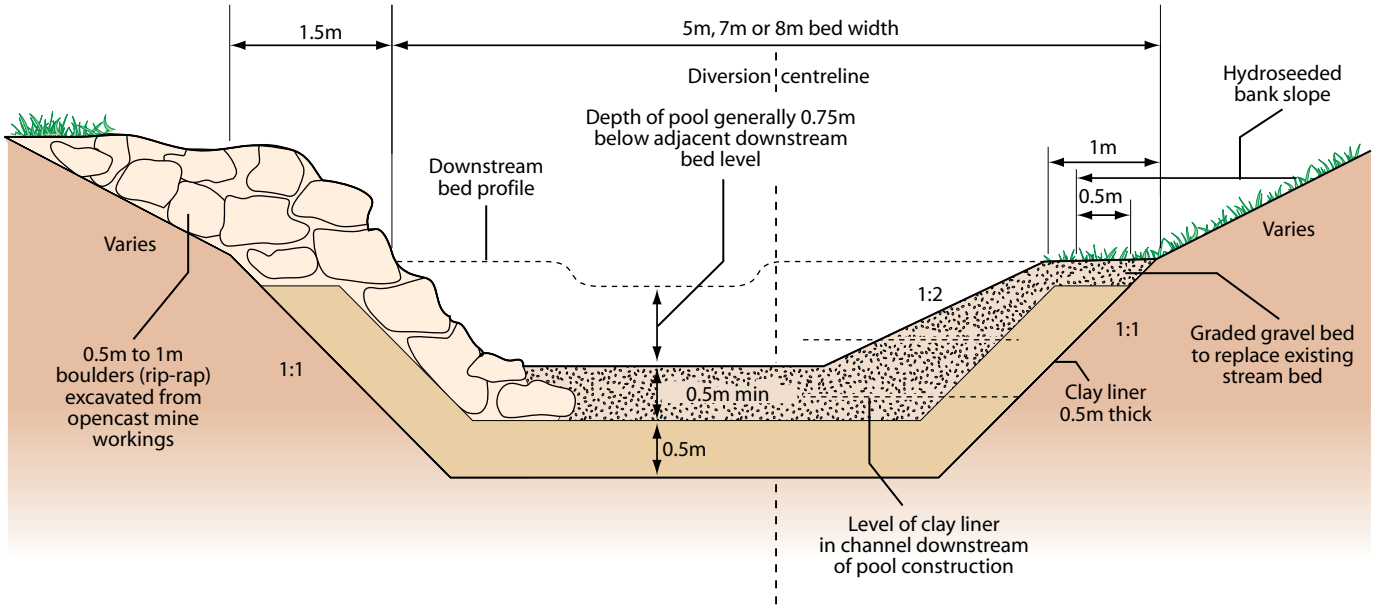
One year on and natural redistribution of in-channel sediments is helping to 'soften' the engineered channel

Subsequent performance 1995 – 2001

The ongoing biological and geomorphological performance of the diverted channel is being monitored under a PhD programme at the University of Stirling, sponsored by those sharing responsibility for the construction. A complete picture of the success of the project will only be possible following several more years of monitoring but the signs after twelve months are encouraging.

Recovery of the plant and benthic invertebrate communities is progressing well, although some species still remain low in abundance and others, found in the natural river, are absent from the diversion. This relates to low mobility and poor habitat and food availability due to the lack of vegetation. Fish have successfully recolonised the new channel, and the scheme has been hailed a success by the District Salmon Fisheries Board. Some additional planting is to be undertaken along the river-banks to provide in-stream shelter.

Figure 11.2.5
TYPICAL POOL CONSTRUCTION



The overwide channel and plentiful bedload gives the river scope to shape its bed

River Diversions

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The rip-rap is still very evident but the in-river form is developing well

During a 1 in 10 year flood event the channel planform remained stable with only minor bank erosion. Channel change was most apparent near tributary junctions; dynamic reaches in natural rivers. The bed material was mobilised, as it was in natural reaches up and downstream, and as a result the constructed low-flow channel was replaced by a natural thalweg. The movement of the bed material resulted in some reaches becoming shallower, and the creation of point bars not in the design, increasing diversity of water depths and velocities.

Sorting of the bed material has deposited finer material on the inside of meander bends, resulting in a more natural appearance than immediately following construction. Minor bed level and bank adjustment is anticipated as a result of further high flows, in the same way as would occur in a natural river, but this will not threaten the integrity of the diversion.

The works have an eight-year maintenance period that will encompass annual inspections and reporting of any erosion control and/or replanting works deemed necessary.

Original Information Providers:
Mark Welsh
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RRC

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River Diversions

11.2 River Nith 2013 Update

River Nith	High energy, gravel
WFD Mitigation measure	**Click Here** to view details
Waterbody ID	GBNI1NB030307129
Designation	None
Project specific monitoring	Macroinvertebrate, Fish

The diverted channel had a wide riparian corridor. However, there was not enough channel sinuosity, and back water habitats were created which were out of character with the natural form of the river. In places the gradient was over steepened which, after the first floods, caused some headward erosion in one of the tributaries, the Dalgig Burn. In addition, bank erosion, slumping and some erosion in tight meander sections occurred. The eroded material was deposited in the lower gradient sections downstream, almost filling the channel in places. While it did create some additional habitat diversity, it was not planned. Problems with erosion were addressed by placing more boulders into the channel. This was fairly cheap to do due to the proximity of material to the site (mining by-product) and the machinery that was available.

Following works, trees and shrubs started to colonise the banks and an increase in macroinvertebrates and fish was observed. Successful recovery of macroinvertebrate richness and abundance was recorded and after 12 months there was a 90% recovery over the whole channel. After 2 to 3 years there was little discernible difference in species composition between the impacted and control sections.

Major changes

In 2004 the channel was moved again, roughly along the course of the original, because of a commercial decision to extend coal mining activities. This allowed the channel design to incorporate lessons from the former project's successes and limitations.

The channel realigned in 2004 after 7 years. Marginal vegetation has established and natural morphological processes are taking place – August 2011

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Reference material – Click here