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Restoring Meanders to Straightened Rivers

1.8 Restoring a meandering course to a high energy river

ROTTAL BURN

LOCATION – GLEN CLOVA, ANGUS, SCOTLAND NO36936919

DATE OF CONSTRUCTION – TWO PHASES - MAY/JUNE 2012 AND AUGUST 2012

LENGTH – 1,200m

COST – £200,000

Rottal Burn	High energy, gravel
WFD Mitigation measure	**Click Here** to view details
Waterbody ID	5812
Designation	SAC
Project specific monitoring	Fish, Habitat, Macroinvertebrates, Plants, Birds, Morphology

Description

The Rottal Burn has a steep catchment of 17.05km² to its confluence with the River South Esk. The final 1km of the Rottal Burn between Rottal Lodge and its confluence with the River South Esk was realigned and straightened soon after the 1830s. In this final reach the steep catchment meets the South Esk glen. This reduces the gradient and results in deposition of bed material. The bed of the channelized burn was continually aggrading and sediment was sediment was being deposited at the confluence with the River South Esk. In response, sand, gravel and cobbles had been dredged and and used for agricultural embankments (up to 2.2m above field level) to reduce the frequency of flooding of the surrounding fields. In 2003, the stretch was dredged again, destroying the existing habitat.

The River South Esk and its tributaries are designated for Atlantic salmon (*Salmo salar*) and freshwater pearl mussel (*Margaritifera margaritifera*). Although spawning habitat was present in the burn, the lack of variation resulted in low numbers of juvenile salmonids and any fry produced were often washed out of the burn by spate flows. Working with the supportive owner of Rottal Estates, the fisheries trust saw an opportunity to improve the availability of fish habitat, and improve the overall habitat, by restoring the burn to a naturally functioning state and reconnecting it with its floodplain. This would support the recovery of sustainable populations of Atlantic salmon, brown trout (*Salmo trutta*) and, in the long term, freshwater pearl mussel (which is dependant on salmonids for the completion of its life cycle).

Council planning permission, a CAR engineering works (Controlled Activities (Scotland) Regulations) licence and a Habitat Regulations Appraisal, due to the site being within a SAC, were all necessary.

Dredged gravel forms an embankment on both banks. The channel runs in a straight line to the confluence with the River South Esk – May 2006

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Design

The scheme was designed to allow natural processes to shape the channel's features, rather than focusing on creating individual habitat areas.The new channel was over-sized compared to the existing straight cut, to allow space for the natural features to develop. It was also anticipated that the burn would actively adjust its course within the wide corridor between the old cut to the north and a knoll and new spoil bunds to the south (*Figure 1.8.1*).

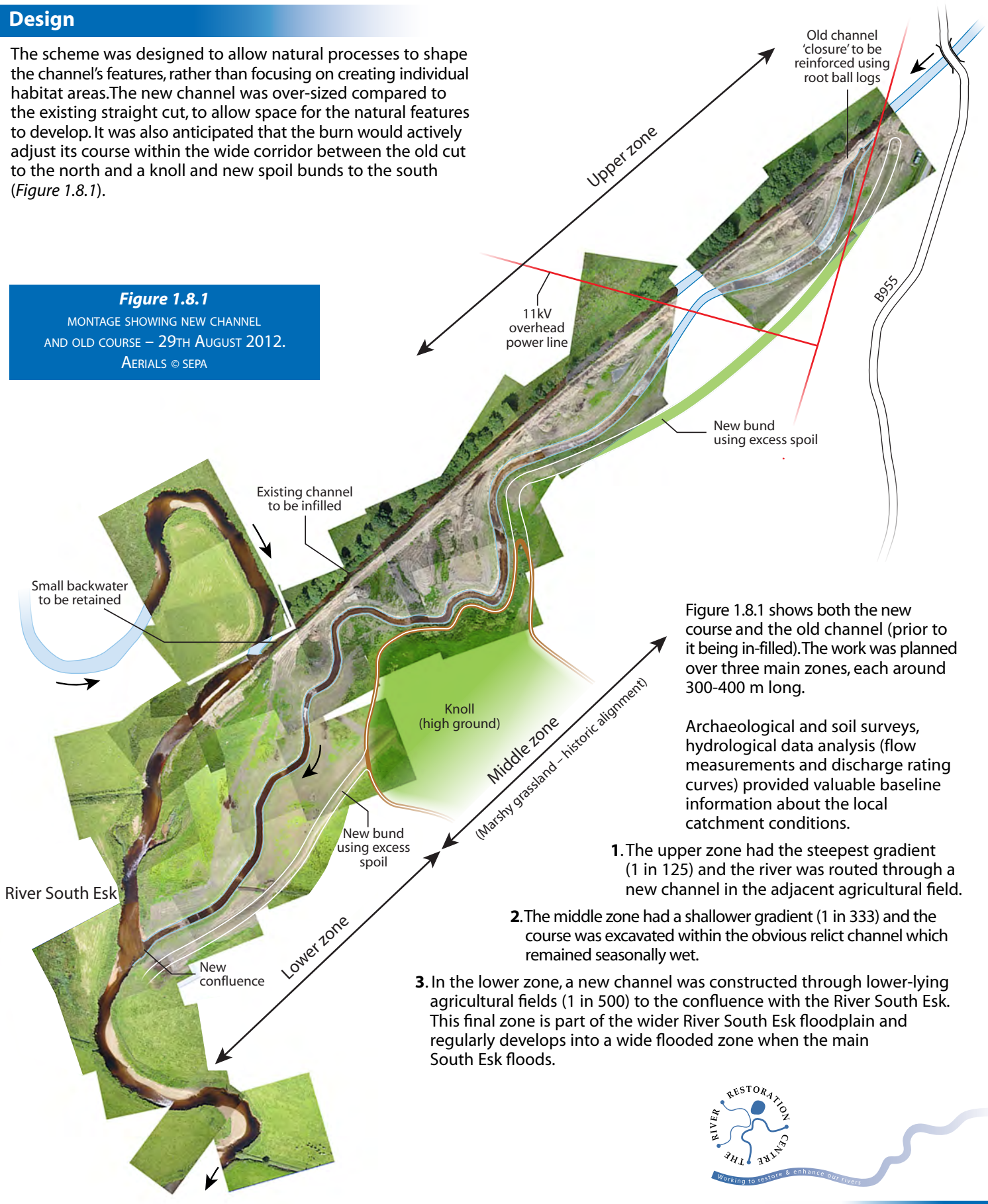

Figure 1.8.1
MONTAGE SHOWING NEW CHANNEL AND OLD COURSE – 29TH AUGUST 2012. AERIALS © SEPA

Figure 1.8.1 shows both the new course and the old channel (prior to it being in-filled).The work was planned over three main zones, each around 300-400 m long.

Archaeological and soil surveys, hydrological data analysis (flow measurements and discharge rating curves) provided valuable baseline information about the local catchment conditions.

1. The upper zone had the steepest gradient (1 in 125) and the river was routed through a new channel in the adjacent agricultural field.

2. The middle zone had a shallower gradient (1 in 333) and the course was excavated within the obvious relict channel which remained seasonally wet.

3. In the lower zone, a new channel was constructed through lower-lying agricultural fields (1 in 500) to the confluence with the River South Esk. This final zone is part of the wider River South Esk floodplain and regularly develops into a wide flooded zone when the main South Esk floods.

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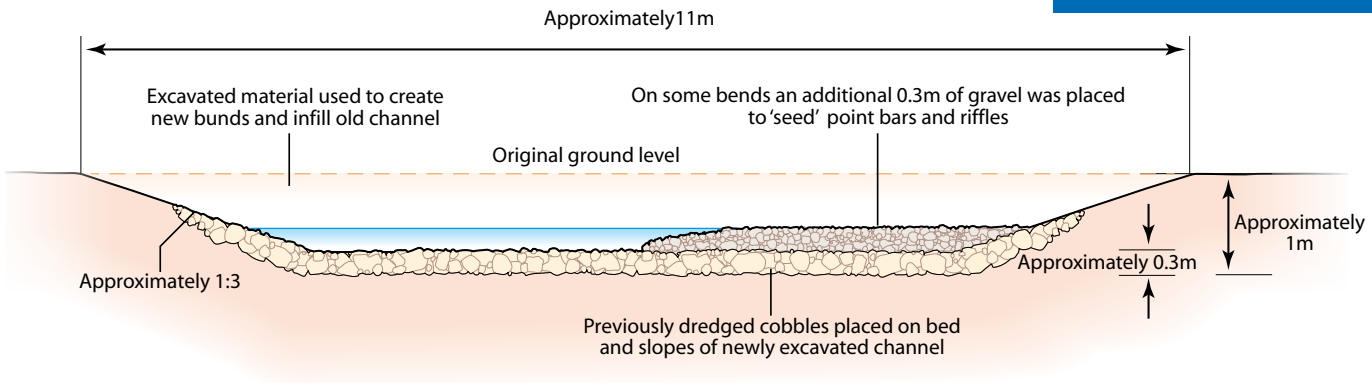
Figure 1.8.2
TYPICAL CROSS SECTION SHOWING A SIMPLE APPROACH TO THE CHANNEL DESIGN



The initial design concept specified the 45 degree bank angles of the upstream reach, and a varying bed profile at meanders. However, during construction the bank slopes were formed at shallower slopes of 1 in 3. This was to reduce the potential for erosion in the sandy soils and to help vegetation establishment.

In a further change, and working on the principle that the channel would quickly rework its material, the cross section at each meander was formed as a flat profile (similar to the straight runs – *Figure 1.8.2*). This allowed the bed of the channel to be used as a haul road for placing the gravel substrate. As a result, the channel profile remained relatively similar throughout but with distinct bed gradient changes over the three zones.

Three panoramas showing the development of the middle reach – 2011 to 2012

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© K.MacDougall

The newly excavated channel, viewed from the knoll, following the old course – Sept 2012

© RRC

The channel is depositing and moving sediment, creating features – July 2013

Substrate previously dredged from the burn and won from the embankments was placed on the bed and banks of the newly excavated channel to an approximate depth of 0.3m. The median gravel size was 60mm with the range of material being fine sand to large cobbles. In thirteen locations, additional gravel was placed to a height of 0.3m above the surrounding design substrate level (*Figure 1.8.2*). These locations were where features were expected to occur and were intended as source material for natural processes to use to shape the burn.

The steeper upper section of the new channel would be subjected to the greatest erosional pressure, so the design width was increased to accommodate both sediment deposition and discharge.

A two-phase construction programme allowed the new dry channel to be constructed during late spring, with additional time given for vegetation to establish on the banks prior to the final opening.

Initially a downstream 'plug' was retained. However, due to both the site layout and the short window of opportunity for vegetation growth, this was removed and the downstream opened up. At the upstream extent, a pipe was installed between the existing and new channel to provide a small feeder flow to allow bankside and aquatic ecology to develop prior to the entire burn being diverted.

By cutting the new channel through the low lying, rush dominated wetland vegetation, very little vegetation establishment was needed in this middle reach. Careful turf stripping, storage and replacement helped to speed up the re-vegetation within such a short growing period. In late summer, flow from the existing channel was diverted into the new course.

Fine silt and sand transportation from the site works into the River South Esk was a major concern, with the river's designation for freshwater pearl mussel. Measures taken to mitigate this included straw bale silt trapping and allowing time for vegetation to establish before the new channel was connected.

Excavated spoil was stockpiled and then used to infill and landscape the old channel once it was dry. Excess material was used to create two left bank bunds to prevent out of bank flood flows from outflanking the knoll.

Wind-blown Scots pine from the estate, was used to reinforce areas of possible adjustment such as the initial bend into the new course. In early 2013 the tree planting was completed and a locally sourced riverbank wild grass seed mix was sown.

A number of challenges were faced during the construction including the presence of overhead services, the remote location, inclement weather, and the limited growing season at an altitude of 220m above sea level.

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Subsequent performance

The new channel was tested by a number of significant flow events, including a large spate just 36 hours after being diverted. This was followed in mid-October 2012 by one of the largest floods in 10 years.

As predicted, the upper reach has been more morphologically active, with new sediment supplying the formation of gravel bars. There has been some local erosion which has allowed a greater variety in channel width and depth to develop. In the middle reach, sand and gravel bars have formed and connectivity with the adjacent floodplain and wetland area has increased. Erosion has varied significantly depending on the bank material (peat, sand or gravel) showing that accurate prediction of channel adjustment is hard to achieve, and that sufficient space needs to be given to allow change to occur.

Bank erosion and channel adjustment are also leading to the erosion of the new upper bund. The main area to be monitored is close to the power lines. Should any stabilisation be necessary, this would be achieved through addition of further woody material.

The lower reach remains relatively unchanged after one year. This is partly due to the greater distance from the new input of bed material and also as the spate events have all thus far involved a simultaneous rise in both the burn and the main South Esk. This creates a ponded floodplain with low velocities and little energy to shape the lower burn.

A fisheries survey identified 30 salmon redds in the upper reaches of the restored channel, while sea trout and otters (*Lutra lutra*) have also been observed.

A monitoring network has been set up to assess the longer term performance of the project. Pre-work surveys included a fluvial audit, topographic assessment and geomorphic appraisal in addition to baseline fisheries, river habitat, bird, plant and aquatic invertebrate surveys. Post construction monitoring has included repeat topographic and aerial survey from a small remote control helicopter.

The as-dug channel with cobbles from the old dredgings embankment – 2012

Subsequent deposition and erosion from, now unconstrained, natural processes – July 2013

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