

11.1 Diversion of a River Valley

SUGAR BROOK

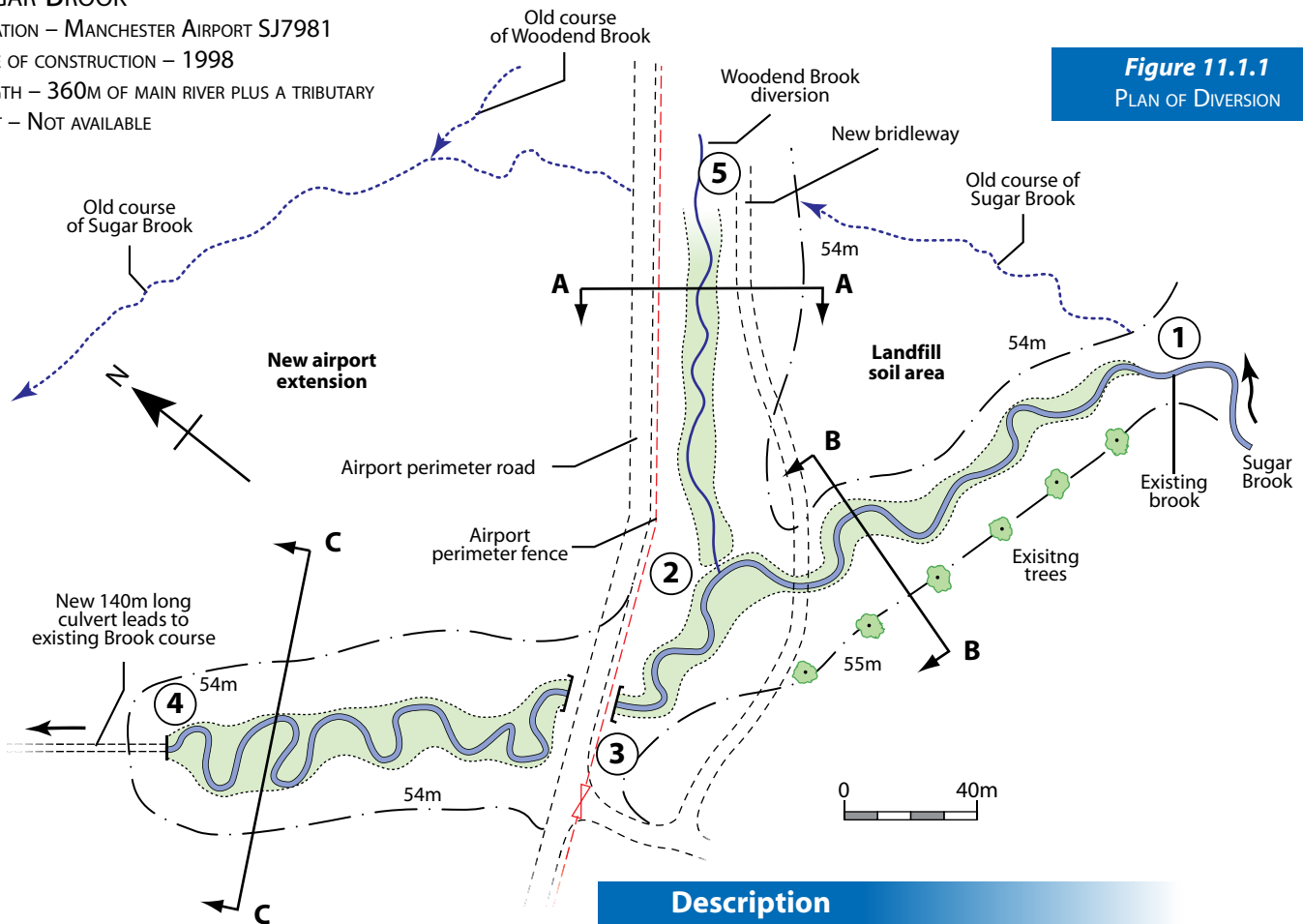
LOCATION – MANCHESTER AIRPORT SJ7981

DATE OF CONSTRUCTION – 1998

LENGTH – 360M OF MAIN RIVER PLUS A TRIBUTARY

COST – NOT AVAILABLE

Figure 11.1.1
PLAN OF DIVERSION





Description

The construction of a second runway at Manchester Airport required the back-filling of a 350m long reach of Sugar Brook, and its valley, to bring ground levels up to the required elevation for the runway, the runway approaches and marginal safety grasslands. Rather than place the entire reach in a buried culvert the brook was realigned over a 500m long reach that reduced the length of culvert involved to 140m where it unavoidably passed under the runway approaches and lighting strip. The remaining length of the diversion, some 360m, was constructed as an open watercourse.

A small tributary stream, Woodend Brook, was similarly affected and needed to be diverted into the realigned Sugar Brook. This was achieved entirely in an open watercourse further avoiding culverting.

Figure 11.1.1 shows the previous route of the two watercourses and the route of the diversions to the south that take them clear of the airport perimeter fence towards the new culvert under the airport approaches (airport culvert). This culvert reconnects directly to the existing Sugar Brook course at its exit. The length of the diversion equalled the length that it replaced, thus maintaining the same overall bed gradient.

Key

-  Contours at 54/55m indicating top edge of new valleys created
-  Indicates extent of relatively flat valley floor (floodplain) with small incised channel meandering through

- 1** Start of Sugar Brook diversion
- 2** Woodend Brook confluence
- 3** Perimeter road culvert
- 4** Airport culvert
- 5** Start of wetland on Woodend Brook



Sugar Brook before culverting, a reference site for the new channel

Many issues arose in the design of the watercourse diversions, but perhaps of greatest significance was the depth to which excavations needed to be taken to achieve the required bed levels. The new bed falls fairly uniformly at about 1 in 200 gradient between existing bed levels of Sugar Brook at each end of the 500m diversion. In contrast to this, the ground levels along the diversion route increased in elevation to heights of over 5m above the new bed. Channel depth of this magnitude (5m) far exceeded the natural channel depth of approximately 1m that are typical of Sugar Brook, so a novel approach to design was essential.

The diversion presented an opportunity to recreate the natural features found on unmodified reaches of the brook.

Design

A preliminary outline design prepared at the planning permission stage indicated a slightly sinuous channel that was trapezoidal in cross-section over its full depth and lacked any of the detail and refinement needed to mimic the natural character of Sugar Brook. This approach aimed to achieve the least possible excavation width and set new bank tops around which various roads, paths and a surplus spoil disposal site were all positioned and linked to the subsequent planning permission. This resulted in an unduly narrow 'approved' corridor of land within which to achieve the detailed design of the diversion.

A trial excavation at the upper end of the diversion reach was undertaken to test the outline design. This was shown to be completely inappropriate. Apart from its deep 'canyon-like' appearance, the predominant clay soils could not be relied

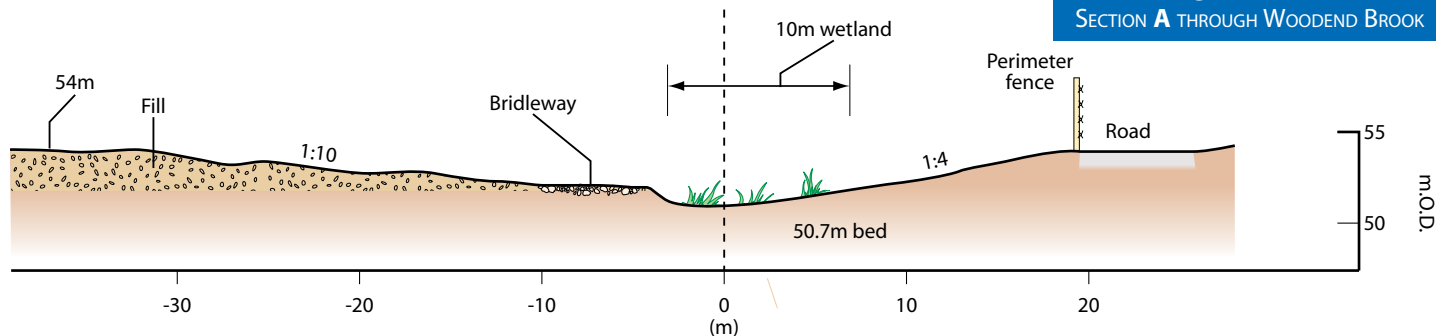
upon to remain stable at the depths of excavation involved. Undercutting of the toe of the slopes could be expected to accelerate collapse of the high banks.

A new approach to design was needed which recognised that the formation of the valley within which the brook naturally flows involved different geomorphological processes than those that sustain the small watercourse that is incised within the floor of the valley. Inspection of the undisturbed reach just downstream of the airport demonstrated a narrow rounded valley formed during glacial retreat with a fairly flat bottom of more recent fluvial sediments through which the brook course meandered. Cross-sectional templates were taken from this reference reach and used to design the new valley.

The approach to detailed design thus involved treating the diversion as a diversion of the valley of Sugar Brook and not as a channel diversion. If an acceptable valley form could be achieved then the creation of a small meandering stream within its floor became a relatively straightforward task.



Figure 11.1.2
SECTION A THROUGH WOODEND BROOK



Woodend Brook

Creating the New Planforms

Figure 11.1.1 shows the top edge of the newly created valleys of both Sugar Brook and Woodend Brook along contours of between 54 and 55 metres O.D. with a top width of between 30 and 50 metres. The relatively flat valley floor of each is also indicated at widths of between 10m and 20m.

The meandering plan form of Sugar Brook, which is cut into the valley floor by up to 1m only, was strongly influenced by templates of meander patterns elsewhere on the brook (Figures 11.1.3 and 11.1.4). Woodend Brook does not feature an

incised course in the new floor but has been encouraged to form a wetland across its full width of around 10m (Figures 11.1.2). Natural channel incision is expected to develop slowly.

Valley Profiles

The manner in which the new valley side slopes were shaped was carefully excavated to mimic natural profiles which vary from concave, where ancient soil slips have arisen, to convex, where they have not. The mean slope associated with concave (slipped) profiles is likely to be flatter than when convex, creating desirable variations and mild sinuosity when looking down the valleys. Compound slopes involving both concave and convex slopes were also incorporated. Three cross-sections A, B and C indicate these variations which are also apparent on the photographs.



Sugar Brook looking upstream

Figure 11.1.3
SECTION B THROUGH SUGAR BROOK
UPSTREAM OF CONFLUENCE

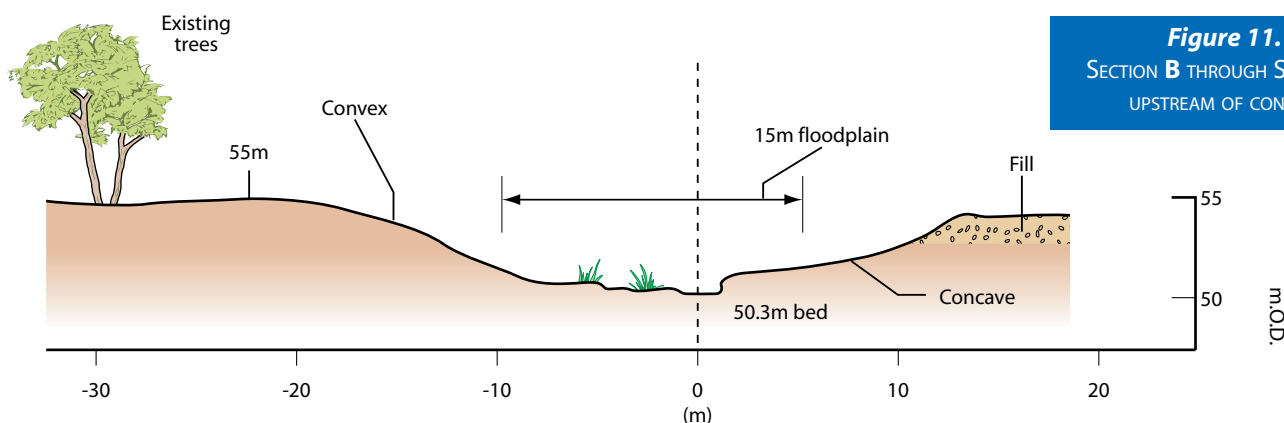
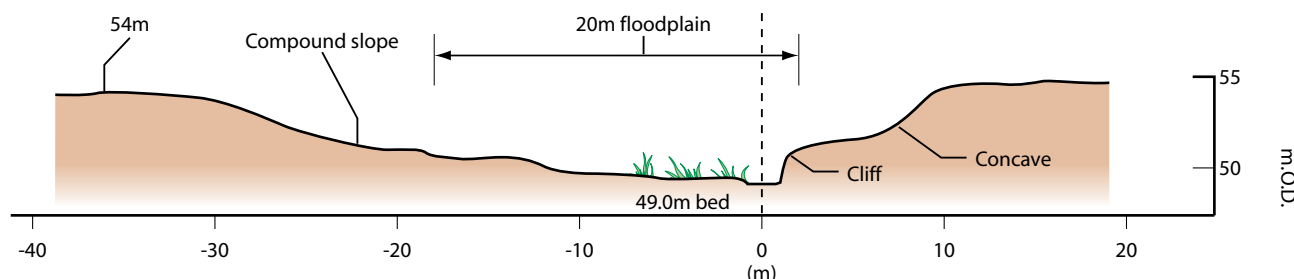


Figure 11.1.4SECTION C THROUGH SUGAR BROOK DOWN-
STREAM OF CONFLUENCE

Sugar Brook Valley below confluence – September 1999.



The river valley vegetation is developing well – November 2001.

Subsequent performance 1995 – 2001

The River Channel

This was meandered down the valley floor following the design principles described elsewhere in this manual (see *Techniques 1.1, 6.2*). Cliffs, riffles, pools and shoals were all initiated within the excavated channel profiles, but it was expected that rapid changes would arise during subsequent flood periods. The aim of the design was to create a channel form that anticipated the type of regime that was appropriate whilst leaving it to the stream to adjust to a reasonably stable form over succeeding years.

Extensive marginal and bankside planting was undertaken as part of the planning permission and a monitoring programme was set up with the first survey in 1999, one year after construction.

Although the extent to which the form of the newly created valley could be naturalised is severely constrained by spatial limits relating to the early planning decisions, its overall appearance is good. It is certainly far better than the trapezoidal profiles envisaged at the start, which suggests that the concept of river valley diversion, rather than channel diversion, is one that needs to be taken up early in similar circumstances.

An MSc study in 2000 (M Guy, University of Nottingham) found that considerable geomorphological activity is occurring on the channel, with active erosion and deposition patterns. It appears that the channel is still adjusting to reach dynamic equilibrium but is comparable with the undisturbed stretches of the stream.

As part of a post project monitoring scheme baseline information was compiled using water quality, benthic invertebrate data, topographical and river corridor surveys. In the first year, monitoring results of the aquatic planting confirmed all species planted had begun to establish, but a short term abundance of annual watercress (*Nasturtium officinale*) was influencing low flow characteristics. Some self-seeding willow (*Salix spp.*) and alder (*Alnus spp.*) are already evident along the riparian channel.

No significant changes in water chemistry have been recorded, with the exception of fluctuating suspended solids during construction and very high flows. Within two years, the benthic invertebrate fauna of the new channel comprises almost all taxa found in the original. The remaining high scoring rare taxa have yet to return (*MSc dissertation 2001 Z. James*). Manchester Airport plc continues to monitor the site.

Original information providers:

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11.1 Sugar Brook 2013 Update



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Looking upstream from the footpath bridge – July 2013

Sugar Brook	Low energy, clay
WFD Mitigation measure	
Waterbody ID	GB112069061350
Designation	None
Project specific monitoring	Macroinvertebrates

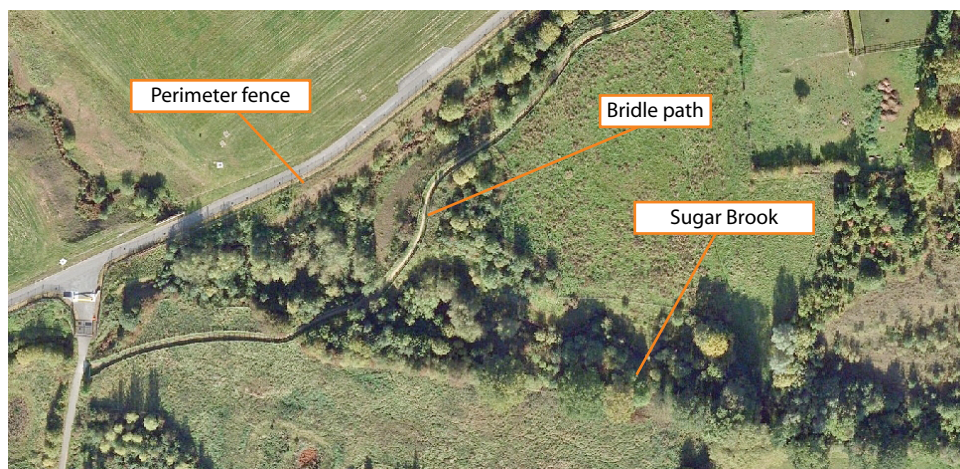
Looking upstream from the footpath bridge – March 2007

The self sown willow and alder mentioned in the 1998 – 2001 subsequent performance have now grown into a dense cover of trees. The photograph taken in 2007 shows the saplings growing along the bank and the more recent photograph taken in 2013 indicates that the channel is now completely shaded by this tree cover.

Invertebrate surveys were carried out in 2000 and 2013. Whilst the BMWP score has increased, there is not enough data to ascertain whether this increase is due to improvement in water quality related to the channel naturalising after the initial realignment.

The channel would benefit from some sympathetic tree thinning to allow at least some daylight to penetrate through to the channel.

Aerial photograph of Sugar Brook showing dense tree cover



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