Advisory Visit

Kirtle Burn – Dumfries and Galloway

Scotland

26/07/2016

1.0 Introduction

This report is the output of a site visit to the Kirtle Burn at the request of Tony Donnelly, director of the River Annan Trust. The purpose of the visit was to assess bank erosion and propose options for effective, environmentally friendly bank protection that could improve habitat quality, rather than degrading it.

Normal convention is applied with respect to bank identification, i.e. the banks are designated left bank (LB) or right bank (RB) whilst looking downstream. Upstream and downstream references are often abbreviated to u/s and d/s, respectively, for convenience.

2.0 Background

Healthy river channels migrate over time and, in the long-term, naturally move from one extreme of the floodplain to the other. However, the land use within a catchment can greatly affect rates of bank erosion and the speed at which a watercourse will migrate.

Deforestation of the uplands and grazing of land adjacent to watercourses reduces rain infiltration to the ground, accelerating the rate water runs off the land, increasing peak flow volumes, velocity and erosive energy. In addition, the straightening undertaken on many watercourses increases their gradient (shorter channel length over the same head-loss) further accelerating flows and reducing the potential for water to spill out onto the floodplains which would otherwise provide floodwater storage and attenuate peak flows. The end result being higher energy rivers with a greater potential for erosion and sediment transport that often become incised as the watercourse scour downwards into their bed. Incision and lowering of the bed further reducing the ability of high flows to spill onto the floodplain and renders the banks more susceptible to undercutting and erosion.

All of the above factors are at play on the Kirtle Burn and while some of the erosion and channel movement that has occurred is natural, deliberate straightening was almost certainly undertaken historically in an effort to protect grazing land and infrastructure like buildings, roads and access tracks. The burn is now naturally migrating towards a more sinuous course.

Figure 1 shows aerial imagery of the area with the locations of the most obvious paleo-channels within the floodplain (Fig. 1B). While some of the channel migration to its current course may have been natural, other areas were clearly artificially straightened and maintained straight, as continues today (Fig. 2). As a consequence, the current channel is straighter and conveys higher energy than it would ordinarily, and erosion is greater as a consequence.

B.

Figure 1: Current aerial imagery of the Fallford Lodge area (A). Some of the paleo-channels highlighted, providing a clue as to past channel routes and a more sinuous and lower-gradient course (B).

3.0 Site assessment

Figures 2 and 3 shows a piece of particularly unsympathetic and poorly executed 'hard' bank protection (revetment) that was undertaken to protect a water pipe towards the u/s end of the site. At this location, the incised (following historic straightening) channel is eroding laterally into the bank of the now disconnected floodplain (LB).

While revetment may be required to protect an important asset here, the fact that it is not tied into consolidated bank at either end means that high flows are likely to quickly out-flank the structure (see examples - https://youtu.be/q7zq1yxaPEA). Once behind it, flows will erode even faster into the softer adjacent bank, greatly exacerbating erosion issues. This is because, unlike softer, green engineering that absorbs and dissipates flow energy, hard, solid structures within a watercourse simply deflect flow energy elsewhere, focussing erosive force onto other areas. In addition to eroding at either end of the structure, flow energy along the revetment that is unable to erode laterally will scour downwards into the bed, eventually undercutting the revetment if the foundations are not sunk deep enough. Livestock access to the recently reworked earth also greatly inhibits recolonisation by the vegetation that is required to stabilise that ground.

Figure 2. Unconsolidated bank at the d/s end of the hard bank revetment (LB – right of shot) that will be subject to exacerbated erosion from flow energy deflected by the structure.

Figure 3. The u/s end of the hard bank revetment where, again, high flows are likely to cut into the unconsolidated bank material. At least some relatively well established vegetation is present (foreground) which may slow the rate of erosion and out-flanking of the structure.

The main subject area of this report is the next bend d/s, where the burn is eroding into the RB (Figs 4 & 5). At this location, repeated realignment of the watercourse had reinstated a straightened channel but with subsequent natural, lateral migration (over recent years), the channel has again reclaimed more sinuosity and threatens the field boundary along the RB. As it is unlikely that adjacent areas of the watercourse will be returned to a meandering lower-gradient course (to reduce the impacts upon flow and sediment conveyance previously discussed), any proposal must work with other natural processes to provide a sustainable, long-term solution.

Key to success will be consolidating the bank with sufficient vegetation and associated root systems, but also providing a means to dissipate flow energy before it hits that bank. The solution requires stock exclusion from at least the susceptible area of bank, so that the required trees, shrubs and other diverse vegetation can become established. Fortunately, the burn already inhibits sheep access to the RB, so grazing pressure in that area is already lower than the LB and, consequently, the diversity of vegetation is greater. This will provide a good seed-bank for further re-colonisation.

In the short-term, more formal, green engineering methods can be employed to provide the flow dissipation and physical protection of the bank while the vegetation and trees become established. Several techniques could potentially be employed here but the simplest and cheapest solution is likely to be achieved by securing a line of brash along the bank (from toe to bank top) as a way of dissipating erosive flows with in the matrix of twigs and branches.

Green engineering techniques are most effective when undertaken just before the growing season starts, to allow the longest possible period of growth in the critical first year. It is understood that some redistribution of the gravel bar has been consented, to reduce pressure upon the bank until next spring when green bank protection can be installed.

N.B. Gravel removal or redistribution is not a suitable, sustainable, or effective long-term solution to bank erosion, as shown by the history of straightening required at this location but, in this instance, it *may* buy some time until the bank protection can be installed, just prior to next growing season. It should also be accepted that, with the gravel removal alone, there is a strong possibility that the next big flood will simply reinstate the channel morphology to a similar state as shown in the picture. This is why a more sustainable, green engineering solution is required.

Figure 4. Looking d/s at the bank protection site. Note how the gravel bar is pushing flows over towards the RB. Fortunately, the clay-based soil offers some resistance, which has led to some downward scour, rather than just lateral erosion, but without greater structure within and along the bank it will continue to migrate right, towards the field boundary.

Figure 5. Looking u/s at the bank protection site. The straightness of the channel (both u/s and d/s) means that sediment is transported straight through the section, only being retained on the slight bend.

4.0 Recommendations

4.1 Brash bank protection

Brash protection provides an effective energy-diffusing barrier that slows flows before they hit the bank. To install the protection, posts are driven into the bank toe and top, ensuring to key into a stable area at either end (Fig. 6). Starting at the u/s end, brash is installed between the post with the butt ends facing u/s and into the bank (Fig. 7) and secured in place, either by wiring directly over the top (Fig. 8) or by clamping the brash down beneath longer more substantial brash/branches batons (Fig. 9). The riverside edge should be left rough and untidy, with the tips of the branches trailing out into the channel to soften the edge and further dissipate flow energy. This also provides valuable fish and invertebrate habitat. Owing to the high energy of the Kirtle Burn, it will be important to ensure that any structure installed is sufficiently robust to withstand the flows and coarse sediment transport likely to be endured (Fig. 10). If installed correctly, the dissipation of flow energy created should actually encourage sediment suspended within the water column to be deposited along the bank.

Inhibiting geomorphological processes is not beneficial or recommended in a natural scenario but, where vital infrastructure (property) requires protection, the method can provide a nature-like solution and limit the detrimental impact upon a watercourse.

Figure 6. Note how the start of the bank protection should start tight up against the more stable bank area (in this case, the roots of a tree). Starting at the u/s end, the brash is tucked in amongst the tree roots to help anchor the whole structure. Bank protection needn't be tied into tree roots but should meet an area of stable ground at either end.

Figure 7. Subsequent brash then linked in to the adjacent brash upstream.

Figure 8. Bank protection secured in place by wiring over the top of the brash between posts.

Figure 9. Brash bank protection secured with batons.

Figure 10. A line of coarse brash bank protection, installed along an eroding bank line. This picture was taken before the posts were trimmed, which should be undertaken upon completion of the brash installation, to prevent the posts from being ripped out by debris in high flows.

The brash technique usually employs at least a proportion of live willow material which should, ultimately take root and form a line of shrubs along the bank, providing further protection and habitat diversity. One consideration with this method is a possible requirement for future pruning/maintenance of the structure; however, it may never become an issue and simply require ongoing monitoring. If maintenance were required it should only consist of trimming the trees and laying some branches (as you would a hawthorn hedge) into the channel.

4.2 Tree planting

Excluding livestock and planting along, and behind, the eroding section of bank is vital and will greatly increase stability of that ground and help to prevent further lateral erosion. The bank only needs to be more stable than the unconsolidated, mobile burn substrate, in which case the scour will be directed downwards into the burn bed, mobilising that material instead of the bank. Planting the bank with a range of native, deciduous species would be beneficial, most of which can be bought in as saplings and formally planted; however, substantial live willow posts could also be driven well into the ground to provide more rapid, larger trees - smaller willow whips can also be included.

The quickest and easiest way of establishing willow trees is by driving short sections of freshly cut willow into the ground. This can be undertaken at any time of the year, but will have the greatest success during the dormant season, shortly before spring growth begins (ideally late Jan-March). Whips should ideally be planted into soft, wet ground so that there is a greater length within the ground than out of it, to minimise the distance that water has to be transported up the stem; 30-40cm of whip protruding from the ground is sufficient. Whips of 5mm-25mm diameter tend to take best, but even larger branches/stems can be used. Care should be taken not to leave excessive amounts of foliage on the whips as these greatly increase the surface area of the plant and can lead to their dehydration.

The willow used in this instance should be the smaller shrub species, particularly grey willow or goat willow (*Salix cinerea* and *S. caprea*), which, being small, tend to create low, dense cover and better bank protection than the larger less-stable species. Material should be sourced locally in an attempt to utilise native trees and reduce the risk of disease and non-native species transport.

5.0 Further information

The WTT website library has a wide range of free materials in video and PDF format on habitat management and improvement:

www.wildtrout.org/content/library

We have also produced a 70 minute DVD called 'Rivers: Working for Wild Trout' which graphically illustrates the challenges of managing river habitat for wild trout, with examples of good and poor habitat and practical demonstrations of habitat improvement. Additional sections of film cover key topics in greater depth, such as woody debris, enhancing fish stocks and managing invasive species.

The DVD is available to buy for £10.00 from our website shop www.wildtrout.org/product/rivers-working-wild-trout-dvd-0 or by calling the WTT office on 02392 570985.

6.0 Disclaimer

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