Comrie FPS: Green Bank Protection Design Method Statement

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Client: SWECO Ltd

Project Manager [redacted]

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INTRODUCTION

Detailed designs have been produced for the sustainable protection of an eroding section of the river right bank on the Water of Ruchill at Comrie, Perthshire. The proposed works focus on a ~225 m extent of bank, between OS NGR NN 7728 2164 (upstream) and NN 7712 2177 (downstream). This work forms part of the wider Comrie Flood Protection Scheme (FPS), scheduled for construction from 2022.

The aim of the design is to mitigate ongoing erosion of the river right bank, which is currently posing significant risk to nearby infrastructure. The erosion also poses similar risk to the proposed set-back flood wall which is to be constructed running parallel to the bank as part of the FPS.

Various geomorphic assessments undertaken (i.e. historical analysis, fluvial audit and morphodynamic 'sediment transport' modelling) identify this reach of the Water of Ruchill as being particularly dynamic. Review of historic map data shows that there is classic meander translation downstream, responsible for the bank erosion observed. This could result in a meander cut-off through the riparian area to river right, immediately downstream of the section of bank erosion at the location of the proposed green bank protection works.

Taking the above into consideration, attempts to 'fossilise' the river into a fixed position are unlikely to be successful, particularly in the longer term. As such, we provide a design that is sympathetic to these dynamic river processes and, to some degree, can adjust with a changing morphology. However, it should be acknowledged that at this site, a degree of change is inevitable and very high magnitude flood events are likely to have some impact on the proposed measures.

To achieve a sustainable, long-term solution for the site a 'nature-based' approach has been adopted, allowing the design to be developed within the context of the physical process regime of the site and wider catchment. This philosophy essentially promotes designs that work with river processes, rather than forcing a condition that may not be appropriate for the site. This has been achieved through application of geomorphic theory, analysis of morphodynamic model output and through cbec's experience implementing stable bank protection designs using large wood.

The final bank stabilisation measures proposed provide a number of benefits, including:

- Significant improvement to the stability of the riverbank through bank reprofiling and installation of green/ sustainable bank protection measures;
- Benefits to physical processes through the use of large wood. The advantage of using LWS (i.e. comprising of trees with root plate attached) is that the complex structure of the root plate presented to the flow actively dissipates hydraulic forces, rather than just translating that energy downstream (i.e. as is the case for large rock bank protection structures, where bank erosion is often displaced to the next section of unprotected bank downstream).
- The use of large wood also provides some ecological benefits due to the localised change in hydraulics around the root plate and the provision of cover/ habitat for fish, invertebrates, amphibians etc (large rock bank protection greatly reduces bankside habitat opportunity) whilst also improving riparian/ bankside habitats as vegetation establishes.
- The opportunity to recycle a ~40 m section of boulder bank protection, using the stone within the bank to stabilise the large wood structures.
- Improvements to the existing riparian habitat through the inclusion of three otter holts within the design (locations to be field-fitted, see description below).

This method statement summarises the proposed methods of construction of the design.

Prior to the commencement of any physical works, an initial on-site start-up meeting is required to ensure that all parties involved are in agreement with the proposed construction process. cbec, as the designer, requires representation to supervise all phases of construction to oversee the appropriate execution of the designs and that any ‘field-fitting’ (see below) can be undertaken appropriately when it is determined necessary.

As with any construction that involves working in the natural environment, complete and spatially continuous supporting data sets (e.g. sub-surface ground conditions etc) are not always available. It is therefore not uncommon for unexpected issues to arise once the construction phase has begun. Under such circumstances, it is necessary to make decisions at short notice as to how designs need to be modified to solve these issues. Additionally, the natural materials (i.e. trees, rocks) used within this design are non-standard and irregular and therefore do not have set dimensions. For this reason, their specific incorporation into the design cannot be planned in detail, in advance, and must instead be implemented at the time of construction. In both situations, the process is known as 'field-fitting’ and this term is used throughout this document.

The design will require a stabilisation period following the completion of works. Stabilisation is a natural process involving the establishment of vegetation and their root structures, the compaction/ vertical sorting of sediments through the effects of gravity and the percolation of water. This can take up to 3-5 years to complete, depending on flow regime and rate of vegetation colonisation. During the stabilisation period, the site is particularly susceptible to a degree of adjustment that could be associated with damage to the bank protection measures. An essential component of the work is to monitor the response of the channel to flood events while it stabilises and identify appropriate ‘adaptive management’ work that could be undertaken to minimise the impact to the design. In a high energy system like the Water of Ruchill, monitoring and adaptive management is especially important and should be undertaken in a timely manner.

DETAILED DESIGN

The final design components for the proposed green/ sustainable bank protection measures are summarised below:

- Removal of a 40 m section of boulder bank protection between NN 7727 2165 (upstream) and NN 7724 2168 (downstream).
- The removal of trees (with root plates attached) from the current channel margins and re-use within the design (where tree sizes are suitable).
- The installation of a four-tier system of large wood bank protection structures (LWBPS) with root plates attached, along a ~225 m section of bank from NN 7728 2164 (upstream) to NN 7712 2177 (downstream), stabilised by stone sourced both onsite (existing boulder bank protection) and through importing any additionally required, as well as imported willow stakes.
- The realignment of ~55 m of river right bank to produce a more gradual bank angle (in order to minimise risk of further erosion to the downstream section of the bank).
- The inclusion of a live willow mattress (secured with additional willow stakes to those previously mentioned) along the top of the design (i.e. above the four tiers of LWS), to provide additional protection/ added stability along the reprofiled bank face/ top.
- The storage of any removed trees which cannot be recycled within the design, as habitat features within the wider floodplain.
- The installation of three otter holts within the near-bank floodplain, to provide additional habitat.

Assumptions

It is assumed that cobble/ gravel material for back-filling of the design will be available from site.

The designs assume that no overground or underground utilities will be affected by the works (as advised by Sweco, on behalf of Perth and Kinross Council, pers. Comm, 2nd November 2021).

It is understood that the green/ sustainable bank protection works will be implemented prior to construction of the wider flood protection measures (construction recommended to begin as early as possible after environmental/ ecological regulations permit).

The site will be monitored for 3-5 years post implementation and adaptive management undertaken in a timely manner to keep the trajectory of channel stabilisation on track.

METHOD STATEMENT OF DESIGN IMPLEMENTATION

Comrie Green Bank Protection (total length 225 m)

Extents: NN 7728 2164 to NN 7712 2177

Site access and preparation

Site access and welfare location will be agreed with the client and landowner prior to mobilisation. Access is recommended from the gateway located at OS NGR NN 7732 2182, via Field of Refuge in Dalginross.

The Principal Contractor's Site Manager will co-ordinate all deliveries of materials and plant, to be planned and timed under liaison with the landowner. Any specific times to avoid vehicular access should be adhered to.

Consideration will be given to the Field of Refuge residential development, keeping disruption/ disturbance to a minimum.

Whilst importation of materials will be required, the design intends for all materials removed from site to be reused within the design or redistributed throughout the floodplain, eliminating the requirement for export and associated additional plant movement.

Riparian Management

- In preparation for the green/ sustainable bank protection construction, there is a requirement to remove several trees from the top of the existing bank line both for access and to allow the bank to be reprofiled along its length. This should be undertaken in accordance with the tree survey and removal plan[1], to be provided by the client ahead of the works.
- If additional trees need to be removed to those marked in the plan in order to proceed with implementation of the design, this should be communicated to the client at the Principal Contractor's earliest convenience.
- Trees removed from the site during the construction process will be either:
  - reused within the green/ sustainable bank protection construction (where of an appropriate size), or
  - piled throughout the wider floodplain to provide additional areas of riparian habitat.

Green bank protection

- It is strongly advised that construction of the green/ sustainable bank protection be done in the dry, as much as is feasible. Options include a moving temporary coffer dam to divert the flow away from the bank/ working area, or use of some gravels from site to create a temporary flow diversion.
- The green/ sustainable bank protection will extend a total of 225 m between *NN 7728 2164 (upstream) and NN 7712 2177 (downstream)*.

[1] Plan provided in excel and map format, to cbec by SWECO during the design phase.

- The design comprises of four tiers of trees (with attached root plates) as shown in the accompanying design sketch.
- The lower two tiers contain trees placed laterally along the bank with approximately 1 m of overlap between the trees in each tier. Trees in these tiers are to be >150 mm diameter.
- The third tier comprises trees with a larger diameter (500 – 800 mm) placed generally perpendicular to the channel/ live flow orientation and extending more normally into the bank (i.e. so that the root plates are angled to be presented to the prevailing flow direction). The third tier of trees (extending into the bank) will be set at an elevation such that at least half of their diameter is below that of the adjacent channel bed surface.
- Trees in Tier 3 will be placed at 3 m centres through the base of the bank. Individual centres can comprise multiple (2 or 3) smaller trees if enough sufficiently large trees cannot be sourced (although no smaller than 300 mm trunk diameter for any individual tree). Trees in this tier will be angled at approximately 45° – 60° from the bank.
- The fourth (upper) tier will be placed at 3 m centres over the trees in Tier 3, at approximately a 30° angle to the bank with the rootplate facing upstream against the direction of flow. Trees in this tier are to be >150 mm diameter.
- The third and fourth tiers will be secured together in order to maximise the stability of the structure. The final method will be determined in discussion with cbec's design team, but the recommended option is to cut notches in the trunks just above the root plates, allowing the overlapping trees to be slotted together to form a robust interlocking lattice framework structure.
- The large wood structures require at least 6 m length of trunk retained. A greater length of trunk can be retained for the parallel-orientated trees. If not possible to source the full number of trees required, the parallel large wood could be sourced from the crowns of trees cut off when the 6 m root plate lengths are extracted (conifers, where possible, and with branches intact).
- Natural wooden stakes (~100 mm diameter, 2 m length, potentially live willow) will be placed at 750 mm centres and used to pin the parallel large wood in against the bank,.
- Large rock (sourced locally if possible) shall be used to pin the upper tiers of large wood in place and provide ballast:
    - Two boulders (of 400 – 600 mm diameter) to be placed at the interface between the root plate and the trunk, resting on the trunk and the underlying sediment surface on the downstream side.
    - One larger boulder (600 – 1000 mm) set back within the bank, positioned on top of the end of each Tier 3 and Tier 4 trunk.
- Coarse gravel and cobble sized sediment (50 – 250 mm diameter) shall be used to provide a foundation for the trees to be embedded within and to fill the voids between trunks.
- Work will be undertaken during a period of low flow, to minimise risk of sediment release downstream and to provide suitable working conditions. In the event that flow is required to be diverted away from the bank to allow for working in dry conditions, the Principal Contractor

will provide details of methods for temporary flow diversion within the Construction Method Statement.

- It is understood that a proportion of the large wood (i.e. trees) and much of the cobble/ gravel sediment required for the design can be sourced from site. However, given the amount of large wood/ trees required and the necessary specification, it is acknowledged that a proportion of this will need to be imported (from the local area where possible). As stated previously, tree crowns can be used within parts of the design if it is not possible to source the required number of tree trunks with rootplates.
- The green/ sustainable bank protection design will be tapered at the upstream and downstream end. At the upstream end, the large wood will taper into existing boulder/ stone bank protection, with smaller diameter trees/ root plates used and at progressively wider spacings. At the downstream end, a similar tapering will occur but into the natural bank (i.e. not retained boulder/ stone bank protection).

Willow brushwood mattress

- A layered willow mattress structure will be laid along the bank directly above the top tier of large wood, providing stability to the top of the bank.
- Brushwood bundles should be cut open and spread on the bank. An even cover of between 150 mm - 200 mm deep layer of live willow cuttings is required. The brush should be thick and relatively dense, but also have an open structure, to allow it to be backfilled with soil.
- Live willow cutting's diameter should be a mix of 25 mm to 50 mm diameter rods.
- The mattress should be staked along its length with 50 – 100 mm diameter, 1.3 – 1.4 m long live willow stakes.
- The stakes need to be on a gridded, at 0.5m centres.
- The stakes should be driven 1 m into the ground, Approximately 300 mm of each stake should protrude out of the ground (100 – 200 mm above the top of the brush mattress and soil fill).
- Stakes should be secured by 8 mm coir twine or 4 mm galvanized wire fencing twine.
- Once the mattress and stakes are full installed and tied off, then a friable soil or soil/ small gravel should be sprinkled into the brushwood matrix. The fill should sit so that it is flush level with the top branches (virtually covering). Rain and/or flows will cause the soils to consolidate and settle into the brushwood over time.
- Note: Willow brushwood mattress must be sourced, cut and stored in February/ early March to ensure establishment once implemented on site. In the event this is not possible, hazel can be used as an alternative to willow and does not require the same early cutting and storing, however, unlike willow, hazel will not rejuvenate, and so should be supplemented with cell grown willow (3 per m^2). It would also be recommended to monitor the bank with the potential for additional rods to be installed during the next winter period if determined required.

Removal of existing boulder bank protection

- A 40 m section of boulder bank protection between NN 7727 2165 (upstream) and NN 7724 2168 (downstream) is required to be removed.

- Following removal, the majority of the rock will require to be sorted and where required, split to provide boulders of suitable size (i.e. 400 – 600, and 600 - 1000 mm diameter) to hold the large wood in place and provide ballast (as per the Design Drawing and Plan View Sketch).

Otter holts (3 No.)

- Three otter holts (flat pack or similar) will be included within the final constructed design.
- These can be constructed on-site or sourced prefabricated.
- They should comprise a chamber partially buried and covered in turves or brash, installed behind the green/ sustainable bank protection structure (estimated to be set back approximately 6 m), with a pipe connecting to the riverbank).
- Installation entrances should be 225mm dia. corrugated drainage pipes
- The structures should be constructed from natural material such as rock, where possible.
- The exact location/ positioning of these structures is expected to be field-fitted under guidance from a suitably qualified ecologist.
- All installation works supervised by the Ecological Clerk of Works.