Eddleston Water: Geomorphic Unit Mapping

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Report version	Description
1.0	Draft report, awaiting information for analysis of geomorphic unit distribution

1.0 Introduction to scope of project

Richard Williams was contracted by the Tweed Forum to map Geomorphic Units for Eddleston Water using a consistent mapping approach based upon high-resolution topographic survey data. Outputs from consistently mapping geomorphic units will provide: (i) evidence to evaluate the morphological diversity of Eddleston Water; and (ii) an underpinning dataset for many of the other scientific research activities that are being undertaken, for example the monitoring of macroinvertebrates and fish.

This report summarises the methodology that was applied to map geomorphic units. It also analyses the distribution of units in different reaches along Eddleston Water.

2.0 Methodology

2.1 Geomorphic Unit Tool (GUT)

GUT (available from https://github.com/Riverscapes/pyGUT) was used to automatically map Geomorphic Units (GUs) from High Resolution Topography (HRT), using a three-tiered hierarchical classification framework that was adapted from Wheaton et al. [2015; Figure 1]. Each tier in the hierarchy is associated with deriving a particular geometry; flow-, topographic- and geomorphic-related for tiers 1, 2 and 3 respectively. User supplied inputs are used, together with outputs from the previous tier, to create evidence layers associated with each tier. These are then used to derive unit names for each tier's polygons. In addition to HRT, the following input layers were prepared for the study areas, for input into the tool: low flow and bankfull extent polygons; a bankfull centreline; and a thalweg polyline. The bankfull extent polygons were used to map in-channel and out-of-channel flow units in tier 1 of the hierarchy; the low flow extent polygon was also used for tier 2 and 3 calculations. The bankfull centreline was used to calculate average bankfull width. This was used as a scalar for size thresholding during unit delineation and to calculate the orientation of units. The thalweg line was used to map tier 2 saddles and tier 3 riffles, and secondary thalweg paths were used to name sub-GUs at the tier 3 level, such as cut-off chutes and diagonal bars.

Topographic unit shape and form were identified during tier 2 processing. Using the input data, a variety of evidence layers are derived by GUT to delineate mounds, saddles, walls, planes, troughs, bowls and transition zones (Figure 2). These include: DEM slope; DEM contours at 0.1 m interval; the channel margin, which is calculated as the region between the bankfull and wetted extent and buffered by 10% into the wetted channel; residual topography, which is an approximation of local relief calculated by subtracting a smoothed DEM, produced using a moving window equal to the wetted width, from the original DEM [Sofia et al., 2014]; and residual pool depth, which is the

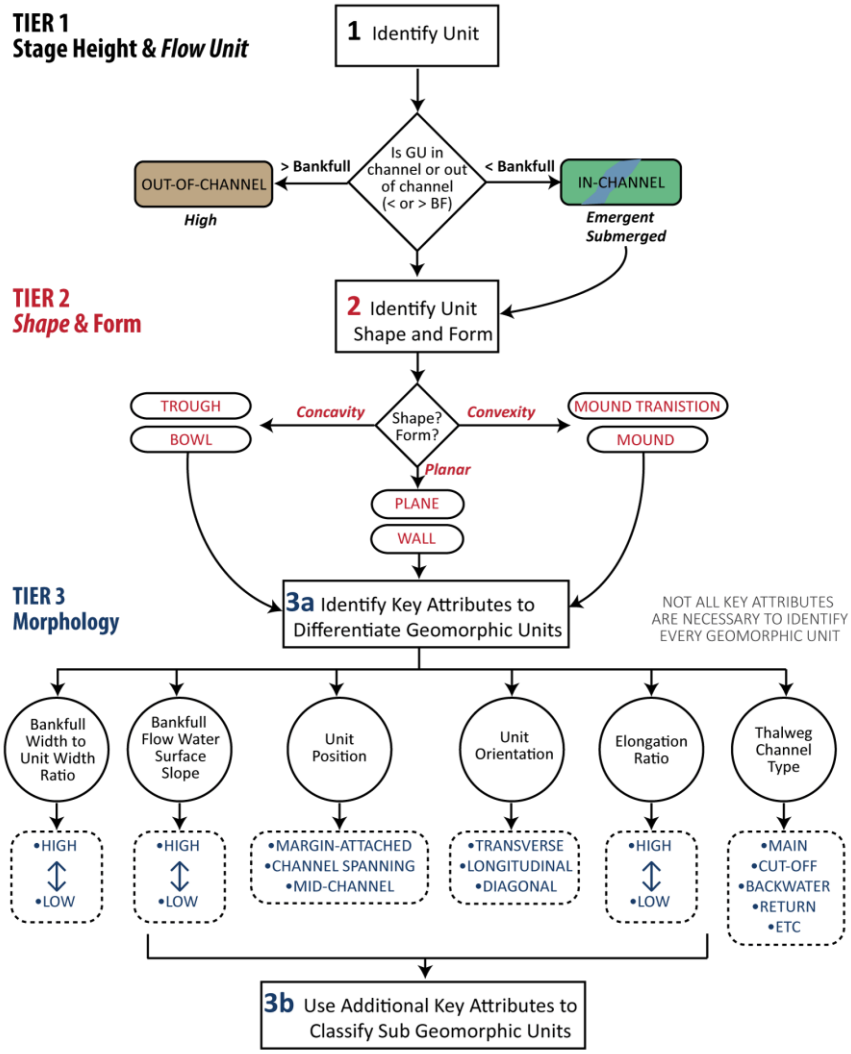

Figure 1. *The Geomorphic Unit Tool's tiered framework. Tiers 1, 2 and 3 are associated with deriving flow, topographic- and geomorphic-related geometry respectively.*

difference between the filled DEM and the DEM. Transition zones were mapped where there was ambiguity in the residual topography thresholds. Saddles were not consistently identified by the residual topography evidence layer, so were mapped using DEM contours and the thalweg polyline.

Geomorphic and sub-geomorphic units were mapped during tier 3 processing. During this tier, each tier 2 form unit was attributed with tier 3 geomorphic unit key attributes. Tier 3 geomorphic units were then classified using a consistent rule set. Subsequently, each tier 3 geomorphic unit was attributed with sub-geomorphic unit key attributes. A variety of attributes were used for geomorphic unit and sub-geomorphic unit classification. Geomorphic unit key attributes included unit position (margin attached, mid-channel or channel spanning), orientation (longitudinal, diagonal, transverse), bankfull water surface slope, bankfull width ratio, channel type (main, cut-off, return) and elongation ratio. Sub-geomorphic unit key attributes included the number of thalwegs intersecting a unit, the meander bend (inside, straight, outside), bed slope, relief and a user defined forcing element (plunge of grade control). Tier 3 geomorphic unit maps were reviewed and, where necessary, attribute data

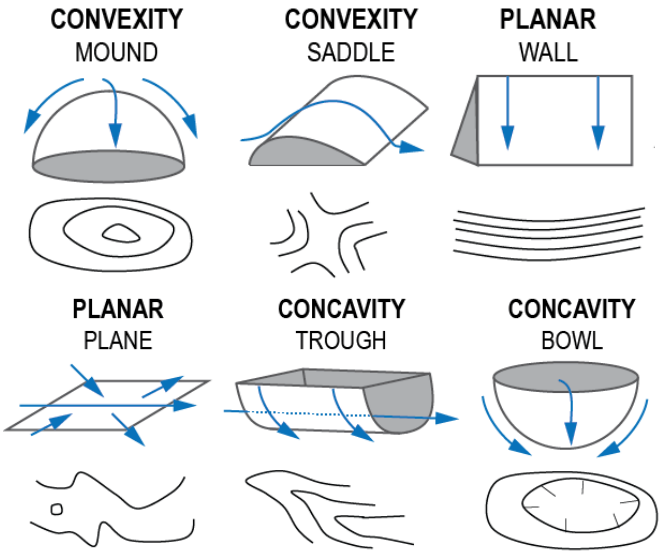

Figure 2. *Generalised topographic shape and contour signatures for each of the tier 2 topographic units delineated by GUT.*

were used to manually edit geomorphic unit classifications. During this manual review, all bar units were further classified into point, lateral, or mid-channel bar types. In total, 2232 geomorphic units were mapped using GUT. 147 of these were bars and required manual classification.

2.2 Input: Digital Elevation Model (DEMs)

CBEC provided Richard Williams with 0.1 m resolution DEMs of the study area. These DEMs were generated from RTK-GNSS and total station surveys that were acquired in May 2018. The DEMs covered the entire bankfull extent of Eddleston Water.

2.3 Field verification

On 16 July 2019, Richard Williams undertook a field verification survey of the GUT results, accompanied by a senior geomorphologist from SEPA (Dr Helen Reid). The objective of the field verification was to check the GUT results for (i) consistency and (ii) against field interpretation of geomorphic units. Printed maps (see section 3.1), produced at a scale of 1:800, were used for field verification. The field verification survey extended (i) along the entire Shiphorns reach (from NT 24348 49983 to NT 24213 48642) and (ii) from Lake Wood (NT 23791 45534) to Cringletie (NT 23797 44639).

It should be noted that the fieldwork was undertaken in summer, when vegetation was high and spatially extensive, and no significant high flow events had occurred in the two year period before fieldwork so many bars were colonised by vegetation. Some reaches were extensively vegetated with Ranunculus, making it difficult to interpret underwater topography.

3.0 Results

3.1 Geomorphic Unit mapping

Two types of deliverables are supplied with this report:

1. a GIS Shapefile that includes polygons that are attributed with their Geomorphic Unit type; and

2. a set of fifteen .pdf maps that show the geomorphic units with BGS orthoimagery supplied by the Tweed Forum or Ordnance Survey Open Map Local background mapping. It should be noted that the georeferencing quality of the BGS orthoimagery is spatially variable and notably erroneous towards the periphery of the orthoimagery extents.

3.2 Analysis of geomorphic unit distribution

To be undertaken once reach extents, names and ages are confirmed.

References

Sofia, G., G. D. Fontana, and P. Tarolli (2014), High-resolution topography and anthropogenic feature extraction: testing geomorphometric parameters in floodplains, Hydrological Processes, 28(4), 2046-2061, doi: doi:10.1002/hyp.9727.

Wheaton, J. M., K. A. Fryirs, G. Brierley, S. G. Bangen, N. Bouwes, and G. O'Brien (2015), Geomorphic mapping and taxonomy of fluvial landforms, Geomorphology, 248, 273-295, doi: 10.1016/j.geomorph.2015.07.010.