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Leeds' plans for flood easing from Apperley Bridge to Calverley

Regarding Leeds' flood-mitigation plans for Apperley Bridge, Bradford

Remarks on general aspects of the plan are first given, followed by a discussion and questions on its specifics. The main observation to note is that the existing flood-easing plans [1] for Apperley Bridge are difficult to assess in any quantitative sense given that they contain neither alternative scenarios nor discussion of costs and cost-effectiveness thereof, thereby materially degrading the plan's presumably intended purpose of enhancing evidence-based decision-making, such as that developed and promoted in [2].

General remarks are as follows:

i. The plans in [1] do not protect against floods of a similar size to the Boxing Day 2015 flood, but only against lesser floods with a 1-in-200-years (or less) return period. As such, overtopping of the proposed flood defense walls and flooding would occur for a flood of similar size or larger than the Boxing Day 2015 flood, since that flood was approximately a 1-in-250-years or 1-in-300-years flood.

ii. The highlighting of Natural Flood Management (NFM) in Leeds' (other) flood-mitigation plans (e.g. [3]) is particularly misleading since quantification of the efficacy of NFM reveals it to be small, contributing less than 5% to the overall flood prevention; by contrast, higher walls contribute about 85%, and the Calverley dynamic flood-storage (augmented by some obstruction removal) about 15%. (Indeed, NFM is seen as extra flood protection only, beyond the near-100% sum of the last two figures.) Leeds' plans rarely provide clarity to the public on the efficacies of the different flood-mitigation measures used [2]: while NFM is often heralded, the factual efficacy of NFM is not only small but also contains high relative uncertainty. NFM in the upper River Aire catchment is notably not mentioned in [1] as being beneficial to Apperley Bridge, indirectly corroborating how limited-to-negligible is its efficacy for flood mitigation there.

iii. The location of the dynamic weir for the Calverley flood storage is further upstream than desirable. A more logical location is closer to the nearby railway bridge, where the valley is narrower; construction of a weir at that location would lead to less damage to nature than the damage inherent in the current plans, since the weir would then have been closer to the existing man-made railway bridge structure. Unfortunately, after the floods of 2015, Leeds decided to build more dwellings near this ideal spot for a weir, thereby precluding any future access to the more optimal location.

More specific comments on the proposed plans now follow:

a) ***An alternative, possibly cheaper and certainly greener, solution to the steel-sheet pile wall*** on the South side of the river along the minor road to Apperley Bridge (see drawings in [1] and Fig. 1) is *a berm formed by clay/soil with grass on top*, e.g., clay/soil from the in-situ flood plain, which would result in a zero-or-negative volume change, concomitantly creating more-or-zero change in floodplain-storage capacity. This would be an example of a green *Nature Based Solution* (NBS), a berm or dike, which can fit seamlessly and naturally to the existing stone wall (with repairs of that wall where necessary) along Apperley Road. See also Fig.1.
Question 1: *How does the steel-sheet pile wall look (there is no image); what are its costs relative to green dikes/berms?*

b) There is a steel-sheet pile wall planned along the North side of and directly along the river to protect the garage (see drawings on [1] and Fig. 2). ***The garage, however, has recently moved and only a car wash remains.*** The car wash can also be moved (both garage and car wash are/were polluting the river), with the soil cleaned, lowered and made into green space; the river bank there can also be widened and lowered in places, thus giving more

room to the river and better preventing floods on the built-up South side because the water can go somewhere (i.e. it can flow onto the floodplain as intended by nature). ***Hence there seems to be no need for this steel-sheet pile wall on the North side along the river between the two bridges. See also Fig. 2.***
Update 06-02: the steel-sheet pile wall connects the two bridges but note that the bigger bridge has open sides and that the garage land and road off the small bridge are lower lying; the bigger road lies higher; hence, there is no need for this wall in order to protect the bigger road. **See also connection with point c) below. See also Fig. 4.**

c) A closed steel-sheet pile wall on the North side of the river along the minor road coming off the old Apperley Bridge will lead to enhanced funneling of the river and, hence, increased river-levels, especially under climate change, which, recalling point (i) above, puts the houses on the South side at increased risk of flooding. Instead, these walls should be lowered, not strengthened/raised, or possibly several operable gates should be included that can be opened at very high river levels to lessen the pressure on the South bank flood-defense wall. In conjunction with b) above, flood waters can then flow over this road (in a case without wall or with a lowered wall) and the flood waters can be led away via the new lowered space between the two bridges. **Cf. Akers and Bokhove 2008 [4].** See also Fig. 2.
Update 06-02: this entire wall can be a green berm as in point a) above, instead of a steel-sheet pile wall, which is greener and probably cheaper, with lock gates to be opened when river levels rise too high such that the flood plain is flooded rather than the houses on the South shore.

d) Downstream of the main bridge on the **North** side, the football pitches are far enough from the river that it is possible to widen the flood channel somewhat, by lowering the banks ~1m-to-2m over a strip, adjacent to the river and of width ~10m, which will be dry during normal river flow but covered with river water and creating more through-flow at lower river levels when the river level rises. This is an example of modern giving-room-to-the-river (GRR) flood-mitigation practice and Nature Based Solutions (NBS) [2].

e) An old river branch just upstream of the bridges on the South side of the river can be opened up to create more floodplain capacity; the river bank further upstream beyond the railway bridge (near Apperley Bridge station) has been raised in the past few decades; the bank there could be lowered again to create more capacity; originally the old river branch may have started at this location. This is also an example of GRR and NBS.

f) The water from Haigh Beck, the beck flowing through Apperley Bridge just North of the canal, once cleaned (of the substantial accumulation of pollution by pieces of industrial cloth, etc.), could preferably flow into the canal and then into Carr Beck via the overflow, further along the canal, thus creating an extra buffer. By doing this, the beck water then avoids filling culverts under housing, and a more green and healthy beck has also been created.

Question 2: *What the origin is of the water collecting in these culverts just South of the river bank between the two bridges? (Grid reference: SE 19412 37920)]*

Update 06-02: the hypothesis f) was confirmed on 06-02 to be caused by Haigh Beck water levels (quoting a flood victim): "The problem causing the repeated flooding is a number of culverts which carry beck water from Tenterfields, under the football fields then under the pub's land. Ill-advised planting and no maintenance means these culverts are blocked, damaged and certainly not watertight! The water currently can't flow freely into to river. It has nowhere to go so fills up the car park our gardens our cellars and in some cases our houses."
On 06-02, I led the EA officer and Yorkshire Water/West people on site to the lock gate just off Tenterfields, where the beck water on that day was divided for circa 10% into the canal and for circa 90% into the culvert towards the houses next to the river between the two bridges. Nobody had the key to the lock to control the flow or

knew who had the authority to control these diversions of the beck flow. Critical issue is whether the (perhaps heavily) polluted beck waters should, in case of an flooding emergency, flood either the (cellars and gardens of) houses or the canal. The canal has an overflow into Carr Beck and the River Aire. In the 21st century the gate could be automated, with waterlevel/flow and quality sampling, and operated with AI, including a manual override. That is a control problem. Such a problem could be a pilot project for the Leeds Institute of Fluid Dynamics; such remotely run water-level controls on canals are found everywhere nowadays, e.g. in The Netherland, so there must be affordable set-ups available. See also Fig. 3.

Finally, what is required is a Haigh Beck catchment plan on water and pollution management.

GRR, a well-known 21st-century concept, is notably absent from the current flood-mitigation plans [1] for Apperley Bridge; the suggestions above are examples of GRR and NBS that could be considered, in particular a) and b). After centuries of narrowing the River Aire valley and its floodplains, the current plans take off further storage volume from the floodplain. By contrast, using the various suggestions above, the net storage volume remains either the same (despite the building of protective walls on the South banks of the river that reduce this volume) or it is increased, thus further reducing flood risk for the residents of Apperley Bridge.

Question 3: *Why are not more flood-mitigation options explored, including the ones above, with corresponding costs, and compared with the currently proposed solution, in order to enhance evidence-based decision-making by Bradford City Council?*

References

[1] Plans of Leeds City Council for Bradford City Council 2021: "Apperley Bridge overview.pdf" and "Members Step 2 overview - January 2021.pdf"

[2] O. Bokhove, M.A. Kelmanson, T. Kent 2020: A new tool for communicating cost-effectiveness of flood-mitigation schemes. Evidence for the UK Government Department of Environment, Food and Rural Affairs Committee inquiry into flooding. https://committees.parliament.uk/writtenevidence/9641/pdf/ Also: github.com/obokhove/wetropolis20162020/blob/master/UKGovfloodinquiryplus.pdf

[3] Dennis, R., Phase 2 Leeds (River Aire) Flood Alleviation Scheme (LFAS2), Report to LCC Executive Board, December 2017. See "Flood alleviation cover report 041217" at host page https://democracy.leeds.gov.uk/ieDecisionDetails.aspx?ID=45047

[4] B. Akers and O. Bokhove 2008: Hydraulic flow through a channel contraction: multiple steady states. Physics of fluids, 20(WP 08-02), 056601.:

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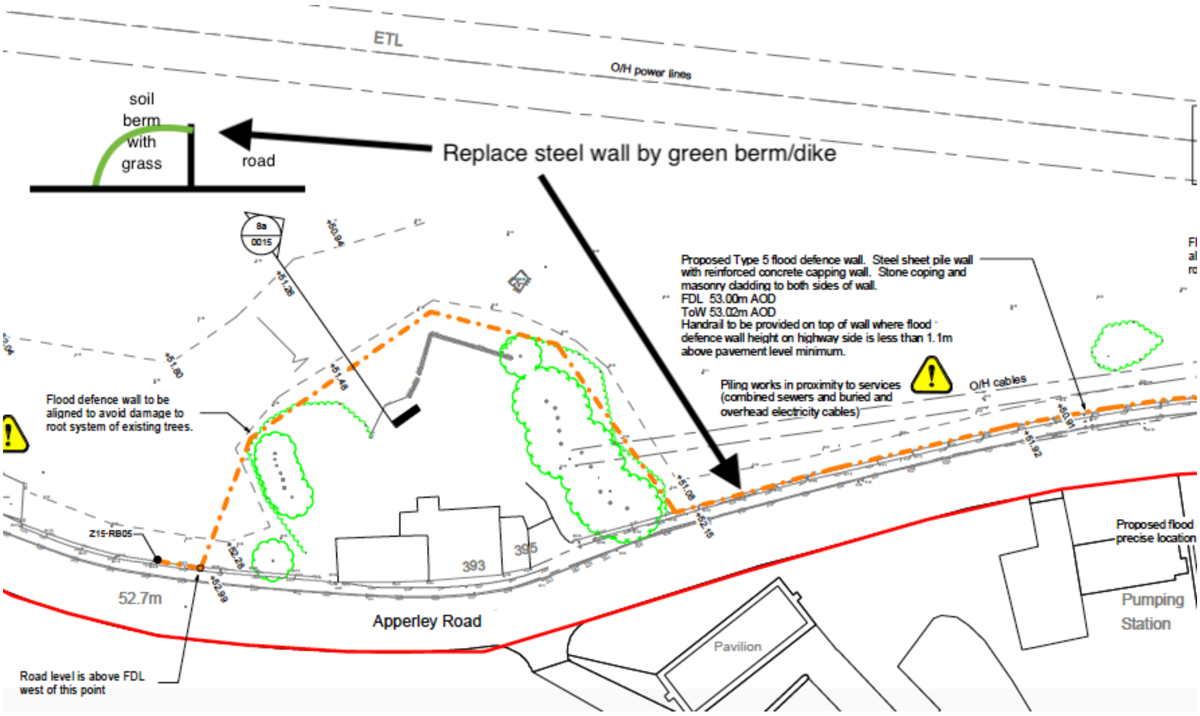

Figure 1: Graph relating to point a) above. Natural green berm/dike instead of industrial steel-sheet pile wall. Subsection of drawing in [1] along Apperley Road. Black arrows, larger text and cross-section of new berm against existing wall (upper-left) added by OB.
(Grid reference: SE 19297 37960)

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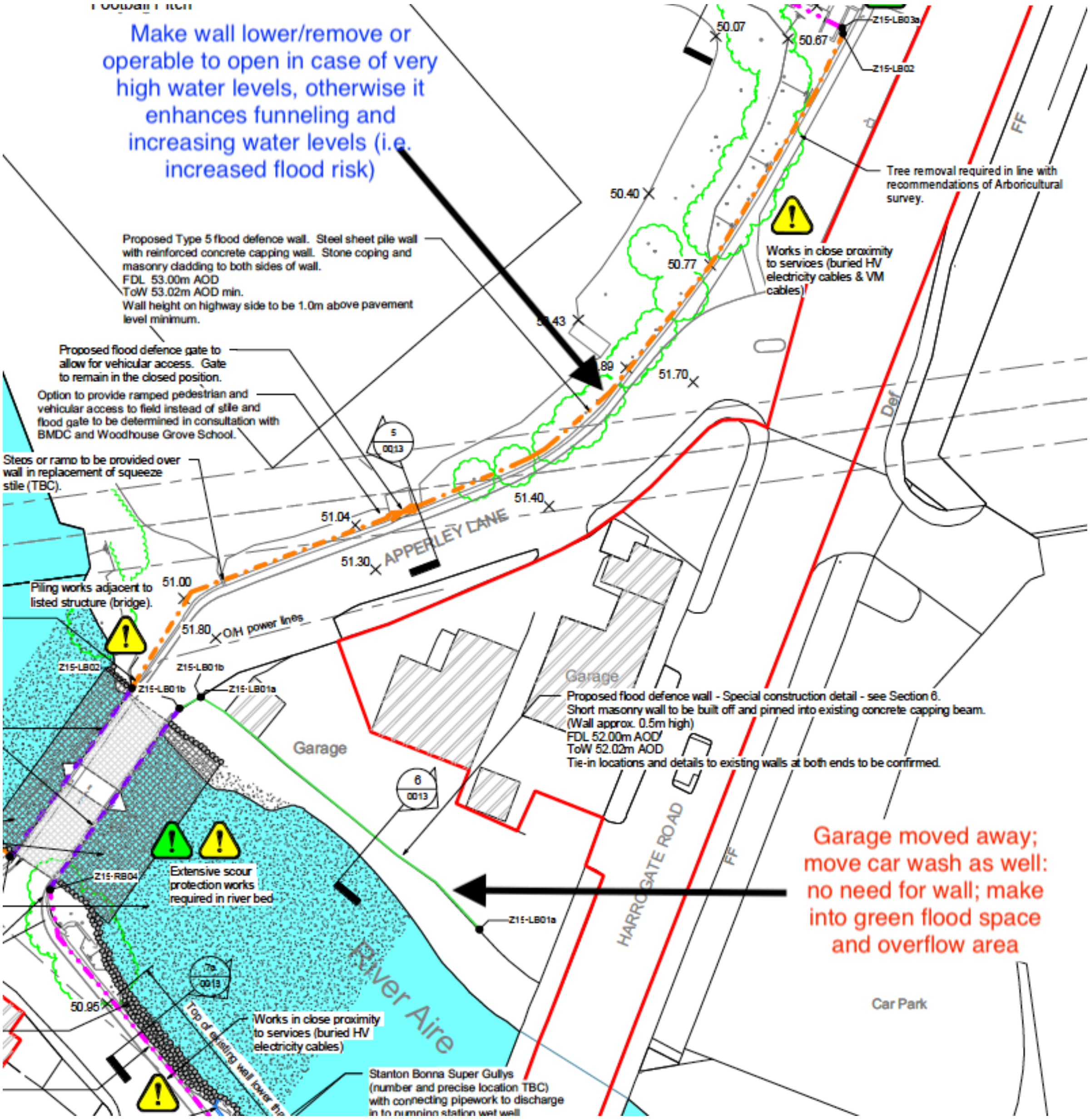

Figure 2: Graphs relating to points b) and c) above. Subsection of drawing in [1] along River Aire in Apperley Bridge. Fat arrows and green/red texted added by OB.
(Grid reference: SE 19475 37978)

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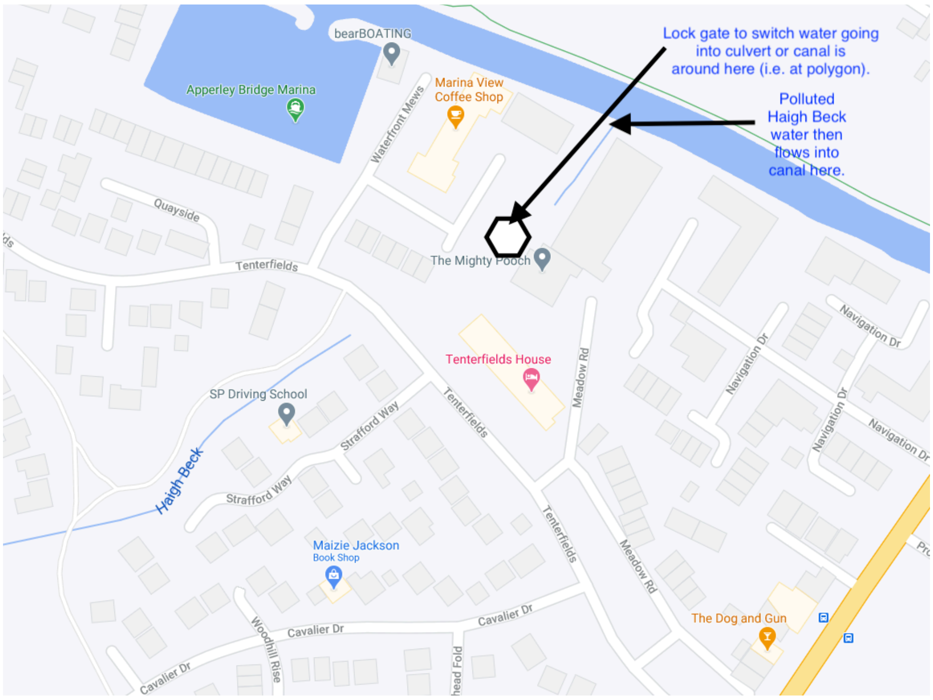
a)



b)

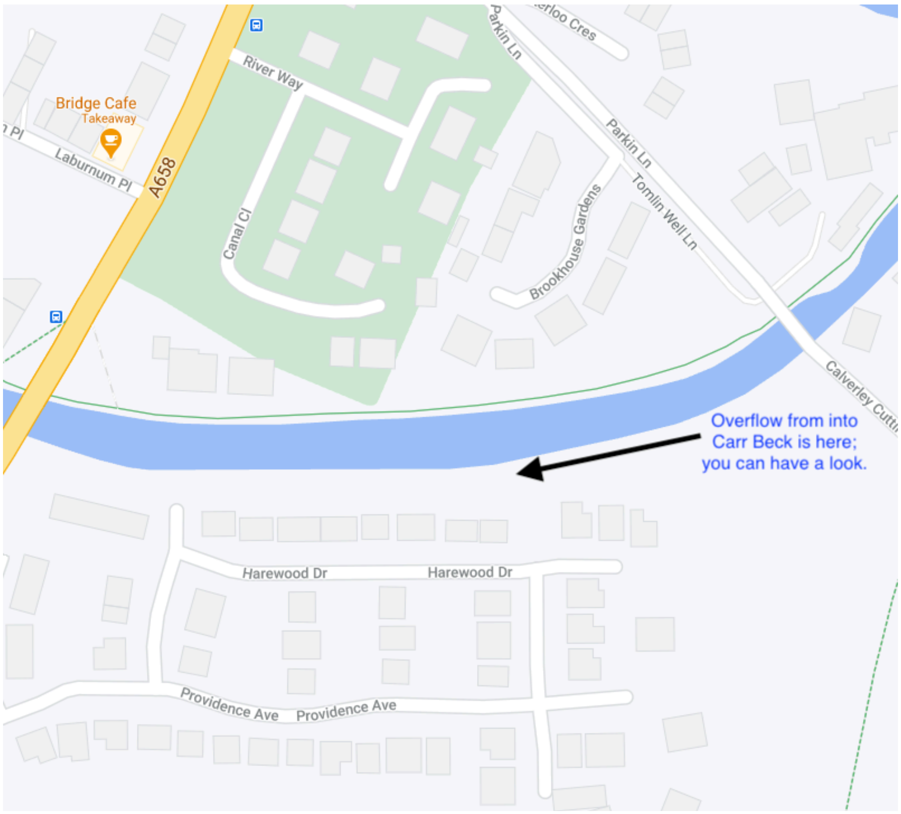


Figure 3: Update 06-02: a) Haigh Beck can either be diverted into a culvert under the football pitches and then under the houses near the Dragon pub or it can flow into the canal (or a partitioning), depending on the lock gate set at the polygon in the map; b) when Haigh Beck water flows into the canal, it will effectively flow to the overflow into Car Beck as indicated on map b).

a)

b)

Fig. 4. Update 06-02: a) The garage has moved so there is no need to protect it; the site can be cleared-up to create lower lying green space and flood fields. b) The level of the garage lot os lower than the level of the main road. See also Fig. 2.