Bevercotes Beck –Catchment Mitigation Desk Study

DRAFT

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Summary

- The catchment is currently failing its WFD target due to poor ecological status, derived from poor phosphorus and biological scorings.
- Scores are likely to be associated with high phosphate loading from wastewater treatment and agriculture, as well as unfavourable hydrological regimes.
- Improvements in WFD status may be achieved by reducing nutrient inputs through phosphate stripping of sewage effluent, protection of areas vulnerable to erosion (gates and tracks) and leaky willow dams installed in agricultural drainage ditches.
- Resilience of aquatic organisms to low flows may be increased by a range of habitat improvements including restoration and diversification of channel morphology and flow conditions.
- This may be achieved by creation of vegetated in-channel pool-riffle sequences, installation of woody debris, meanders and berms in a widened riparian corridor along the length of the watercourse.

1. Catchment Background

Bevercotes Beck is a small groundwater fed stream and tributary of the River Maun (fig. 1). The watercourse rises to the South of Wellow (SK 6765 2569) and runs for 10.7 km, forming part of Boughton Dyke before finally becoming Bevercotes beck and joining the River Maun north of Lound Hall.

The catchment area is relatively small (19.3 km^2) and linear in shape along the trajectory of the waterbody (SW-NE). Despite its small size, the catchment encompasses urban, industrial, agricultural, sewage treatment and former mining sites, potentially creating a wide range of pollutant sources and pressures.

The catchment contains low fertility free draining acid sand soils to the west, with shallow gradients towards the channel. The east of the catchment is characterised by acid loamy clay soils with moderate to high fertility and steep gradients. The riparian zone sits atop loamy and clayey floodplain soils.

Bevercotes Beck Catchment (trib of Maun)

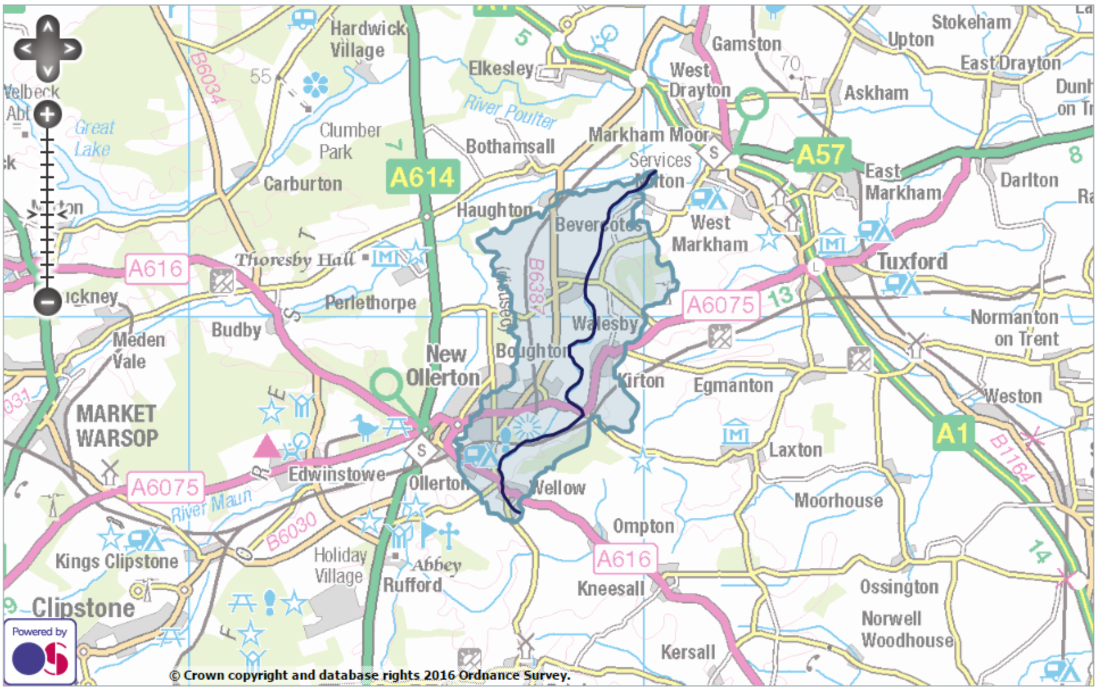

Figure 1 Bevercotes Beck and catchment.

2. Current status of the waterbody

In the latest cycle (2015) of WFD water classifications, Bevercotes Beck was designated as poor and highlighted as a deteriorating water body. This was due to a poor ecological status, caused by a 'poor' phosphate classification. Additionally both biological quality elements and invertebrates scored as 'poor' (Macrophytes and Phytobenthos combined were moderate). The waterbody was classified for as 'good' for chemical status. The target is to reach overall 'Moderate' status by 2021.

Bevercotes Beck was also identified as having a hydrological regime which does not support good status (low flows). It is probable that this is partially attributed to groundwater abstraction for public water supply by Severn Trent, from four boreholes in close proximity to the catchment (Boughton, Ompton, Amen Corner and Markham Clinton). The catchment is currently under investigation by Severn Trent through their Restoring Sustainable Abstraction (RSA) Programme.

Both the poor water quality and heavily impacted hydrology are likely to be the cause of stress to aquatic biota.

3. Potential Pollutant sources within the catchment

A. Water from former colliery sites and spoil tips (SK 6767 3829)

The former Ollerton Colliery was redeveloped and forested (now Ollerton Park) (fig.2). Runoff from the former spoil tips is diverted via water control structures/features into a retention pond. While such drainage schemes are usually self-contained, it is unknown whether there may be a connection into Boughton Dyke. If this was the case, the tip may be a potential source of heavy metals into the stream system (although no data to support this).

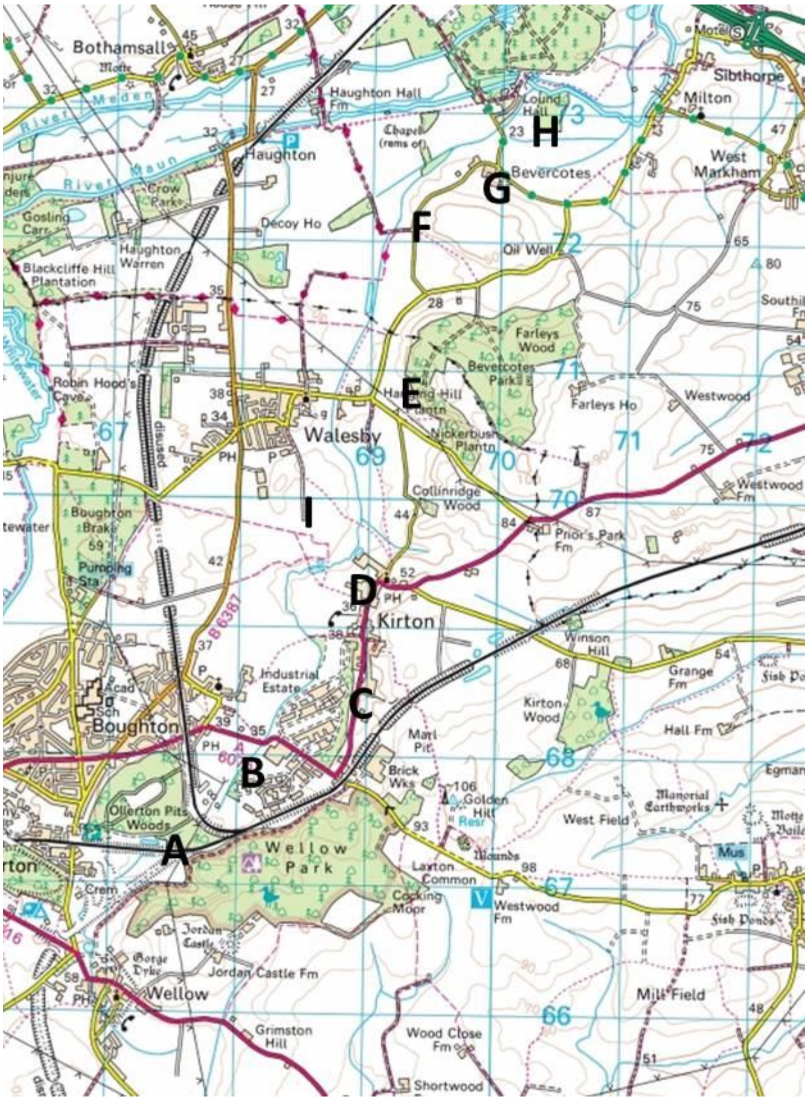

Figure 2 Potential pollutant sources within the Bevercotes Beck catchment.

B. STW wastewater treatment works (SK 6767 8065)

Boughton sewage treatment works (STW) discharges treated effluent continuously into Boughton Dyke, which becomes Bevercotes Beck. This may represent a continuous point source of nutrients and, in particular orthophosphates to the watercourse. The low flow regime in the stream suggests that effluent discharges from the STW may make up a considerable proportion of the stream base flow. In turn this may limit the dilution of the final effluent and exacerbate phosphorus/BOD concentrations.

C. Road drainage/ drainage from industrial estate (SK 6868 5429) , scrapyard (SK 6767 7552) and construction depot (SK 6666 9393)

Both tributaries of Bevercotes beck flow adjacent to or through several areas which may be sources of hydrocarbons and industrial contaminants. These include a construction depot, a scrapyard and Boughton industrial estate. The extent to which the watercourse receives water form surface drainage is unclear.

D. Pig farm/ cattle farm and AD clamp (SK 6869 9752)

Manor Farm at Kirton is predominantly an indoor pig/ outdoor cattle unit which backs onto both Bevercotes Beck and a connected drainage trench which then flows into the main channel. Aerial imagery shows a large slurry lagoon or pond located directly next to the watercourse, which potentially represents a significant source of P and BOD. Depending the age and construction of the pond/pit, the contents may be permeating through into the watercourse through the earth bank. The farm also appears to have several AD silage clamps which may leach effluent.

Aerial images suggest that several points around the farm suffer from soil erosion, particularly tracks, gateways and ditch crossing points. These may act as critical source areas for the mobilisation and transfer of sediment.

E. Small cattle unit (SK 6870 8785)

Willoughby Farm is a small cattle unit located to the east of Walesby. Although field gradients are very low, grazing takes place next to the river with only a narrow riparian buffer. Together with yard and spreading activities, the farm may be a potential source of nutrients, sediment and FIOs into the beck. There is also evidence of arable activity on the farm, suggesting there may be risk of incidental pesticide transfers.

F. Off-road course (SK 6972 4108)

A large off road course is located on steep grass slopes to the east of the beck. The compacted and continuously exposed soils are likely to be a source of sediment and increased runoff. The course also appears to be grazed by sheep. Although some distance from the beck, an adjacent track could act as a transfer pathway.

G. Small Pig farm and livery Stables (SK 6972 785)

Home Farm is a small high-welfare indoor pig unit situated upslope of the watercourse in the northern area of the catchment. Any dirty water or slurry from the farm may be a source of nutrients and FIOs to the channel, as is also the case for the adjacent Grange Farm (livery stables). The neighbouring Manor Farm and Lound Hall Farm may also be potential pollutant sources of nutrients and pesticides, particularly as the yard area is located next to a drainage ditch feeding the beck.

H. Holiday Chalets (SK 6972 9899)

Holiday cabins within the grounds of Lound Hall are located next to the final reach of the Beck before it reaches the Maun. It is unknown whether these cabins are connected to the main sewer network or to septic tank/onsite treatment works. In the case of the latter, there may be potential for septic tank leakage (although unlikely) or additional micro-point nutrient inputs to the beck.

I. Agricultural land (catchment wide)

A large proportion of the catchment is utilised for both arable and livestock farming. Due to the nature of the soils, particularly those in on the western side of the catchment, excessive agricultural nutrient applications are likely to occur in order to compensate for low fertility. Soils (particularly the clay soils to the east) may be susceptible to compaction and erosion, potentially providing an additional route of P transfer to the beck. Livestock grazing and spreading of organic manures adjacent to the watercourse are further potential sources of nutrients and FIOs. Although livestock do not appear to have access to the channel, in many areas the riparian buffer is narrow-extending only to the bank top (1-2m).

4. Opportunities for catchment management

4.1 Enhanced monitoring up/downstream of pollutant sources

- The numerous pollutant sources within the catchment may all impact on the stream ecology. However the extent to which individual sources may be responsible is currently subjective.

- Targeted monitoring of nutrient loading, invertebrates and phytobenthic communities up/downstream of the outfall for the STW, may provide quantitative evidence of watercourse deterioration.
- Similarly, monitoring of metals and other substances found in mine drainage may indicate whether harmful substances are leaching into the surface water and impacting on water quality.
- Quantitatively based source apportionment may then allow more robust business cases to be made for remediative work either at these locations or elsewhere in the catchment.

4.2 Phosphate Stripping Wetland at Boughton STW

Details of mitigation work

- Boughton STW (fig. 3) represents a potentially significant source of P and other substances to Bevercotes Beck. However it may also provides a significant proportion of baseflow to the watercourse.
- Reducing the nutrient loading of final effluent (or portion of) but maintaining discharge rate may help to reduce stress on aquatic biota.
- A constructed wetland containing P-stripping materials such as mining waste (ochre) and raw water treatment residuals may be installed onsite at the STW or in the adjacent agricultural land. A similar wetland system is currently being planned to treat effluent from Lound STW.
- The wetland may be planted with native reed species to increase nutrient uptake potential.
- Final treated effluent may then be passed through the wetland system before being released into Bevercotes Beck.

Figure 3 Boughton STW and adjacent farmland.

Benefits of mitigation

- The phosphate stripping wetland may potentially provide a cost effective method of reducing nutrient loading into the watercourse while maintaining baseflow.
- Reduction in nutrient loading may decrease the stress on aquatic organisms downstream and promote conditions to enable natural vegetation to recover.
- The wetland would re-use waste products from water treatment and mining activities, both of which could be sourced locally.
- Reed beds may provide additional habitat for wetland species such as birds, amphibians and insects.

4.3 In-channel vegetated Pools

Details of mitigation work

- Aerial images suggest that the beck at SK 6869 4331 (fig. 4) may naturally flood into adjacent riparian areas along the bottom of a shallow valley.
- The area, currently used to graze cattle, appears to be colonised by marsh species such as *Juncus* and also features a permanent irrigation/nature pond. This indicates that the ground may be highly saturated. The naturally wet condition of the area may therefore be exploited to form a series of vegetated ponds/wetland features.

Figure 4 Site of potential in-channel wetland construction in saturated fields.

- This may be achieved by excavating or diverting the current watercourse to form additional in-channel pools, particularly in locations which are known to collect surface water. Pools may include deeper central sections and shallower and wider marginal areas. Short, shallow meandering channels could be used to connect pools.
- The marginal zones of pools may be planted with native reeds or other macrophyte species, while connecting channels may be planted with species such as Water Crowfoot.
- The riparian area should be surrounded by livestock fencing to exclude cattle and be planted with appropriate tree species. Density of riparian vegetation should be sufficiently low in order to ensure the created features received adequate light.

- A cattle drink may be required to allow the livestock continued access to water.
- Smaller scale in channel wetlands may also be possible further down the watercourse.

Benefits of mitigation

- Aquatic vegetation would aid removal of nutrients from the watercourse, with pools increasing the residence time of water and thus potential for nutrient uptake.
- The creation of a variety of water depths/speeds/light conditions and vegetation types would also provide additional habitat for aquatic fauna, as well as bird species.
- Establishment of species such as water crowfoot within interconnecting channels would encourage nutrient uptake while also providing a more diverse habitat for fish and aquatic invertebrates. Once established, vegetation may naturally narrow sections of the channel, increasing water depth and speed. This may increase the range of in channel habitats/conditions favoured by aquatic fauna and promote scouring of accumulated silt.
- The in-channel design of the features should not require any additional flow once filled, as the level of the bed at the entry and exit points would be maintained.
- At times of low flow, water would continue to pass through the central channel. Thus the features should not be affected by the hydrological regime. Deeper pools may provide a refuge for fish during low flow periods.

4.4 Increasing riparian zone width and diversification of stream morphology

Details of mitigation work

- The reach of the beck north of Kirton to the confluence with the Maun has been straightened in order to follow field boundaries.
- Although some riparian fencing is in place, land adjacent to the watercourse is farmed almost to the bank top in some areas. This increases the likelihood of incidental pesticide/nutrient/sediment transfer into the channel.
- Implementation of a wider riparian corridor along the length of the watercourse would increase the separation between the farmed land and the channel.

- This would also allow diversification of the watercourse morphology. Meanders and pool-riffle sequences may be introduced to re-naturalise straightened sections.
- Such features may be achieved by construction and planting of small berms, willow spiling and introduction of woody debris.
- Vegetation within the riparian zone may also be improved and diversified by implementing a variety of native grasses, shrubs and trees.

Benefits of mitigation

- Introduction of the morphological features would aid the diversification of in-channel flow conditions and promote scouring of accumulated silt. This may improve conditions for invertebrate and fish communities, whilst also creating improved habitat for aquatic macrophytes.
- Narrowing of the channel by naturally constricting flow would result in increasing water velocity and depth. This may help to offset the effects of low flows on invertebrate communities.
- Establishment of in-channel vegetation would increase the diversity of habitat whilst promoting the uptake of nutrients.
- Increased diversity of bank vegetation would give improved cover for birds, mammals and invertebrates whist also providing variable shading for in-channel communities.

4.5 Improvement of Tracks, gateways and bridges

Details of mitigation work

- Gateways, crossings and farm tracks at several locations adjacent to the watercourse or connected drainage channels, appear to be susceptible to soil erosion from vehicle or livestock movement e.g. SK 6969 1663 (Fig. 5)

Figure 5 Evidence of soil erosion in tracks and gateways on Manor Farm, Kirton.

- The location of these areas greatly increases the potential for direct transfer of sediment, nutrients and faecal matter into the waterbody. Therefore minimising sediment mobilisation and transfer is a priority.
- Bridging structures may be modified to include bunded or raised sides and access ways in order to direct polluted water away from the watercourse.
- Gateways and tracks may be reinforced by grass protection mats and railway sleepers. More heavily used areas may benefit from installation of hard-core or concrete pads to give a more durable surface

Benefits of Mitigation

- Relatively low cost
- Reduces sediment and nutrient mobilisation from critical source areas.
- Reduced compaction of soils may reduce surface runoff and transfer of pollutants.

4.6 Willow dams in drainage ditches

Details of mitigation work

- Numerous drainage ditches feed into Bevercotes beck, from the point where it rises to the confluence with the Maun.
- These ditches may act as transfer pathways for entrained sediment and nutrients from agricultural land.
- Whips of cut willow may be inserted into the bank and bed of such ditches to form loose/leaky dams. These allow water to pass through them but may slow flow velocities enough to allow sediment and particulate bound nutrients to fall out of suspension.
- If wet enough, the willow will root into the bank to form a living structure.

Benefits of Mitigation

- Capital cost of each dam would be extremely low and could be constructed with locally sourced materials.
- Dams would permit transfer of water to the main channel but promote the retention of sediment, which may be periodically excavated and returned to land.
- Once rooted, willow may take in nutrients from retained water and sediment.
- Dams may be constructed in series within the same channel in order to increase effectiveness off sediment/nutrient retention.

5. Concluding Summary

Due to the recognised pressures from P loading and low flows, the greatest potential for the improvement of the waterbody, may potentially be achieved by restoring favourable hydrological regimes and reducing nutrient (P) input from the wastewater treatment works.

However, such work may be both prohibitively expensive and still fail to fully achieve the required improvements in water quality/flow. As such, future mitigation work may aim to reduce agricultural nutrient inputs, maximise nutrient uptake along the watercourse and diversify aquatic habitats.