Green Recovery Bid for phosphorus removal across the River Irwell catchment; treating urban runoff to capture phosphorus, to reduce pollution and to create pleasing places for people in the City

Introduction

Urban runoff is known to contain Phosphorus both in the particulate and dissolved forms and this contributes to the pollution that urban runoff causes across the UK. There are many treatment options to reduce the Phosphorus pollution from this urban runoff, but first we must consider if it is cost-effective to install and operate these devices, and which urban surfaces are the most appropriate for treatment.

Because Phosphorus levels in urban runoff are relatively low in terms of mg/l when compared with rural runoff, it is important to understand the total pollutant load in urban runoff and the broader benefits of installing and operating treatment devices. Although these devices will reduce total Phosphorus pollution, they will also reduce pollution with toxic metals such as Copper and Zinc, and toxic organic compounds, such as Benzo(a)Pyrene. These pollutants exert a toxic impact on the river and the associated suspended solids cause physical pollution and high levels of turbidity. These pollutants affect invertebrate & fish populations and if they are not controlled, the ecological potential of urban rivers will never be reached. The case studies below consider the opportunities to install treatment devices in four different catchments; a residential road, an arterial road, an industrial estate and a motorway. The costs & benefits of installing these devices to reduce Phosphorus pollution from road surfaces are considered and are quantified in Table 1. But Table 2 is important too, where we estimate the additional benefits of installing these devices, both for reducing loads of other pollutants, but also for delivering green spaces in urban places, and in creating habitat for wildlife. If any of the case studies are selected for delivery, then a comprehensive cost:benefit analysis can be completed and these additional benefits can be quantified in detail.

Phosphorus loads in urban catchments

There is little UK data on levels of Phosporus in urban runoff, but there is a wealth of information in the Minessota Stormwater Manual, and by comparing the data there with the little data we have for UK sites, it suggests that the levels will be similar. For the purposes of these case-studies, we shall use the figures from the Minessota Stormwater Manual but before any investment in treatment devices is made, we need to collect site-specific data to allow the design of effective treatment devices.

The sources of Phosphorus in urban runoff are identified as:

- plant and leaf litter;
- soil particles;
- pet waste;
- road salt;
- fertilizer, and
- atmospheric deposition of particles

The techniques to reduce phosphorus pollution associated with urban runoff include:

- Increased street sweeping in Autumn to reduce pollution from fallen leaves;
- Reduced mowing of roadside verges to reduce the pollution from cut grass in the roadside drains;
- Capture runoff from municipal parks & gardens and treat it using nature-based solutions to reduce Phosphorus levels before it discharges to the River;
- Treat the urban runoff from streets, yards & pavements before it is allowed to enter rivers & streams to reduce the levels of Phosphorus, and
- Making sure residents clean up after their pets.

The treatment devices that can be used to reduce Phosphorus pollution in urban runoff include:

- Infiltration basin or infiltration trench;
- Bioretention zone or rain garden;
- Swale or bioswale;
- Permeable pavement, and
- Urban trees planted in infiltrations cells or tree-box

The construction of these devices on new developments is cost-effective and can be included in the landscaping to add habitat for wildlife and places for people to enjoy. However, when they are being retro-fitted, as we propose here for the River Irwell catchment, it can be more difficult to design cost-effective solutions and we must consider the pollutant load and the soil types so that we can assess their effectiveness. We have selected three sites to consider as case-studies, and also included a motorway runoff scenario for comparison.

Suggested case studies

Site name	Proposed intervention	Surface area drained (estimated from Google My Maps)	Estimated Phosphate level in runoff	Estimated reduction from intervention %	Total Phosphate in Runoff per annum	Total Phosphate reduction per annum	Cost of intervention	Cost per kg of P removed
Downham Avenue SuDS **RESIDENTIAL ROAD**	Retrofit infiltration basins to capture runoff from urban surfaces	2.54ha	0.2mg/l	90% if all flows up to 27mm/hr can be infiltrated	5.461kg	4.91kg	£180,000	£36,660
Crompton Way **ARTERIAL ROAD**	Retrofit treatment devices to road runoff outfall	2.77ha	0.3mg/l	80% If sediment removal & pond provided	8.93kg	7.144kg	£250,000	£34,994
Union Road Industrial Estate **INDUSTRIAL ESTATE**	Retrofit approx. 17 bioretention zones to treat runoff from yards & roads	16.1ha	0.235mg/l	80% if all flows up to 10mm/hr can be infiltrated	40.67kg	32.54kg	£600,000	£18,438
M66 outfalls to the R Irwell at Ramsbottom **MOTORWAY**	Install bespoke treatment system to remove suspended solids in the runoff	Assume 6.5km of M66 @ 30m width discharges to River so approx. 19.5ha	0.28mg/l	40% reduction if 50% of suspended solids is removed from 27mm/hr rainfall	59kg	23.6kg	£1,500,000	£63,559

Notes:

- Costs of intervention only include capital costs; maintenance will be necessary for all the treatment devices.
- The M66 treatment options would be delivered by Highways England; the outfalls are their assets.
- If any of these schemes are progressed for consideration, local Phosphorus levels in the runoff must be gathered before detailed design is completed.
- Any costs associated with land-purchase for ponds/wetland is not included.
- Estimated Phosphorus reductions will depend on a number of site-specific factors such as slope of drainage network, soil type, infiltration capacity, Phosphorus mobilisation in rain etc.

Downham Avenue SuDS

Downham Avenue is a residential area just off Crompton Way and the layout of the roads & houses includes two large green open spaces which would be ideal for the installation of retro-fit infiltration basins which would receive the runoff from the roads & pavements. This would prevent the runoff from entering the drainage network for the majority of rain events (up to 27mm events) and reduce Phosphorus pollution in the River. Soil type and condition would need to be assessed for the suitability of this design.

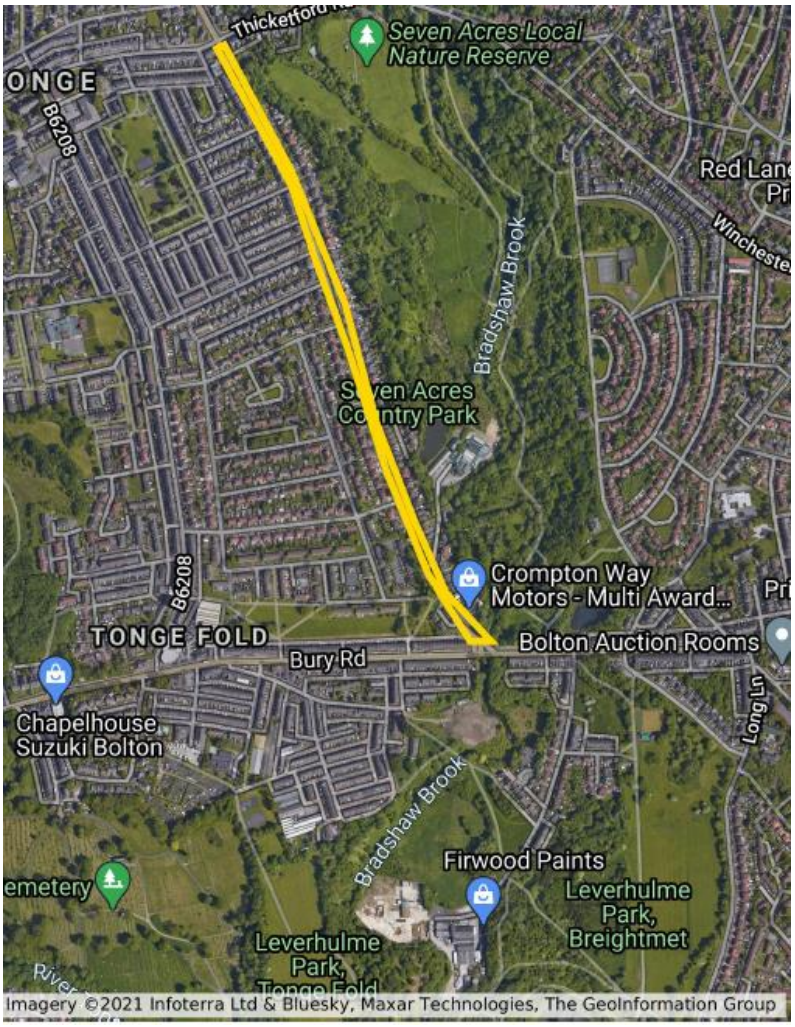
The area drained is approximately 2.54ha and the estimated annual load of Phosphorus off this catchment it 5.461kg. By installing two infiltration basins, one on each of the green spaces, and diverting the runoff to them, the Phosphorus pollution can be reduced by an estimated 90%. Equally, the infiltration of runoff would help to reduce flood risk in the local area.

Downham Avenue SuDS catchment outlined in white.

Crompton Way

Crompton Way is a busy arterial road leading into Bolton and it suffers from congestion in the rush-hour. The runoff from Crompton Way will be significantly more polluted than that from Downham Avenue, although the Phosphorus levels may be similar. There will be many other pollutants in the runoff, and some of these will be present at unacceptable levels too. The proposed solution for this catchment is to install a treatment device or management train at the point where the runoff leaves the road and enters Bradshaw Brook. This treatment device may be a sediment removal device and a stormwater filter or, if space allows, a pond or wetland. Maintenance of these devices will be essential, to remove the sediment that is captured. The catchment area is estimated to be 2.77ha and the annual Phosphorus load is 8.93kg. If sediment removal is installed and operated, that will remove 50% of the Phosphorus in the runoff, although additional treatment can be added that will remove the dissolved Phosphorus, taking the total removal efficiency to 80%, but that makes the installation more expensive.

The illustrative costs in Table 1 assume that a sediment removal device and a pond/wetland are installed to treat flows up to 27mm/hr rainfall.



Crompton Way Treatment catchment outlined in yellow

Union Road Industrial Estate

Union Road Industrial Estate outlined in yellow

Union Road Industrial Estate is a busy, compact industrial estate on the banks of the River Tongue. The proposed solution for this site is to retro-fit of up to 17 bio-retention zones across the estate, possibly including one for each occupied unit. This may allow partnership working with the businesses 'sponsoring' the installation of the bio-retention zone for their unit and taking on some of the routine maintenance. The runoff from these units will include other pollutants, as well as Phosphorus, and so the devices will provide additional water quality benefits for the River. If the devices can infiltrate at the base, this will contribute to reductions in flood risk too, and the bio-retention zones will deliver green spaces for the workers to enjoy and habitat for wildlife that can link to the River corridor. If they are well designed and maintained, the bio-retention zones will protect the River from acute pollution incidents and also reduce ongoing chronic pollution.

M66 outfalls to the River Irwell at Ramsbottom

There is a cluster of outfalls from the M66 to the River Irwell near Ramsbottom. They are the responsibility of Highways England so any investment on the treatment of these outfalls would be made by HE. However, it is useful to include them to allow a comparison with other possible interventions on the catchment. Phosphorus is present in road runoff, but in relatively low concentrations; the other pollutants have a far more deleterious effect on water quality. But the installation of treatment at these outfalls would deliver a reduction in Phosphorus pollution in the catchment. The runoff from motorways is particularly difficult to treat because flow rates will be in excess of 1000 l/s during a 1 in 1-year storm event which makes attenuation and sedimentation difficult, and filtration almost impossible. The best level of treatment we can reasonably achieve is 50% pollution reduction for regular rain events, and up to 80% treatment for partial flow. The benefits of this treatment are to the water quality in the receiving watercourse; the reduction in toxic metals, toxic organic compounds and suspended solids can make a meaningful difference to water quality.

This is a sedimentation basin treating runoff from a trunk road in Devon; it was installed by Highways England and discharges to an extensive reed bed.

Potential additional benefits that may be delivered by these schemes

If any of these schemes are delivered, they won't just reduce Phosphorus pollution in the River Irwell; they will deliver additional benefits too. In Table 2, we have indicated the benefits that might be delivered and whether those benefits would be high, medium or low. These benefits can be quantified if the schemes are selected, so that a comprehensive cost:benefit analysis can be completed

Table 2: Estimated opportunities for additional benefits from schemes

Opportunities for Additional Benefits	Downham Avenue	Crompton Way	Union Road	M66
Flood Risk Reduction	Medium	High	High	High
Reduced CSO spills downstream	Medium (if currently drains to foul sewer)	High (if currently drains to foul sewer)	High (if currently drains to foul sewer)	None (does not drain to combined sewer)
Improved/additional habitat for wildlife	Medium	Medium	High	Low (pollution load too high to create clean habitat)
Improved/additional amenity areas for local people	Medium	Low	High	Low
Reduced levels of pollution from toxic metals and organic compounds	Low	High	High	Very High
Improved chance of WFD compliance in receiving watercourse from combination of P removal and other pollutants	Medium	Medium	Medium	High
Increased public perception of stormwater management	High	Low	Medium	Low

Jo Bradley, Stormwater Shepherds. December 2020