Appendix 1:

Measures to be funded through the Developer Contributions Scheme

FINAL VERSION 1.0 (October 2012)

Short Term measure: Installation of silt traps

Phosphorous release from silt can/will occur under anoxic and anaerobic conditions. In rivers, such conditions tend not to exist in thin layers of mobile silt, but tend to develop if significant silt accumulations are formed in slow moving sections of the river.

Road run off, especially where roadsides are being eroded, and the decomposition of organic matter are often the more important sources of phosphate release in rivers.

The use of silt traps can reduce total phosphorous in a river, as a consequence of removing silt holding phosphorous that has the potential to become soluble phosphorus downstream. The size of the reduction may be dependent upon the nature of the silt captured, but the more organic material capture the better.

Silt traps are normally constructed with a 'wetland' i.e. a water holding pond, planted up, with the actual silt trap structure at the end letting water out. The removal rate therefore increases when the phosphorous taken up by the wetland is considered.

Work on the River Eye with the installation of silt traps has resulted in a total phosphorous removal rate in the region of 50%. This concurs with research work undertaken by Lancaster University where it has been determined that phosphorous removal efficiencies of well designed sediment traps are likewise around 50%.

A good level of monitoring and maintenance is required for silt traps, both to remove silt captured and also to harvest the wetland plants at the end of the growing season to prevent die back and return of phosphorous to the river. The amount of phosphorous removed by harvested wetland plants can be quantified as 1 gram of phosphate per 5 kilograms of plant material such as reeds.

On a precautionary basis, it is estimated that the installation of silt traps will remove 25% of total phosphorous. Assuming an upstream phosphate concentration of 1.05mg/l (an average total phosphorous concentration for the River Mease), with 25% total phosphorous removal, silt traps are assumed to remove 0.2625mg/l from water flowing through them.

The Environment Agency has provided flow estimates[1] for 2 locations that are potential sites for silt traps. These have mean flows of 0.102m^3 per sec and 0.0427m^3 per sec respectively. A precautionary approach takes the lower sample of 0.04 m^3 per sec.

[1] Flow estimates created by Low Flows Enterprise

Silt traps start to remove phosphorous as soon as they are installed and will therefore deliver phosphorous reductions immediately, allowing development to come forwards. The ongoing management and maintenance requirements mean that they are not however very sustainable in terms of delivering benefits over the lifetime of the development.

The DCS acknowledges this and has therefore identified long term sustainable phosphorous removal measures, through the River Mease SSSI/SAC Restoration Plan. These will be delivered in parallel with the short term measures. Once the long term measures are sufficiently established the short term measures will no longer be required and it is envisaged that the silt traps will then be removed.

Calculations based on 25% total phosphorus removal:

Average total phosphorous concentration in the River Mease = 1.05mg/l

Flow in the identified tributary locations, based on the lowest sample location

= 0.04 m^3 per second

= 3456m^3 per day

=3456000 litres per day

X 1.05 to get the mg of P per day = 3628800 mg P per day

3628800 mg P per day = 3629 g P per day

25% of P removed = **907 g phosphorous per day per trap**

Long term measure: River Restoration

Restoring a river to a more natural state clearly has significant benefits for river biodiversity and water quality. A river's ability to function as a diverse ecosystem, including its ability to 'clean' itself through its management of silt and nutrients in a sustainable way is highly dependent on a naturally functioning river channel and connectivity to its vital floodplain.

The River Mease River Restoration Plan, prepared by Natural England and the Environment Agency, sets out a vision for the SAC that addresses past modifications; restoring and enhancing natural river function which in turn will improve water quality and the river ecosystem. The plan sets out a long list of specific restoration proposals, with estimated costs. The plan refers to the Developer Contributions Scheme as one of the potential funding mechanisms.

Whilst all actions to restore a more natural river function will contribute to the river's ability to manage and reduce nutrients, in proposing projects to be funded by the developer contributions scheme those that have more direct and clear links to phosphorous removal have been identified. Projects within the plan are divided into reaches, and there are 22 reach projects where the action will result in a clear phosphorous reduction. Seven of these

reaches include projects that could take place in the very near future as landowner liaison has already commenced.

Projects included are those relating to floodplain restoration, wetland and wet woodland creation, riparian planting and restoration, removal of modified bank structures and re-naturalising bank profile and weir removal.

The floodplain has the potential to take up phosphorous from the river. A properly functioning floodplain, typically supporting woodland or wet grassland habitats, slows down surface water input and therefore reduces sediment and the phosphorous it carries being brought into the river via surface water, and also allows the river to undertake the natural process of sediment deposition onto the floodplain in flood situations. Furthermore, taking floodplain land out of agricultural production removes the input of phosphate rich fertilisers or organic matter from that land. Re-profiling of river banks contributes to the reconnection of the river to its floodplain by enabling flood water to spill into the floodplain where modified banks have prevented this in the past.

As explained above for silt traps, wetland creation, if properly managed provides plant material to take up phosphorous. Likewise, riparian planting will also take up nutrients. Weir removal brings back the river's ability to properly manage its silt, and therefore phosphorous within that silt, and prevents the retention of phosphorous laden silt behind weir structures.

Whilst exact figures for the amount of phosphorous that will be removed by each project cannot be provided, the scientific justification for the fact that phosphorous will be removed is considered to be robust. The task for the developer contributions scheme list is therefore to provide estimations that are realistic, based upon best available information, and take a precautionary view in light of the uncertainties.

Taking a precautionary approach, the following proposal has been agreed. Some of the river restoration projects relate to floodplain function and they will therefore be most effective in flood situations. On average, the River Mease is in flood nine times per year[2]; these events last an average of four days each. It is assumed therefore that the river restoration projects would be effectively removing phosphate for 10 % of the time (i.e. 36 days per year).

The research available suggests that a silt trap, i.e. a 'man made' river restoration mechanism will remove 50% of total phosphorous, it is proposed that half this rate, i.e. a 25% total phosphorous removal figure is estimated for the river restoration projects, again taking a precautionary approach.

Some of the projects will contribute to phosphorous removal all year round and the delivery of the measures within the Restoration Plan will therefore deliver phosphorous reductions at two levels. Firstly phosphorous will be removed during flood conditions through the reconnection of the river with a functioning floodplain. Secondly phosphorous inputs will be reduced through the amelioration of phosphorous laden sediment via surface water input,

[2] EA Flood Event data (Oct 2009-Oct 2012), data from Clifton Hill gauge compared to the River Mease Flood Alert level of 1.48mALD

and reduction of fertiliser input associated with floodplain land being taken out of agricultural production.

Unlike the short term installation of silt traps measure, there is a significant lead in time before the Restoration Plan measures will start to deliver actual phosphorous reductions. The Restoration Plan measures are therefore regarded as long term measures which will provide phosphorous removal from the river in a sustainable manner, with a minimum requirement for ongoing maintenance. Upon removal of the short term silt trap measures (estimated in 2027), the phosphorous removed through the delivery of the Restoration Plan will continue to offset the negative effects of development over the lifetime of the development itself (ie: in perpetuity).

Precautionary calculations of total phosphorous removal for river restoration projects:

a) P removal during flood conditions:

Average total phosphorous concentration in the River Mease = 1.05mg/l

Average flow in the River Mease, based on 5 sample locations provided by EA = 0.5 m3 per second

= 43200m3 per day

=43200000 litres per day

X 1.05 to get the mg of P per day = 45360000 mg P per day = 45360 g P per day

25% of P removed = 11340 g P, but as this is only 10% of the time then

10% of 11340 = 1134 g P per day, on average.

If we divide this by the 22 reaches where phosphorous removing projects are proposed, then

= 52 g P per day, per project, or 361 g P per day for the 7 reaches where projects can proceed imminently and therefore be placed in the first 'development window.'

b) Phosphorous removal through amelioration of surface water input

From above calculation the river carries 45360 g P per day. Diffuse sources contribute an average of 11.7% of the overall load[3].

The measures delivered through the Restoration Plan are carried out on land adjacent to the SAC itself. The phosphorous load within the SAC associated with surface water run-off will be derived from two sources: i) the tributaries joining the river along the length of the SAC and ii) directly from land adjacent to the SAC itself. The Restoration Plan measures will only

[3] Source: Environment Agency Review of Consents, River Mease SAC Stage 4 Site Action Plan

reduce surface water phosphorous load from land adjacent to the SAC itself (source ii). On a precautionary basis it is estimated that the delivery of the Restoration Plan measures along the length of the SAC itself will reduce the diffuse phosphorous load by 20%.

Diffuse P load = 11.7% of 45360 = 5307 g P per day

20% of diffuse load = 1061 g P per day

If we divide this by the 22 reaches where phosphorous removal projects are proposed, then

= 48 g P per day per project, or 338 g P per day for the 7 reaches where projects can proceed imminently and therefore be placed in the first 'development window.'

Overall phosphorous removal

Combining the figures (a) and (b) above, the overall phosphorous removal from the delivery of the River Restoration Plan measures is:

52 + 48 = 100 g P per day per project, OR

361 + 338 = 699 g P per day for the seven reaches where projects can proceed imminently.

Estimated phosphorous removal = 700g phosphorous per day for seven reaches

Overall costs for the measures to be delivered within the first development window to remove at least 700g/day in both the short and long term are detailed in Table 1 below.

Table 1: Measures to remove at least 700g P / day in both short and long term

P reduction and Monitoring Actions					
Action	**Estimated P reduction (mg P/day)**	**Implementation & maintenance Costs (£)**	**Monitoring approach**	**Monitoring cost (£)**	**Overall Costs (£)**
Short term measure: Silt traps project Costings based per trap - Land drainage specialist to survey sites, design and oversee works - Ground works - Trap checks and maintenance (e.g. clean outs) - Potential removal at 2027?	See calcs above. 25% of P removed = 907 g P per day per trap	<u>Per trap costs</u> £10k £5k £5k (up to 2027) £5k	Monitoring of water quality entering and exiting the trap, and potentially also take sediment samples entering and exiting. This will verify extent of P reduction and inform future silt trap projects	£20k (up to 2027)	£45 per trap (up to 2027) Assume one trap in first development window? Total = 45k
Long term measure: River restoration projects Specific in river projects to increase natural cleaning capacity of the river, in accordance with the river Restoration	See calculations above. 700g P per day, for the	£79k min to £245k max for the seven reaches that can come			Assume maximum cost of £245k for the seven

Plan. see river Restoration Plan for details	seven reaches that can come forward now.	forward immediately			reaches?
Management Actions					
Project officer - staff cost (suggest an initial contract for 5 years)	Implements measures above	£50k per year	Project Officer reports to the Programme Board	none	£50k/annum 5 years = £250k
Project officer's implementation budget - 2 x main campaigns per year (working with schools, interest groups, Councils etc, local events/education materials) - Travel and Subsistence		£15K per year £5k per year	Project officer to provide feedback and a measure of effectiveness of campaigns as part of role, so no additional costs	none	£20k/annum 5 years = £100k
Overall Costs					
Delivery of All Measures	**700 g P per day over short and long term**				**£640k**