Winford Brook Diffuse Pollution Walkover Survey

Bristol Water

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1. Introduction

1.1 Project Background

Bristol Water commissioned APEM to undertake a walkover survey to identify the extent and causes of diffuse pollution in the Winford Brook catchment upstream of Chew Magna Reservoir. In particular, diffuse pollution from fine sediment is known to be an issue within the catchment.

The Winford Brook catchment upstream of Chew Magna Reservoir is being used as a pilot catchment for a Defra funded project looking at developing the payment for ecosystem services approach to catchment management. Rural diffuse pollution and diffuse sediment pollution have been identified as issues that can be improved through catchment management.

Prior to the undertaking of this report, a desk study of the catchment, a risk assessment for potential diffuse sources and some limited surveying at road crossing points had been undertaken (AMEC 2013). However, a more detailed understanding of the specific farm scale sources and pathways of diffuse pollution is required in order to determine the potential measures that can be applied to reduce diffuse pollution in the Winford Brook.

Winford Brook, currently assigned poor ecological quality status and poor biological quality status under the Water Framework Directive (WFD) from its source to the confluence with the River Chew. Winford Brook, number GB109053021900, is failing to meet WFD requirements for fish based on the Environment Agency data from 2011 as documented in the 2013 River Basement Management Planning cycle 2.

1.2 Aims and Objectives

The main objective of the survey was to identify the extent and causes of diffuse pollution and in particular diffuse sediment pollution sources in the Winford Brook catchment. This was achieved as follows:

- Where access allowed, walkover survey of the full extent of the river was used to identify potential sources of diffuse urban pollution. Sources were graded according to their severity and extent of impact. An attempt was made to trace the sources of the pollution;
- Wet weather sampling was used to verify the findings of the walkover survey. This provided a greater evidence base when evaluating the severity of identified pollution sources.
- Based on the findings of the surveys, a number of measures are proposed which will help to mitigate the impact of diffuse catchment pollution and sediment sources.

This report details the findings of the walkover surveys and sampling that were conducted in the Winford Brook catchment (Figure 1) during January and February 2015. The results are accompanied by an interactive GIS as an electronic record of the surveys’ findings.
Figure 1  Winford Brook location and survey extent.
2. Methodology

2.1 Survey and Mapping Methodology

A standardised approach has been developed for rural diffuse pollution walkover surveys which identifies and categorises the prevalence and severity of diffuse and point discharges to rivers, streams and drainage ditches. The technique has been developed from APEMs approach to agricultural diffuse pollution surveys which has now been used to map over 14,000 km of rivers in England & Wales. Our approach has formed the basis of the EA operational instruction 356_12. May 2012 and will be the methodology used for this survey.

The walkover survey methodology is now being successfully converted to water body action plans to address the specific issues that are causing failure to meet required drinking water and environmental quality standards in a quick and cost-effective way. This approach is increasingly considered to be leading the way in turning the Catchment Based Approach into action for protecting drinking water sources and for delivering the WFD.

Following a review of existing understanding and a desk based study, a project specific approach was developed which combined survey, sampling and testing.

2.2 Walkover Survey

Winford Brook rises in a rural/agricultural setting, approximately 1km north of Winford, Somerset. The Brook then flows through the village of Winford, occasionally entering culverted sections. On leaving Winford, the river flows south east for a further 3km before entering Bristol Water’s Chew Magna reservoir to the west of Chew Magna (ST 56643 63227), this marks the downstream extent of the walkover survey. Before reaching the reservoir, numerous small tributaries and agricultural ditches join the Winford Brook main stem. Downstream of the reservoir, the brook continues for a further 1.7km through Chew Magna before joining the River Chew. We have estimated the total surveyed length of the river to be 22 km.

The project involved a team of trained field scientists who undertook standardised and systematic walkover surveys along continuous reaches of the Winford Brook catchment. Where critical sources of runoff, sediment or nutrients were found entering the watercourse, a grade and category were assigned, based on the observed severity and source type respectively.

Impacts were graded on a scale of Grade 1 to Grade 3; Grade 1 being the most severe. A qualitative outline of the grading system is presented in Table 1. Further to this grading, the issues identified were categorised according to Table 2. This standardised categorisation facilitated subsequent analysis, enabling key issues to be identified and summarised for each catchment. Photographs and/or video footage were taken at each location, depending on the severity of the issues identified, along with comments to provide specific details of the observations made. For example, particular attention was paid to Grade 1 impacts and individual accounts of these sites are reported throughout section 3.5. Furthermore, the location of each source was recorded in the field using a GPS, enabling subsequent GIS analysis of the spatial distribution of sources to be undertaken.

Using this information, we provide a measure of prioritisation for each of the Grade 1 sources identified. The priority refers to those sites that we feel are most important to
address. A high priority recommendation refers to a Grade 1 issue that should be addressed as soon as possible. A low priority issue needs to be dealt with but the impact, whilst still significant, is less urgent.

Table 1  Definitions of Grades 1 to 3 sources, as classified during the walkover surveys

<table>
<thead>
<tr>
<th>Grade</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Observed (or potential for) widespread propagation of sediment, polluted discharge or effluent, which may cause localised and widespread impacts more than 100m from the point or diffuse source.</td>
</tr>
<tr>
<td>2</td>
<td>Observed (or potential for) local deposition of in-stream sediment or effluent release which may cause noticeable impacts within 100m of the point or diffuse source.</td>
</tr>
<tr>
<td>3</td>
<td>Minimal observed (or potential for) deposition of in-stream sediment or effluent with very localised effects in the immediate vicinity of the input.</td>
</tr>
</tbody>
</table>

Table 2  Categories and recording codes of diffuse sources

<table>
<thead>
<tr>
<th>Category</th>
<th>Source</th>
<th>Type Example</th>
<th>Abbr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Arable</td>
<td>• Overland runoff (cropland) • Arable field drain • Arable drainage pipe • Arable spreading</td>
<td>OR FD ADP ASP</td>
</tr>
<tr>
<td>B</td>
<td>Livestock</td>
<td>• Farmyard surface runoff • Farmyard discharge (infrastructure) • Poaching – direct input • Overland runoff (grassland) • Drainage ditch • Overgrazing • Livestock spreading</td>
<td>FR FD PO POR PDD OG LSP</td>
</tr>
<tr>
<td>C</td>
<td>Conduits</td>
<td>• Road • Track • Ditch (non-agricultural) • Footpath • Pipe</td>
<td>RR TR DD FP PI</td>
</tr>
<tr>
<td>D</td>
<td>Domestic and industrial</td>
<td>• Sewage treatment works • Combined Sewage Overflows • Urban runoff • Septic tank • Industrial effluent</td>
<td>STW CSO UR ST IE</td>
</tr>
<tr>
<td>E</td>
<td>Others</td>
<td>• Spoil heap • Erosion • Unknown</td>
<td>SH ER UNK</td>
</tr>
</tbody>
</table>
2.3 Data Processing

On completion of the walkover survey, results were incorporated into a GIS using ArcGIS 9.2. A detailed map was produced which shows each of the sources, coloured by respective grade. Clicking on a point brings up the attributes of the source including the field description. For grade 1 sources, a record sheet is brought up including photographic evidence.

The attributes in the GIS are used to calculate some descriptive statistics covering grades and source types (Sections 3.3 and 3.4).

2.4 Wet Weather Sampling

Following the walkover survey, Grade 1 and other high priority sites were screened and selected for water quality sampling. Sites were also chosen on the tributaries feeding into the main Winford Brook especially to see if there were clusters of lower grade sources that could be targeted for measures.

Wet weather sampling took place during periods of significant rainfall that had been preceded by dry weather. Samples were collected at the beginning of the event in order to capture the ‘first flush’ of contaminants. For each pre-identified potential source of diffuse pollution a sample was taken from the river where the source discharge and river water had fully mixed. In some instances, additional samples were taken up and downstream to assess, to what extent, dilution effects were affecting the concentration. In total samples were taken from 15 different sites.

Samples were analysed for the following:

- Total suspended solids;
- Nitrogen: total as N;
- Nitrogen: total oxidised;
- Ammoniacal nitrogen as N;
- Nitrite as N;
- Orthophosphate, reactive as P; and
- Phosphorus, total as P.

In addition, in situ aquatic physicochemical readings were recorded on the day of the survey using a multi parameter probe. The following determinants were measured at each site:

- Temperature (°C);
- Conductivity (mS); and
- pH

Any additional observations regarding the presence of visual contamination such as surface oil or unexpected water colour were also reported.
The evidence base, provided by the sampling and targeted walkover surveys, assisted in the quantification of the relative importance of different sources, along with a suitable origin and type of classification.

Using this information we provide a measure of prioritisation for each of the Grade 1 sources identified. The priority refers to those sites that we feel are most important to address. A high priority recommendation refers to a Grade 1 issue that should be addressed as soon as possible. A low priority issue needs to be dealt with but the impact, whilst still significant, is less urgent.

### 2.4.1 Limits of Detection

The limits of detection for the different chemical tests that were undertaken are provided in Table 3. This information is particularly important for those chemicals present in very low concentrations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkalinity to pH 4.5 as CaCO3</td>
<td>5 mg/l</td>
</tr>
<tr>
<td>Total Oxidised Nitrogen as N</td>
<td>0.005 mg/l</td>
</tr>
<tr>
<td>Ammoniacal Nitrogen as N</td>
<td>0.002 mg/l</td>
</tr>
<tr>
<td>Nitrite as N</td>
<td>0.001 mg/l</td>
</tr>
<tr>
<td>Orthophosphate as P</td>
<td>0.001 mg/l</td>
</tr>
</tbody>
</table>
3. Results

3.1 Diffuse Pollution Sources

Figure 2 shows the location and spatial distribution of the diffuse pollution sources that were identified during the walkover surveys on the Winford Brook. The different colours represent the different grades of sources/pathways that were noted.

![Diffuse pollution locations identified from walkover survey in the Winford Brook catchment – January 2015.](image-url)

---

**Legend**

Pollution location (Grade)
- 1
- 2
- 3
- Other

Survey Extent

---

Figure 2 Diffuse pollution locations identified from walkover survey in the Winford Brook catchment – January 2015.
3.2 Diffuse Pollution Grade breakdown

Over 100 potential sources of diffuse pollution were identified within the catchment. Table 4 and Figure 3 show the grade distribution of pollution sources along the surveyed reach of the Winford Brook. Grade 3 sources were the most frequently observed pollution source, totalling 63 entries and 60% of the identified sources. Nine grade 1 sources were identified during the survey. All of these sources were located on tributaries of Winford Brook rather than the main channel. More information on the causes and types of sources identified is provided in Sections 3.4 and 4.0.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9</td>
<td>8.65</td>
</tr>
<tr>
<td>2</td>
<td>32</td>
<td>30.77</td>
</tr>
<tr>
<td>3</td>
<td>63</td>
<td>60.58</td>
</tr>
<tr>
<td>Total</td>
<td>104</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3 Pollution site grade distribution in the Winford Brook catchment
3.4 Diffuse pollution – Source Categories

Each source that is identified is categorised. Figure 4 shows the contribution of different pollution categories to the sources identified in the Winford Brook catchment for all of the grades observed. Of all the pollution sources identified, livestock was found to be the most frequently observed diffuse pollution source. Poaching (PO) was the most frequently occurring cause of livestock pollution (Figure 5). After livestock, conduit sources were the most abundant, with road runoff (RR) being the most frequently occurring conduit. Only a small number of arable sources were observed.

![Figure 4](image.png)

**Figure 4** Categories of potential diffuse pollution sources identified for all grades.
Figure 5  Frequency distribution of potential diffuse pollution source types in the Winford Brook catchment.

Figure 6 shows the breakdown of the categories and types of the nine grade 1 sites that were identified. It confirms that two categories (Livestock and Conduits) were the cause of the grade one sites. Livestock causes were responsible for two grade 1 sources, one of which was overland runoff associated with livestock; the other was classed as farmyard runoff. Conduits were responsible for seven of the nine grade 1 sites. Six of the sources were from either track or road runoff and one source was from a drainage ditch.

Figure 6  Category and type of all identified grade 1 sources
### 3.5 Grade 1 Information Sheets

Where a grade one source of potential diffuse pollution is identified a report card is produced to detail the observation. We have produced report cards for the nine grade one sites that were identified.

<table>
<thead>
<tr>
<th>Site Number</th>
<th>CG6</th>
<th>River/Beck</th>
<th>Winford Brook and tribs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>19/01/2015</td>
<td>NGR</td>
<td>ST5477164025</td>
</tr>
<tr>
<td>Pollutant type</td>
<td>Road surface water</td>
<td>Priority</td>
<td>Medium</td>
</tr>
<tr>
<td>Source category</td>
<td>Conduit</td>
<td>Source type</td>
<td>Road run-off</td>
</tr>
<tr>
<td>Land use</td>
<td>LHB: Pasture</td>
<td>RHB: Pasture</td>
<td></td>
</tr>
<tr>
<td>Vegetation</td>
<td>LHB: Grass</td>
<td>RHB: Grass</td>
<td></td>
</tr>
</tbody>
</table>

**Synopsis:** High flow in stream has overwhelmed culvert. Water now runs down the road along side hedge and re-enters ditch by side of road. Flow comes from sheep field. Water running from sheep field is too much for culvert (CG7) so instead takes the path of the road.
<table>
<thead>
<tr>
<th>Site Number</th>
<th>CG7</th>
<th>River/Beck</th>
<th>Winford Brook and tribs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>19/01/2015</td>
<td>NGR</td>
<td>ST5468263913</td>
</tr>
<tr>
<td>Pollutant type</td>
<td>Field run-off</td>
<td>Priority</td>
<td>Medium</td>
</tr>
<tr>
<td>Source category</td>
<td>Conduit</td>
<td>Source type</td>
<td>Road run-off</td>
</tr>
<tr>
<td>Land use</td>
<td>LHB: Pasture</td>
<td>RHB: Pasture</td>
<td></td>
</tr>
<tr>
<td>Vegetation</td>
<td>LHB: Grass</td>
<td>RHB: Grass</td>
<td></td>
</tr>
</tbody>
</table>

**Synopsis:** Water running out of sheep field un-able to flow through culvert. This results in water flowing over road down slope towards CG6 carrying with it all debris from field and road. Clear evidence of sediment build up behind obstruction at culvert.
<table>
<thead>
<tr>
<th>Site Number</th>
<th>CG10</th>
<th>River/Beck</th>
<th>Winford Brook and tribs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>19/01/2015</td>
<td>NGR</td>
<td>ST5392463545</td>
</tr>
<tr>
<td>Pollutant type</td>
<td>Land run-off</td>
<td>Priority</td>
<td>Medium</td>
</tr>
<tr>
<td>Source category</td>
<td>Livestock</td>
<td>Source type</td>
<td>Overland run off (grassland)</td>
</tr>
<tr>
<td>Land use</td>
<td>LHB: Pasture</td>
<td>RHB: Building works</td>
<td></td>
</tr>
<tr>
<td>Vegetation</td>
<td>LHB: Grass</td>
<td>RHB: Grass</td>
<td></td>
</tr>
</tbody>
</table>

**Synopsis:**

House building ground works in field lead right up to bank of stream. Lots of loose soil created in field. No buffer zone or boundary to prevent direct input of soil into river in rain events. May be temporary during building works.
Site Number | CG11 | River/Beck | Winford Brook and tribs
---|---|---|---
Date | 19/01/2015 | NGR | ST5385263490
Pollutant type | Livestock manure | Priority | High
Source category | Livestock | Source type | Farmyard run-off
Land use | LHB: Pasture | RHB: Farm yard
Vegetation | LHB: Grass | RHB: Concrete

Synopsis:

Un-able to get a good photo or footage as there is a large dense hedge one side of the stream and the cow’s yard directly on the other side.

The yard runs right up to the stream bank, the concrete stops and forms a drop-off into stream. Any manure from rain fall or scraping out the yard would fall directly into the stream.

They have a system at the end of the yard where manure is scraped up a slope and drops directly into a muck spreader, whilst doing this I fear some would fall off the edge of the yard and straight into the stream.
Site Number | CG20 | River/Beck | Winford Brook and tribs
--- | --- | --- | ---
Date | 19/01/2015 | NGR | ST5512865028
Pollutant type | Land run-off | Priority | High
Source category | Conduit | Source type | Drainage ditch
Land use | LHB: Building works | RHB: Building works
Vegetation | LHB: Grass | RHB: Grass

Synopsis:

Building works being carried out on both sides of stream with soil being exposed and left loose. High potential for soil run-off to occur here. Some standing water in places from recent rainfall. They have a small silt trap in place to try and catch most of the silt. Unsure of effectiveness.
Site Number | CG33 | River/Beck | Winford Brook and tribs
---|---|---|---
Date | 20/01/2015 | NGR | ST5527664570
Pollutant type | Road run-off | Priority | High
Source category | Conduit | Source type | Road run-off
Land use | LHB: Horse yard/House | RHB: Pasture
Vegetation | LHB: Concrete | RHB: Grass

Synopsis: When on site a lady came out of house to complain about the water running down the road and into her horse yard and horse stable. I was told in heavy rain events the water goes through the car doors when parked at bottom of road.

Water originates from surrounding pasture fields and is funnelled down road, entering the stream at the footbridge. Road is heavily damaged with gully’s and potholes being cut.

Bridge is also damaged where large vehicles have driven past in high flow and knocked the corner of the bridge.
### Site Information

<table>
<thead>
<tr>
<th>Site Number</th>
<th>River/Beck</th>
<th>Date</th>
<th>NGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT20</td>
<td>Winford Brook and tribs</td>
<td>19/01/2015</td>
<td>ST5646464409</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pollutant type</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track run-off</td>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source category</th>
<th>Source type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduit</td>
<td>Track</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Land use</th>
<th>Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHB: Pasture</td>
<td>LHB: Grass</td>
</tr>
<tr>
<td>RHB: Pasture</td>
<td>RHB: Grass</td>
</tr>
</tbody>
</table>

### Synopsis:

Extremely muddy track on downward slope to stream. Sign of direct input into stream. Potential for high input of silt into river in heavy rain events.
<table>
<thead>
<tr>
<th>Site Number</th>
<th>LT28</th>
<th>River/Beck</th>
<th>Winford Brook and tribs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>19/01/2015</td>
<td>NGR</td>
<td>ST5576664400</td>
</tr>
<tr>
<td>Pollutant type</td>
<td>Track Run-off</td>
<td>Priority</td>
<td>Medium</td>
</tr>
<tr>
<td>Source category</td>
<td>Conduit/livestock</td>
<td>Source type</td>
<td>Track/poaching</td>
</tr>
<tr>
<td>Land use</td>
<td>LHB: Pasture</td>
<td>RHB: Pasture</td>
<td></td>
</tr>
<tr>
<td>Vegetation</td>
<td>LHB: Grass</td>
<td>RHB: Grass</td>
<td></td>
</tr>
</tbody>
</table>

**Synopsis:**

Muddy track crossing stream in pasture. There is a direct pathway for water to flow into stream from muddy track. Poaching has occurred also around the drinking station, from here water can also flow directly straight into stream.
Site Number | LT38 | River/Beck | Winford Brook and tribs
---|---|---|---
Date | 20/01/2015 | NGR | ST5542164765
Pollutant type | Field run-off | Priority | Medium
Source category | Conduit/livestock | Source type | Track/poaching
Land use | LHB: Pasture | RHB: Pasture
Vegetation | LHB: Grass | RHB: Grass

**Synopsis:**

Muddy track at stream crossing point and Heavy poaching and cattle waste around feeding station. Direct access to stream for water carrying sediment into stream.
3.6 Wet weather sampling

This section shows various measurements of river chemistry taken from Grade 1 and high priority sites during the wet weather sampling. The locations of these sites are indicated on Figure 6.

Figures 7 – 10 show some physicochemical parameters of the river which, other than alkalinity, were all measured in situ. Figures 11 - 14 show the concentrations of potentially harmful nutrients at each site. Where possible, recommended limits or thresholds derived from: The Water Framework Directive, Freshwater Fish Directive, Surface Water Directive, and Drinking Water Directive have been added to show what risk the sources may pose to the watercourse. Descriptions of these standards/limits are included in Table 6.

It is important to consider that many of the limits/standards, described in Table 6, are based on annual average concentrations. The sampling was undertaken at a time when contaminant concentrations are likely to be at their peak. Therefore, although in some instances the river may fail to meet certain standards during wet weather periods, the river may still meet the standards during drier times of the year.

Table 5 A description of the chemical standards included in the presentation of the wet weather sampling data.

<table>
<thead>
<tr>
<th>Limit Type</th>
<th>Directive</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3 Waters</td>
<td>Surface Waters</td>
<td>Water with chemical concentrations equal to or surpassing these limits require extended treatment and disinfection before it may be considered suitable for drinking water.</td>
</tr>
<tr>
<td>Cyprinid/Salmonid Limit</td>
<td>Freshwater Fish</td>
<td>Recommended maximum limit of chemical based on the tolerance of Salmonid and Cyprinid fish species.</td>
</tr>
<tr>
<td>Salmonid Limit</td>
<td>Freshwater Fish</td>
<td>Recommended maximum limit of chemical based on the tolerance of Salmonid species.</td>
</tr>
<tr>
<td>Cyprinid Limit</td>
<td>Freshwater Fish</td>
<td>Recommended maximum limit of chemical based on tolerance Cyprinid fish species.</td>
</tr>
<tr>
<td>Drinking Water Standard</td>
<td>Drinking Water</td>
<td>Maximum acceptable concentration for ensuring the quality of water intended for human consumption.</td>
</tr>
<tr>
<td>Water Framework Directive - Poor</td>
<td>European Water Framework (WFD)</td>
<td>At or beyond these limits, biological communities may deviate substantially from those normally associated with the surface water body type under undisturbed conditions.</td>
</tr>
<tr>
<td>Water Framework Directive - Moderate</td>
<td>European Water Framework</td>
<td>Concentrations at these levels may cause moderate signs of distortion and are significantly more disturbed than under conditions of good status.</td>
</tr>
<tr>
<td>Water Framework Directive - Good</td>
<td>European Water Framework</td>
<td>At this level, conditions will deviate only slightly from those normally associated with the water body type under undisturbed conditions.</td>
</tr>
<tr>
<td>Protection of Surface Water Quality</td>
<td>European Water Framework</td>
<td>The standard imposed by the WFD to ensure a good quality of water.</td>
</tr>
</tbody>
</table>
Figure 6  Map showing the wet weather sampling locations
Figure 7: Temperature measurements from high priority sites, taken during wet weather sampling.

Figure 8: Conductivity measurements from high priority sites, taken during wet weather sampling.
Figure 9  pH measurements from high priority sites, taken during wet weather sampling.

Figure 10  Alkalinity to pH 4.5 dissolved as CaCO₃ from high priority sites during wet weather sampling.
Figure 11  Alkalinity to pH 4.5 as CaCO₃ from high priority sites during wet weather sampling.

Figure 12  Nitrogen (Kjeldahl as N) concentrations at priority sites during wet weather sampling.
Figure 13  Nitrogen (Total Oxidised, Filtered as N) concentration from priority sites during wet weather sampling.

Figure 14  Nitrogen (Total Dissolved as N) from high priority sites during wet weather sampling.
Figure 15  Nitrogen (Total as N) from high priority sites during wet weather sampling.

Figure 16  Nitrogen (Total Oxidised as N) concentration from high priority sites during wet weather sampling.
Figure 17  Nitrogen (Filtered as N) concentration from high priority sites during wet weather sampling.

Figure 18  Nitrite (as N) concentration from high priority sites during wet weather sampling.
Figure 19  Ammonical Nitrogen (Filtered as N) concentration from high priority sites during wet weather sampling.

Figure 20  Ammoniacal Nitrogen (as N) concentration from high priority sites during wet weather sampling.
Figure 21  Phosphorus (Total as P) concentration from high priority sites during wet weather sampling.

Figure 22  Phosphorus (Dissolved as P) concentration from high priority sites during wet weather sampling.
Figure 23  Orthophosphate (Filtered as P) concentration from high priority sites during wet weather sampling.

Figure 24  Orthophosphate (Reactive as P) concentration from high priority sites during wet weather sampling.
Figure 25  Silicate (Filtered as SiO$_2$) concentration from high priority sites during wet weather sampling.

Figure 26  Silicate (Reactive as SiO$_2$) concentration from high priority sites during wet weather sampling.
Figure 27 Chloride (Filtered) concentration from high priority sites during wet weather sampling.

Figure 28 Chloride concentration from high priority sites during wet weather sampling.
4. Mitigation Measures

The walkover survey has identified that the most abundant categories of diffuse pollution are related to livestock and conduits. For a relatively small catchment there are a large number of sources identified. Both conduit and livestock pressures are prevalent throughout the entire catchment. However, the most severe cases (grade 1) are located on the tributaries of Winford Brook as opposed to the main stem. Figures 5 and 6 highlight the importance of poaching, track runoff and road runoff as sources of pollution and sediment. The walkover revealed that in many cases there was a strong interaction between livestock land use and road/track drainage. In many cases road/track runoff would act to convey sediment which had been eroded as a result of heavy livestock grazing. Controlling these measures in particular is therefore likely to yield the most significant improvement in catchment condition.

This section will outline the possible mitigation strategies that could be employed in order to reduce the impacts of: (i) Livestock poaching, (ii) track runoff and (iii) road runoff (Figure 30).
Figure 30  Locations of observations of poaching and road runoff sources of diffuse pollution in the tributaries of the Winford Brook.
4.1 Livestock Poaching

Although only one incident of poaching was recorded as a grade 1 site during the walkover, the high number of poaching incidents (36 in total) across the catchment is of cause for concern (Figure 30). It is likely that, due to the density of poaching incidents across the catchment, the overall impact on the catchment is large.

The most effective way to mitigate the impact of poaching is to, as far as possible, prevent unrestricted access of livestock to the river and river banks. This can be achieved through the construction of fences and designated watering locations or ‘cattle drinkers’. These watering locations limit the area of river that can be accessed by the livestock and promotes watering in specific locations. Although some nutrient and sediment contributions will still result from the use of prescribed watering locations, the size of the impact is reduced significantly.

4.2 Track Runoff

Track runoff was identified in seven locations during the walkover. There were two main causes of runoff: (i) regular use by heavy vehicles and (ii) The movement of cattle over narrow tracks or bridges. These tracks are privately owned and would require modification by the relevant land owner.

The first option for the prevention of track runoff would be to change the use of these tracks, avoiding their use following rain events or during winter months. Although this may be possible in some areas, due to their current regular use it is likely that they provide important access to agricultural land. Alternatively, the addition of hard standing material along the tracks will help to prevent the erosion of the earth surface and therefore reduce the input of sediment into the rivers.

4.3 Road Runoff

In total, 20 examples of road runoff were identified in the Winford Brook catchment. Road runoff can have two different impacts on a catchment. Firstly, roads can act as rapid, highly efficient conveyors of water and sediment. As a result, sediment and pollutants from large areas can be transported into rivers at a much higher rate than would normally occur from typical overland runoff. In the Winford Brook we have attempted to map the potential road pathways based on identified diffuse pollution points and observation in the catchment (Figure 31). Based on the pathways identified, the total length of drainage channel increases by 50% when roads are included.
Figure 31  Potential road contribution to the Winford Brook
The second impact relates to the direct pollution from the roads. Roads can act as a significant source of sediment where verges become eroded by vehicles and over-widen the road. Similarly, the types of pollutants which can accumulate on roads are wide ranging but can often include: heavy metals, hydrocarbons, cold weather grit and nutrients in rural areas.

In order to mitigate the impact that road runoff may have in the Winford Brook catchment, it is important to improve the road drainage in those locations where road runoff has been identified as a problem (Figure 30). More specifically, it is important to design a drainage system that both increases the lag time between agricultural fields and the streams and provides suitable locations where the deposition of fine sediments and pollutants can be stored. For example, low gradient ditches containing some low level vegetation, such as grasses, would help to reduce the velocity of runoff and provide a form of filtration. Coordination with the Highways Agency would be a critical part of these works, in order to design the most appropriate drainage system.

In some cases, particularly those sites identified as high severity (grade 1), the volume of runoff along the roads would far exceed the limits of most viable road drainage systems. In these examples it may be suitable to divert the runoff away from the road, increasing the distance required to travel before reaching the river. Alternatively, stilling wells/ponds could be constructed in locations where road runoff and pollutant discharge is considered to be very severe. The diversion of runoff to these ponds would significantly increase the lag time between the catchment and stream, whilst also promoting the deposition of fine sediments and the processing of nutrients.
5. Summary

4.1 Walkover Survey

Over 100 potential sources of diffuse (sediment) pollution have been identified in the Winford Brook catchment. Of these nine were categorised as being grade 1, meaning that they have a potential to impact on the entire catchment. Looking in detail at the sources, the majority are from livestock related sources or related to pathways associated with tracks and road runoff. Arable sources were not identified as being significant.

Whilst there are no clearly significant individual sources of any type, there are a relatively high number sources of all grades identified compared with APEM’s experience of other catchments of a similar size that we have completed walkover surveys for. In addition to there being a relatively high number of sources, there is a strong connectivity within the catchment that provides an efficient pathway for the sources to get to the watercourse.

To address diffuse (sediment) pollution within the catchment, management of livestock poaching at both field entrances and access points to the watercourse will help to reduce the amount of sediment that is made available for mobilisation. Similarly reducing the connectivity between the field and the watercourse will be important. Management of track and road drainage is important to make less efficient pathways for mobilised sediment to reach the watercourse. This may involve management of existing drainage measures or developing improved road drainage; at one location the road is acting as the continual pathway for one of the tributaries of the Brook. The road network has the potential to increase the length of efficient competent flow in watercourse by 50%.

To address the potential sources and pathways will require engagement with a range of stakeholders, not just land owners/farmers but also wider functions in the catchment including highways management.

4.3 Wet Weather Sampling

The wet weather sampling has provided an insight into the key sources of diffuse urban pollution in the Winford Brook catchment. One of the major issues facing the catchment is elevated nutrient levels. Sites CG33, CG11, R7 and R1 discharge the highest concentration of nutrients into Winford Brook, exceeding the tolerance limits of both Cyprinid and Salmonid fish species for Nitrite or Ammoniacal Nitrogen. Prolonged periods of elevated nitrite and ammonia concentrations could therefore cause a decline in fish community and an alteration to ecosystem function.

Sites R7 and R1 were not identified during the walkover survey as specific Grade 1 sources but were recognised as nodes in the road network where diffuse pollution could enter the watercourse during wet weather events. Observation and sample results from the wet weather sampling suggest these should be considered as Grade 1 sites, as significant pathways for transport of pollution from catchment sources.

In detail:

- Alkalinity is high at CG11 with an increase found at the source, coinciding with a lower pH at this site. Alkalinity is notably lower at the sources of R1, CG33 and R7.
• Grade 1 sites CG33, R7 and CG11 (source and downstream) exceed the salmonid and cyprinid levels of ammoniacal nitrogen. Further, the samples taken at the source and downstream at CG11 also exceed the minimum A3 waters guide limit.
• Levels of nitrite exceed the limits for salmonids at CG33. Levels at R1, CG33 (at the source) and R7 (upstream) also exceed the limits for cyprinids.
• Orthophosphate levels at CG11 (at source and downstream) are currently rated as poor according the WFD status. CG33 (at source) and LT1 (at source) are currently rated as moderate.