Local Government Association

LOW and BEHOLD
RESOURCEFUL SOLUTIONS

The impact of household food waste disposers

Results of the field trials in Shropshire

Acknowledgements

Low and Behold were commissioned by the Local Government Association (LGA) to carry out this research. The LGA would like to thank Low and Behold and all those who supported the field trials. The views in this report are the author's own and do not necessarily reflect those of the Local Government Association.

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Executive summary

Food Waste Disposers (FWD) may have the potential to remove organic waste from the residual waste stream thereby potentially reducing waste collection costs. Many local authorities are becoming increasingly interested in exploring new to dispose of domestic food waste, and with no previous pilot studies carried out on FWD in the UK, the guidance available is currently limited. There are concerns from the water industry about the impact of FWD on household behaviour and the sewer network, as well as wastewater treatment works' (WwTW) capacity and waste prevention messages. Low and Behold have managed the field trials investigating the impacts of FWD at two pilot sites in Shrewsbury, Shropshire, on behalf of the Local Government Association (LGA).

Two new build development sites were identified in Shrewsbury. Working with Shropshire Council, the two developers and a number of sub-contractors and other interested parties, FWD will be fitted to 200 homes in total. This report covers the period of monitoring from April 2013 to March 2014, at which point 92 homes were fitted with FWD and occupied across the two sites.

The monitoring covered a number of different areas. These were the: impact on residual waste evaluated using waste compositional analysis; impact on the sewers evaluated using CCTV and sewer sampling; impact on householders assessed through attitudinal surveys; and potential cost savings to the local authority.

The table below shows the reduction in residual waste that resulted from the use of FWD across both sites. The table shows the difference between the pilot sites and the control round. It should be noted that the control round has lower average residual waste than the rest of Shropshire. **The total reduction in residual waste when compared with this control round was 44 per cent.**

Table 1: Comparing volumes of residual waste in Abbey Foregate (control), Riverside Meadow (pilot 1) and Abbey Wharf (Pilot 2)

	Abbey Foregate round data (control)	Waste composition analysis data from Riverside Meadows (Pilot 1)	Waste composition analysis data from Abbey Wharf (Pilot 2)	Difference between control and pilot (total reduction)	Difference between control and pilot (total reduction)
Month	**kg/hh/week**	**kg/hh/week**	**kg/hh/week**	**kg/hh/week**	**per cent**
Oct-12	6.85	-			
Feb-13	7.05	-			
Oct-13	6.13	3.52		2.60	42.50%

Feb-14	6.57	3.94		2.63	40.09%
Feb-14	6.57		2.96	3.61	54.90%
Average residual waste	**6.63**			**2.95**	
Total annual average residual reduction				**153.31**	
Average percentage reduction in residual					**44.45%**

In terms of responses from householders, the results of the attitudinal surveys were as follows:

- at Riverside Meadow a total 21 households (66 per cent) surveyed completed the questionnaires, of which 81 per cent of households use the FWD
- **16 (89 per cent) respondents at this site said that they found the FWD easy and convenient to use**
- 83 per cent of respondents at this site agreed that using the FWD meant that their bin did not smell
- the greatest concern with FWD at this site was its water usage, with 56 per cent of respondents agreeing that they worried how much water they use.

The CCTV results from Riverside Meadow have shown no evidence of blockages as a result of food waste at the site. However there is evidence that debris from the construction site is entering the sewers.

The sewer sampling considered the impacts of food waste on the oxygen demands in the sewage, the levels of phosphorus, nitrogen and fats, oils and grease. It also measured the level of settled and suspended solids, which are indicators of the level of treatment needed at the wastewater treatment plant.

While there were fluctuations in all the samples over the course of the monitoring period, it can be stated that, broadly speaking, most of the indicators did not fall outside of a typical range.

Finally, the potential for cost savings to the local authority was calculated. The cost savings relate predominantly to the reduction in residual waste. The evidence gained from the pilot studies in Shropshire suggests that a reduction in residual waste is possible. The average reduction during the pilot period was 153.31kg per household per year when comparing the pilot area against the most compatible waste round. This is Scenario 1. Assuming a disposal cost of £100 per tonne, this would equate to a saving of £15.33 per household per year. There are 135,000 households in Shropshire. The USA has a market penetration of 50 per cent for FWD disposer use, so assuming this became the same in Shropshire, then the total cost saving as a result of reduced residual waste would be £1,034,843 per year, based on these assumptions.

However both the control waste round and the pilot area have below average levels of residual waste for Shropshire. Therefore rather than look at kg per household, it is also possible to look at the percentage reduction in waste. This is Scenario 2. Average waste was 6.63kg per household per week for the control round during the pilot period. During the same period it was 2.95kg per household less in the pilot areas, which is a reduction of 44 per cent.

The average cost of disposal for Shropshire Council is £55.56 per household per year. Again assuming 50 per cent usage, the total saving in disposal costs per year would be £1,666,875 in this scenario.

Table 2: Cost savings summary

Scenario	Total waste reduction per year (50 per cent usage)	Total waste reduction per year (25 per cent usage)	Disposal cost saving	Reduction in loads tipped per fortnight	Total cost savings to Shropshire after water company charge
Scenario 1 (50 per cent usage)	10,348		£1,034,843	50	£917,679
Scenario 2 (50 per cent usage)	16,669		£1,666,875	80	£1,549,711
Scenario 1 (25 per cent usage)		5,174	£517,421	25	£458,839
Scenario 2 (25 per cent usage		8,334	£833,438	40	£774,856

The total cost savings each year to Shropshire Council, with 50 per cent FWD usage, taking into account a cost transfer to the water company, would be between £917,679 and £1,549,711.

1.0 Introduction

Food waste disposal (FWD) units are small grinders that are installed in the kitchen sink outlet of domestic households. The householder separates food waste and flushes this down the plug and into the unit with a small flow of cold water. Most foods are reduced to small particles and pass via the kitchen drain to the public sewer.

Defra's guidance on processing food waste that is collected at the doorstep is that anaerobic digestion (AD) is the best environmental option[1]. Water industry figures suggest that approximately 70 per cent of the UK's sewage sludge[2] is currently processed in anaerobic digestion. Therefore, the hypothesis is that FWD can be used to transport FWD to AD via the sewer network, rather than by the provision of food waste bins and separate collections in vehicles. For example, Severn Trent Water, which serves the Shrewsbury sites in this pilot, processes all of its sewage sludge by AD.

Low and Behold are project managing a pilot on behalf of the Local Government Association (LGA) to investigate the impact of food waste disposers (FWD) on households and household waste. Commercial FWD are not being investigated as part of this project. FWD may have the potential to remove organic waste materials from the residual waste stream thereby potentially reducing waste collection costs. Many local authorities are becoming increasingly interested in exploring a variety of ways to dispose of food waste from their residents, and with no previous pilot study carried out in the UK the guidance available to them is currently limited. This pilot aims to be the largest worldwide study of food waste disposers in residential properties and will provide crucial information on their effects on sewers in the UK. This report covers the surveying and monitoring of 92 homes as Phase I of a project that aims to fit 350 FWD to households in three pilot sites.

There are concerns from the water industry about the impact on household behaviour and the sewer network as well as wastewater treatment works (WwTW) and waste prevention messages. Many water companies have taken a negative stance to their use and Water UK has released a policy statement suggesting a ban on their use (Water UK, 2009).

[1] Defra. Applying the Waste Hierarchy: evidence summary. June 2011. https://www.gov.uk/government/publications/applying-the-waste-hierarchy-evidence-summary
[2] Ofwat *Competition in upstream sewage and sludge markets. Feb 2010.* p47-48.

A survey has been undertaken to review the available literature on FWD. Firstly to provide a comprehensive list of research and opinion that will be a useful tool for others interested in this technology and subject area. Secondly to identify potential barriers to the proposed pilot study and to ensure that these will be fully mitigated against and investigated as part of the innovation project.

The pilot project is working directly with local authorities, a housing association and a water company to trial the use of FWD in residential kitchens. The purpose of the project is to test the technical, regulatory and legal barriers to using this technology for taking food waste out of the residual waste stream.

A final cost-benefit analysis has been carried out to calculate potential cost-savings to local authorities and to calculate any cost transfers from local authority onto householders or water companies.

2.0 Background information

The first stage of this project was a review of the available literature on FWD and its impacts. Literature published since 1947 and anywhere in the world was considered.

147 individual pieces of information were assessed as part of the initial literature review, of which 95 were deemed to be relevant for the purposes of the report.

All the pieces of literature except one agree that the introduction of FWD will increase water use in individual households but that the increase will be negligible.

There is also general consensus that there will be an increase in total suspended solids, BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand) and sewage sludge. What they do not consistently agree on is the level of this impact and whether this impact is negative or positive.

An important issue for most pieces of literature is the level of market penetration. At low levels of market penetration the impact of FWD is difficult to measure. The literature has a range of opinions about the maximum level of penetration that can be reached before new investment may be needed in WwTW infrastructure. The cut-off point varies in the literature from 15 per cent to 60 per cent.

Each piece of literature was labelled based on whether it found a positive, negative or neutral impact resulting from the use of FWD, which are detailed in the table below. It is important to note however, that each publication did not set out to examine the same impact, and therefore the headline figures given in this summary are indicative of a trend rather than representative of an opinion.

Table 3: Summary of total studies reviewed and outcomes

Category: Measured or observed impact of FWD use	Number of studies	Percentage
Neutral	22	23%
Negative	7	7%
Positive	60	63%
N/A	6	6%
Total	95	

From this review of the current literature on the use of FWD it is possible to conclude that local circumstances are important and that a UK pilot is critical to understanding the impacts in more detail. The full literature review can be found on the LGA's website at:
http://www.local.gov.uk/productivity/-/journal_content/56/10180/3510540/ARTICLE

2.1 The housing developments

There are two housing developments in the Shropshire pilot, Abbey Wharf and Riverside Meadow. The two sites will have over 240 homes in total once the projects are completed in 2015.

Riverside Meadow is a David Wilson Homes development on the site of the old Gay Meadow Football Ground, on the banks of the river in Shrewsbury. Phase A of the project consisted of three main spurs of 32 residences each. These are a mix of 4 bedroom homes and 2 bedroom flats and all are fitted with FWD. Phase B of the project consists of Montgomery House, a development of 1 and 2 bedroom apartments. At the end of March 2014, there were 62 homes occupied in Riverside Meadow.

The Abbey Wharf site is a Shrewsbury Homes development, located just off the Abbey Foregate road in Shrewsbury. The site initially had planning permission for 62 homes, but since the project started this has been extended so that the total site will now have 18 houses and 56 apartments. The first 62 homes are all fitted with FWD. These homes are a combination of 1, 2 and 3 bedroom apartments and 3, 4 and 5 bedroom town houses. At the end of March 2014 there were 30 homes occupied at Abbey Wharf.

2.2 The disposers

Insinkerator, a division of Emerson, manufacture the FWD procured for this project. Shropshire Council ran a competitive tender process for a FWD supplier, with Insinkerator providing the best value for money.

The Evolution 100 that has been supplied in Shrewsbury is a continuous feed model and comes with a full five-year warranty. The advertised average water use is 5 litres per household per day and the average electrical usage is 2-3kWh per year (Insinkerator, 2012).

3.0 Methodology

The methodology for this project is based on Defra's 'Protocol for Conducting Practical Field Trials Involving Food Waste Disposal Units', prepared by the WRc (Water Research Centre) in September 2009, but as yet, unpublished. The Defra Protocol is used because it follows from the original Defra report into FWD and aims to provide guidance for the resulting trials to ensure that a high and uniform standard of investigation takes place.

The Protocol states that relatively small scale field trials in a typical urban area would be unlikely to generate sufficient food waste to allow a feasible evaluation of the impact on primary and secondary treatment processes. The proposed pilots will take this into account and work with water company partners to ensure that the pilots produce useful information.

The pilot aims to collect and collate data in six modules, subject to the boundaries listed below.

Pilot boundaries

- The households in the pilot area must be connected by the sewer network to a WwTW that uses, or aims to use, AD (Anaerobic Digestion) as its sludge treatment.
- The aim of the pilots is to evaluate FWD performance when compared against a baseline. The pilot households "A" will therefore be compared against either the same pilot households before the installation of FWD "B" or a control of comparable households "C" during the testing period. It is not intended to compare "A" households against households that are offered a kerbside food waste collection.
- The Defra Protocol states that a pilot of less than 50 households would have a high level of uncertainty and that more than 500 households would produce diminishing returns. For that reason, the pilots initiated in this study will aim to have between 100 and 500 households with installed FWD in each trial area.
- The pilot is funded to run for a twelve-month period of monitoring. However the benefits of longer term monitoring are understood and the final pilot trial length will depend on the cost of monitoring and evaluation.

Technical objectives

The Defra protocol suggested that the main purpose of any trial would be to obtain a quantitative assessment of the relative performance of the use of FWD units when compared with kerbside collection options. As a consequence it proposed nine modules that would be suitable for data collection.

For the purposes of this project, where no field trial comparison will be made of kerbside collections, it was decided that the pilots collect data in the following six modules. Module C is qualitative and an addition to the original suggested protocol:

A. demographic information
B. kitchen waste
C. householder behaviour
D. conveyance of food waste within the sewer
E. combined treatment of food waste with sewage (primary and secondary treatments)
F. combined treatment of food waste with sewage sludge (sludge treatments).

Modules for data collection

Module A: demographic information

Socio-economic data from the area in question and specifically of the properties with FWD installed.

Module B: kitchen waste

Waste composition analyses carried out before the pilot starts and during the pilot, or with a comparison to a control area. This also relates to the frequency and duration of use of FWD by participating households.

Module C: householder behaviour

Surveys to monitor the participation of the householders and householder satisfaction including attitudes towards recycling and the sewer network.

Module D: conveyance of food waste within the sewer

The condition of the local sewers and drains prior to the use of FWD and after fitted. Maintenance and operation of the sewers is monitored before and during the pilot.

Module E: combined treatment of food waste with sewage (primary and secondary treatments)

Monitoring of the treatment of waste within the sewage plant before and during the pilot. Treatment monitoring including the influent characteristics, screening, primary settlement and secondary treatment, and both activated sludge and biological filtration.

Module F: combined treatment of food waste with sewage sludge (sludge treatments)

Monitoring the treatment of sludge produced in all stages of the process including the sludge thickening, anaerobic digestion and dewatering.

3.1 Module A: demographic information

Demographic information has come from a variety of sources. Shropshire Council provided socio-economic data for the area, and as both developments in Shrewsbury are new builds, the respective sales offices have provided basic demographic data on the inhabitants as they move in. Monthly conversations were held with the sales advisors to collate this information as it became available

Table 4: Sources of Demographic and Socio-Economic Information

Source	Medium	Information
Shropshire Council	Monthly discussions	Socio-economic data
Developer information	Monthly discussions	Resident information
Surveys	Survey schedule in Table 3	Householder behaviour

3.2 Module B: kitchen waste

The manufacturer has provided technical specifications for the equipment installed. The literature review carried out prior to this study highlighted several pieces of research analysing the usage patterns of the food waste disposers as well as the duration per use. As part of the surveys into householder behaviour, residents have been asked to provide information on their usage characteristics.

Waste composition analyses have been carried out on three separate occasions. The first was carried out on the same waste round as the new developments and has provided baseline data. This first waste composition analysis took place on Thursday February 14 2013 and sampled 1,200 houses.

A second waste composition analysis took place in September 2013 at the Riverside Meadow site, once the first spur of properties h occupied. The third analysis in February 2014 covered both the Riverside Meadow and Abbey Wharf sites.

These audits have provided us with values for the percentage of food waste produced per household, the residual waste per week per household and also the proportion of the food waste that could be treated

through a food waste disposer. The analyses have also focused on the type of food waste found in the samples, and where possible it has been noted if the food waste was packaged or not.

Shropshire Council has provided monthly waste round data for both the Shrewsbury area, and the wider county, for the duration of the project and for the twelve-month period before the project began. It is therefore possible to compare the FWD households' waste data with other parts of the county and the same waste round before the FWD were fitted.

3.3 Module C: householder behaviour

Households in Riverside Meadow were surveyed in June 2013. Surveys were hand delivered and could be handed back into the Sales Office in return for a small gift. The survey was distributed to the Abbey Wharf site once enough households were occupied in autumn 2013. A second survey has been distributed at the end of the year as more houses become occupied. The survey can be seen in full in Appendix 3.

A public event for householders at Riverside Meadow was held in September 2013, with demonstrations of the food waste disposal unit provided by the manufacturer. Residents were encouraged to complete the survey at this event and more detailed interviews were held face-to-face with those who had already completed surveys.

3.4 Module D: conveyance of food waste in the sewer

The conveyance of food waste through the sewer has been monitored at Riverside Meadow by monthly CCTV inspections and monthly sampling of the sewage. A private pump serves the Abbey Wharf site and the installer and maintenance company have been interviewed to ascertain whether the pump performance has differed from what would normally be expected at a domestic site of that size.

Any complaints from the area regarding pests and odours to the Environmental Health team at Shropshire Council have been noted, and quarterly conversations with this department recorded any problems in the area of the development.

The local Environment Agency office was contacted quarterly to collate any complaints or incidents in the area related to the sewer network.

3.4.1 CCTV surveys

CCTV surveys took place at the Riverside Meadow site monthly from April 2013 until February 2014. This provided a visual inspection of the main sewer leaving the development, before it reaches the larger trunk sewer. Prior to the first survey, jetting took place to ensure any debris from the build has been removed.

The Abbey Wharf site has had an initial CCTV survey taken by the developer. However, due to the location of the access point in the main highway, it was not possible to undertake CCTV surveys monthly.

3.4.2 Flow monitoring

Initially a flow monitor was installed at the Riverside Meadow site for two weeks from the 31 May 2013. A small weather station has also been fitted at the Riverside Meadow site.

3.4.3 Waste water sampling

Samples were taken monthly from the Riverside Meadow site, beginning in April 2013. The samples were taken at the same time as the CCTV surveys in order to minimize disturbance. Initially they were spot samples with a single sample being taken. The samples were then taken to a laboratory where they were tested for the parameters: Nitrogen; phosphorus; total suspended solids; suspended solids after one hour settle; biochemical oxygen demand (BOD); chemical oxygen demand (COD); NVM (non-volatile matter as an indicator of fats and greases); and settled solids after 30 minutes. These are detailed further in the Parameters Table below.

It is important to measure a number of these parameters, as any significant increases would result in extra treatment required at the wastewater treatment plant. Before wastewater treatment plants can release water into the environment they are required to ensure nutrient levels (indicated by phosphorus and nitrogen levels) are kept below a safe threshold. The type of treatment needed depends on the material load and the water body the effluent will be discharged into. Sensitive areas with higher population equivalent loads being discharged will require higher levels of treatment (Defra, 2012).

Table 5: Sewer sampling parameters

Sample	Reason	Potential causes	Parameters
Nitrogen	Nitrates in the water that are released into the environment can cause eutrophication, which leads to algae growing faster than ecosystems can handle. This in turn harms the quality of the water, food resources and habitats and reduces the oxygen available for fish and plants.	In urban areas causes are most likely to be faeces, urine, garden fertilisers and pet waste. The type of surface can also impact, but in our pilot sites, storm water travels separately to household wastewater.	European Standards are 50 mg/l for nitrate and 0.5mg/l for nitrite. A normal range for Nitrogen testing would be between 15-90n mg/l with a typical reading being 40 mg/l.[3]
Phosphorus	Phosphorus has the same impact as nitrogen, in that it causes eutrophication.	In urban areas causes are likely to be detergents and urine and faeces.	A wastewater range would be 6-20 mg/l with a typical reading being 12 mg/l.[4]
Total suspended solids	Total suspended solids are both organic and inorganic solids that are suspended in the water and give a good indication of the level of treatment that will be needed at the WwTW.	Total suspended solids will be those that do not pass through a filter with pores of around 2 microns. This will include any organic matter that has not settled in the sewage. This may include the output from FWD and other normal organic materials found in sewage.	
Suspended solids 1 hour settle	This is the total suspended solids after the sample has settled for an hour. Indicates the level of	As above but after settling for one hour.	

[3] *Burks and Minnis: Benchmark Values for Wastewater Sampling. 1994.*
[4] Ibid.

	treatment that may be needed.		
Biochemical oxygen demand (BOD)	When waste reacts with nutrients and bacteria in the water the biochemical reactions reduces the available oxygen. This is often regarded as a measure of pollution.	Any waste that reacts with the bacteria in the existing sewage.	A wastewater range would be 100-400 mg/l with a typical reading being 250 mg/l[5]
Chemical oxygen demand (COD)	As above, but this measurement is of the chemical demand for oxygen in the reaction between oxidizable chemicals in the waste and the water.	Any waste that reacts with the bacteria in the existing sewage.	A wastewater range would be 200-1,000 mg/l with a typical reading being 500 mg/l[6]
Fats, oils and grease (NWM)	FOG are a major concern to water companies because of the potential to block sewers.	Oils and grease from food and cooking being poured down the sink, or coming with food through the FWD.	NWM is non-volatile material, which are the materials that are soluble in petroleum spirit. This should include all fats, oils and grease and therefore a wastewater range would be 50-150mg/l with a typical reading being 100 mg/l[7]
Settled solids after 30 minutes			A wastewater range would be 50-200mg/l with a typical reading being 100 mg/l[8]

[5] ibid.
[6] ibid.
[7] ibid.
[8] ibid.

3.5 Module E: combined treatment of food waste with sewage and Module F: combined treatment of food waste with sewage sludge

The original proposal was to work with Severn Trent Water for Modules E and F, looking at both primary and secondary treatments and sludge treatments. After extensive discussion about the monitoring programme, Severn Trent decided that they could not continue with the project and therefore it has not been possible to collect date for Modules E and F.

3.6 Project management

In order to help guide the project a Technical Advisory Group was established. This included representatives from the Department of Environment, Food and Rural Affairs (Defra); Water UK; Ofwat; the Department for Communities and Local Government (DCLG); and the Water Research Council (WRC). The first meeting took place in December 2011 and discussed the legality of disposing of food using a food waste disposer. Further meetings took place in November 2012, May 2013 and March 2014.

Working group meetings were subsequently set up at each pilot site and representatives from the developments, Shropshire Council and any subcontractors involved were invited. These took place quarterly once the monitoring had begun to discuss the project's progress and any issues.

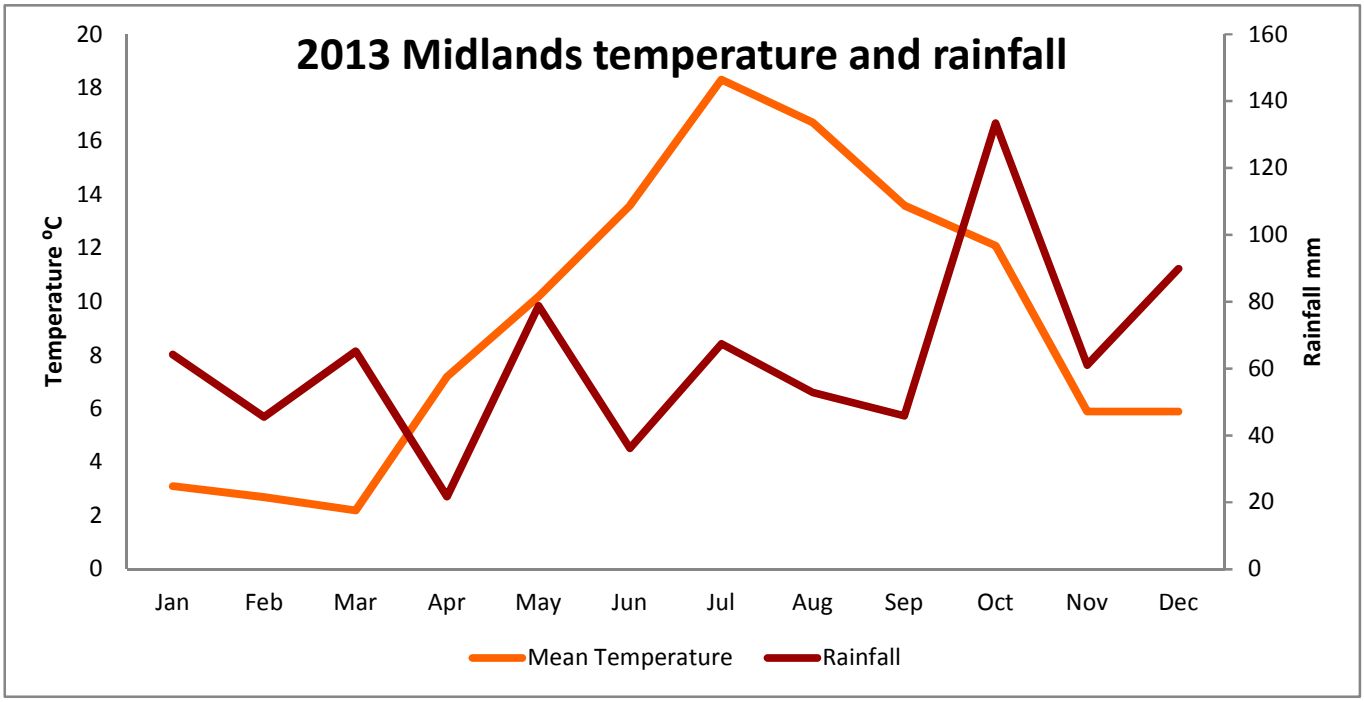
4.0 Results

4.1 Background data

At the end of March 2014, there were 75 properties with FWD fitted at Riverside Meadow and 62 properties occupied. At Abbey Wharf there were 48 properties with FWD fitted and 30 properties occupied.

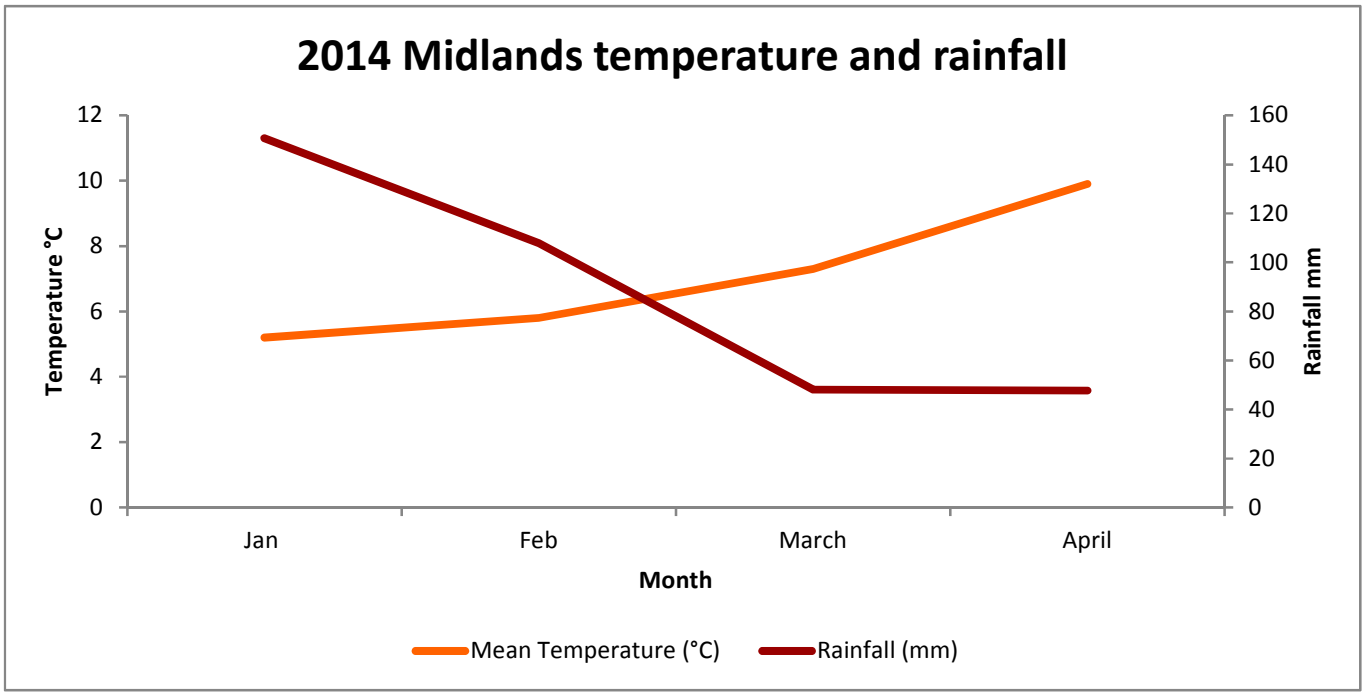
The temperature and rainfall for the West Midlands in 2013 can be seen below in Chart 1. The start of the year was cold with a minimum occurring in March 2013. Maximum temperatures were reached in July and stayed relatively warm through October until temperatures dropped in November. The highest rainfall in the year occurred in October 2013, while the lowest took place in April.

Chart 1: 2013 Midlands temperature and rainfall



In 2014, the year started off with some heavy rainfall (150.7mm for January) with relatively mild temperatures and rainfall significantly decreasing in March and April 2014 to a low of 47.8mm in April shown in Chart 2.

Chart 2: 2014 Midlands temperature and rainfall

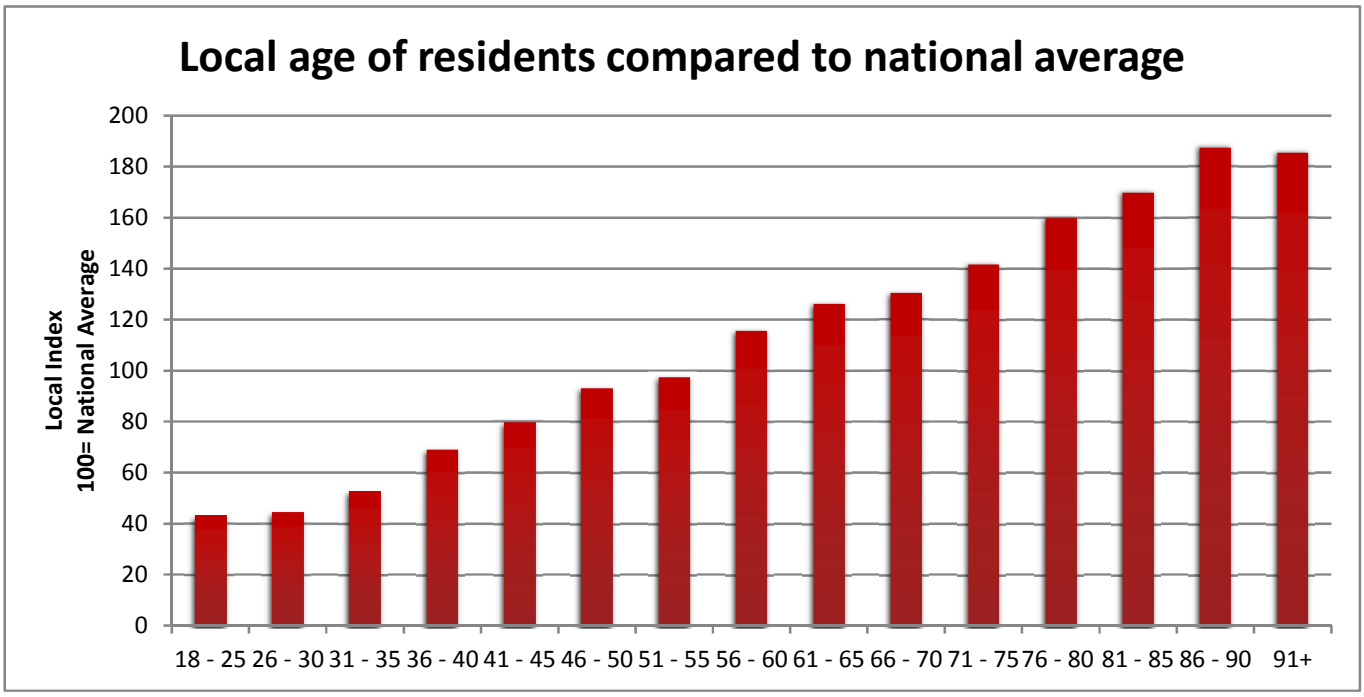


The temperatures and rainfall should not impact the sewer network that was being monitored for this project as storm water from rainfall uses a separate sewer system. Heavy rainfall may impact pollution incidents recorded by the Environment Agency in the Shrewsbury area, as a result of combined sewers that discharge in heavy rain. A combined sewer is one that takes sewage from households and rainwater runoff.

4.2 Module A: demographic information

Mosaic data for the postcode area SY2 6 has been investigated. This is the area that includes the Abbey Foregate waste rounds and the southeast side of Shrewsbury. It is clear that this area has a higher than average population aged 56 and above, as can be seen in the table below.

Chart 3: Local age of residents compared to national average



There are an above average number of pensioners and couples without children. The social grade is below the national average for A to C1 and above the national average for C2 to E, with the greatest deviation from the national average being for the E group. This may be a result of the large number of widowed older people and pensioners.

The properties tend to be owner occupied and the data shows that more people feel 'comfortable on their income' than the national average. In terms of the Green Aware classification, the largest group is the 'Green but doubtful' group, followed by the 'Sceptical libertarians'.

Properties in the Riverside Meadow development are mainly above the national average with prices ranging from £149,579 to £525,000. Abbey Wharf had more flats aimed at single people and couples starting out, but the price range was between £125,000 and £370,000.

4.3 Module B: kitchen waste

According to WRAP, we throw away 7 million tonnes of food and drink from our homes every year in the UK.

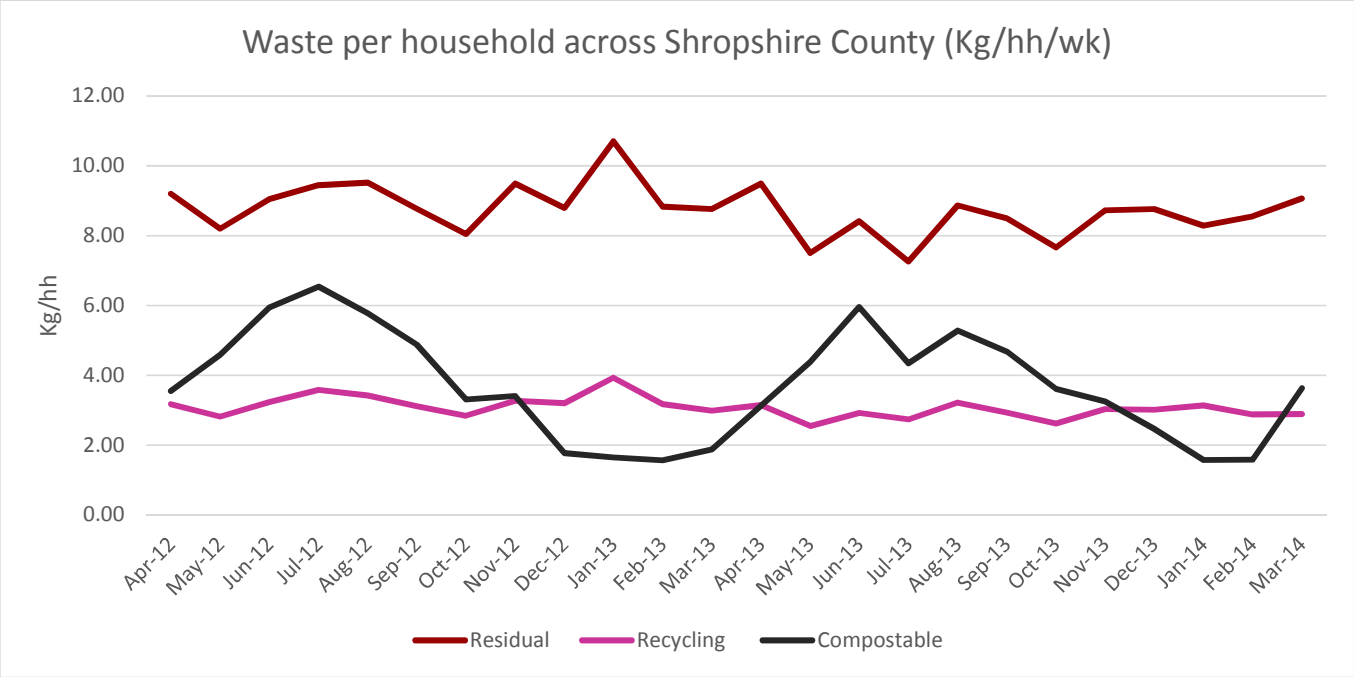
Waste round data has been collated from Shropshire Council. This provides a range of baseline data sets, including the following:

- Shropshire Council: residual, dry recycling and compostable waste
- Shrewsbury and Atcham Borough Council (SABC), which covers both developments: residual, dry recycling and compostable waste
- Abbey Foregate waste round, which covers both developments: residual waste.

In addition, we conducted a baseline waste composition analysis (WCA) of the Abbey Foregate round on 14 February 2013, to analyse the level of food waste in the residual waste.

The Chart below shows the total waste collected in the county for each month of the project, broken down into residual, recycling and compostable. There are areas in Shropshire that have a separate food waste collection service, but this is not the case for SABC or the Abbey Foregate round. Therefore the compostable figure relates mainly to garden waste.

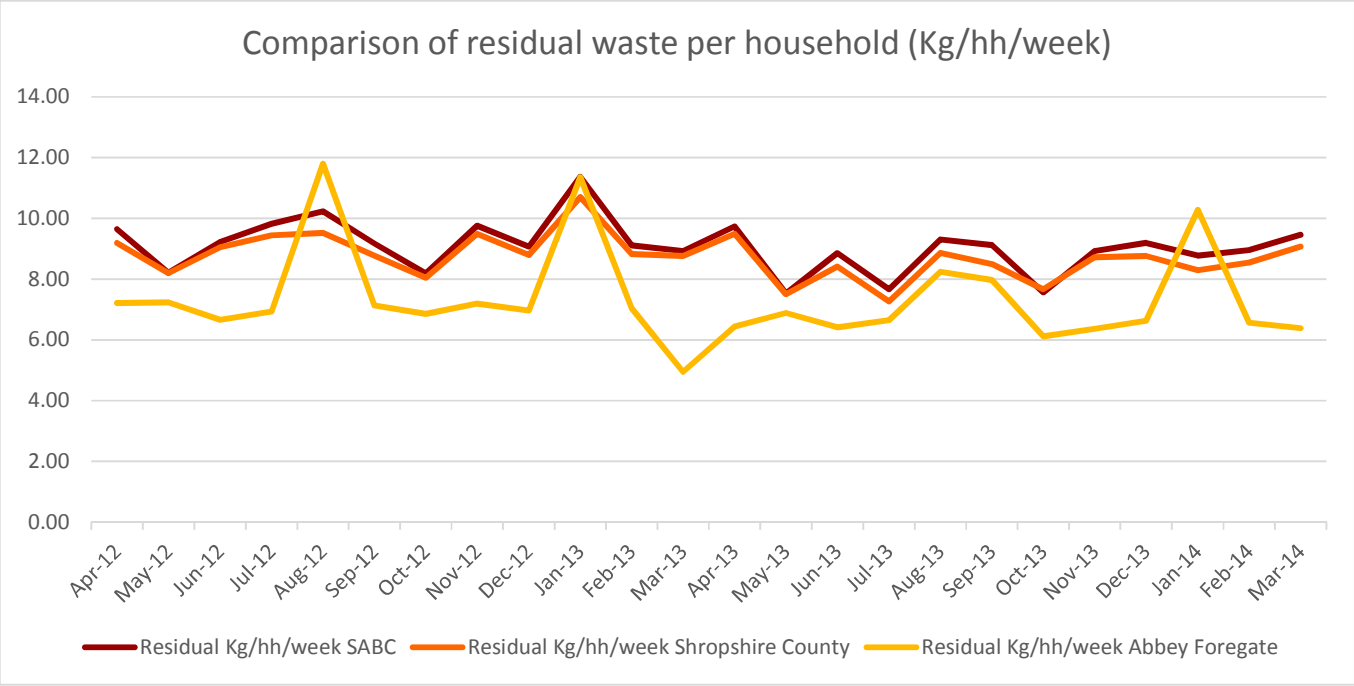
Chart 4: Shropshire Council, waste per household, April 2012 – March 2014



The seasonal fluctuation in the compostable waste is clear, with a large drop in the winter months. Small increases in residual waste in January can also be seen, after the Christmas holiday. Recycling performance remains fairly static through the period.

For the purposes of this study we are interested in volumes of residual waste, so the Chart below show the residual tonnages per household, comparing Shropshire County, SABC and the Abbey Foregate round.

Chart 5: Comparison of residual waste per household



Although Shropshire county and SABC have residual waste per household following broadly the same pattern, the Abbey Foregate round volumes fluctuate much more dramatically. Large increases in residual waste can be seen in the summer and Christmas holiday periods. The overall levels of residual waste are also lower than either SABC or the county as a whole. Therefore, when making comparisons to our FWD pilot sites, data from the Abbey Foregate round has been used, rather than data from SABC or the whole county.

4.3.1 Waste composition analysis at Riverside Meadow

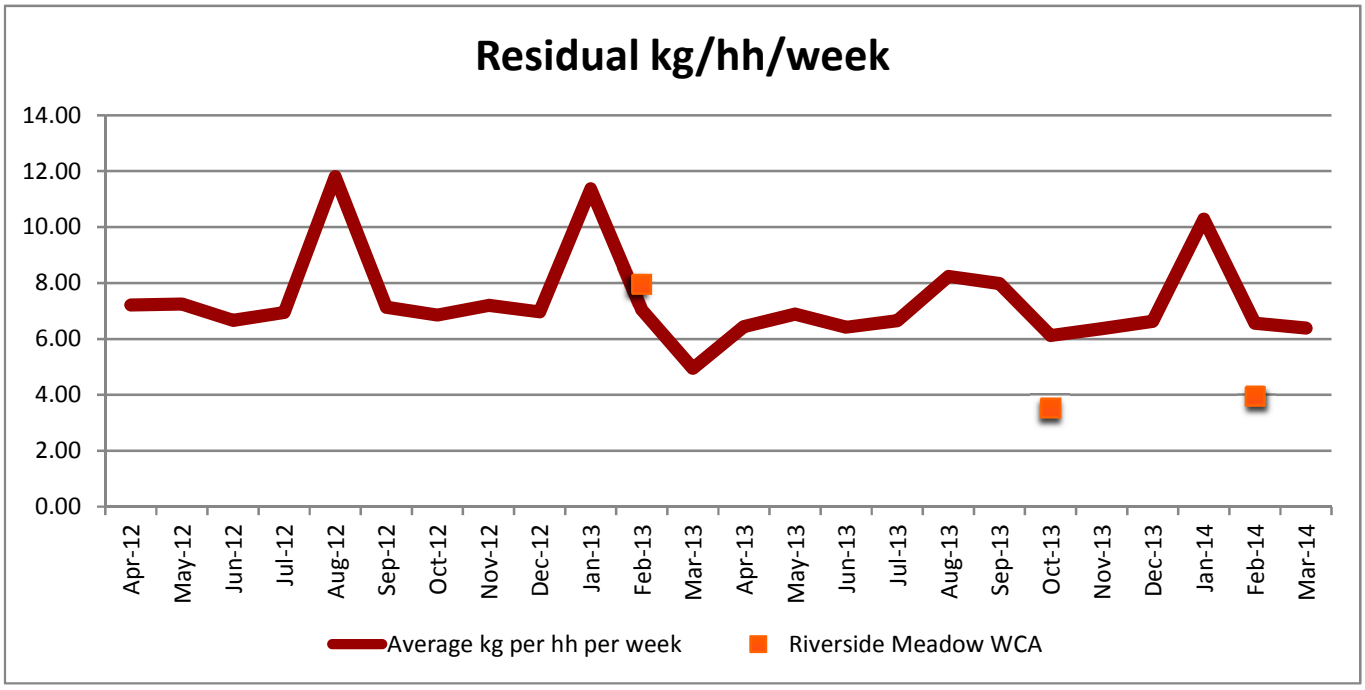
Waste composition analysis was undertaken to determine both the volume of residual waste produced on average by householders and also the amount of food waste that was found in the residual waste. Three WCA were undertaken at the Riverside Meadow site. A baseline survey on 14 February 2013 looked at households on the Abbey Foregate round and took place before any of the properties at either Riverside Meadow, or Abbey Wharf, were occupied. There are concerns about the validity of this data[9] however it has

[9] The number of households in the sample was calculated based on the percentage of waste that was taken from the total load under the assumption that the total load had collected from 1200 householders. However the total load weight is not consistent with other days on the Abbey Foregate round and the times on the weighbridge tickets suggest that the vehicle did not collect a normal Abbey Foregate round. Therefore the percentages within the residual weight can be used, but it is believed there is an error in the number of households figure.

been used in the Chart below, alongside the kg per household per month data from the Abbey Foregate round in total.

A second WCA took place on 10 October 2013 looking at the residual waste of properties with FWD in Riverside Meadow. This and the third WCA from February 2014 are included as points on the chart below.

Chart 6: Residual waste kg/hh/week collected from Abbey Foregate and compared to waste composition analyses at the FWD pilot site Riverside Meadow



The chart shows that while there were fluctuations in the amount of residual waste collected per household each month on Abbey Foregate, the amount of residual waste was noticeably less at Riverside Meadow where properties had been fitted with FWD. The first point on the chart is the baseline WCA where the kg/hh/week figure can be seen to be higher than the average that month. The second and third points on the chart are the volumes of residual waste in Riverside Meadow in properties fitted with FWD. These are considerably lower than the monthly averages.

This is also demonstrated in Table 9 below, where the difference between the pilot sites and the Abbey Foregate round is an average of 2.95kg of residual waste per household per week. This equates to a reduction in residual waste of 153.31kg per household per year.

The question is whether this fall in residual waste is consistent with the removal of food waste from the residual waste. WRAP's most recent survey[10] shows a sharp drop in the amount of food waste produced by households between 2007 and 2012. However their study shows that 174.7kg of food waste is still disposed of through local authority collections by households each year. This means each householder throws out 3.36kg of food waste each week. It is therefore conceivable that the reduction in residual waste is a result of the removal of food from the residual waste stream.

A baseline WCA was undertaken in February 2013. While there is uncertainty about the validity of the data in respect of household figures, we can look at the percentages of food waste that were in the residual waste stream from the Abbey Foregate round. The table below shows that just under a quarter of the waste was food waste. It also shows that less than 0.2 per cent of the food waste in the sample was not suitable for disposing of via an FWD.

Table 6: Food waste data from waste composition analysis, February 2013

Category	Total kg in sample	Per cent
Food waste suitable for disposer	285.8	20.16%
Food waste not suitable for disposer	2.2	0.16%
Food waste in packaging suitable for disposer	45.8	3.23%
Food waste in packaging not suitable for disposer	0	0%
Other	1084	76.46%
Total Waste	1417.8	100%
Total Food Waste	333.8	23.54%

The following observations were made during the baseline WCA:

- much of the food waste was compostable, for example iceberg lettuces, bags of salad, whole leeks, potatoes and fruit as well as peelings
- packaged food such as whole chickens, bags of sausages, packets of ham were found in the waste, these could potentially be opened, cut up and put through FWD
- the proportion of food waste may have been underestimated, since the presence of food waste in the waste stream adds moisture to the dry materials.

[10] WRAP Household Food Waste Survey 2012, Table 12. http://www.wrap.org.uk/content/household-food-and-drink-waste-uk-2012

4.3.2 Waste composition analysis at Riverside Meadow and Abbey Wharf

Two further WCA took place, in October 2013 and February 2014. The WCA in February 2014 took place at both pilot sites: Riverside Meadow and Abbey Wharf. These all showed a small amount of food waste present in the residual waste, considerably lower than the WRAP average household figure of 3.36kg per household per week.

Table 7: Waste composition analysis data for residual and food waste

Month	Abbey Foregate round data (control)	Riverside Meadow WCA (pilot 1)	Abbey Wharf WCA (pilot 2)	Abbey Foregate round data (control)	Riverside Meadow WCA (pilot 1)	Abbey Wharf WCA (pilot 2)	WRAP household data
	Waste kg/hh/week	Waste kg/hh/week	Waste kg/hh/week	Food in waste kg/hh/week	Food in waste kg/hh/week	Food in waste kg/hh/week	Food in waste kg/hh/week
2012	-	-	-	-	-	-	3.36
Oct-12	6.85	-	-	-	-	-	-
Feb-13	7.05	-	-	-	-	-	-
Oct-13	6.13	3.52	-	-	0.653	-	-
Feb-14	6.57	3.94	2.96	-	0.778	0.594	-

Taking into account the fact that volumes of residual waste in Abbey Foregate are lower than the county average, the fall in residual waste at the two sites fitted with FWD is consistent with a removal of the majority of the food waste from the residual waste stream.

Observations noted at Riverside Meadow during the second WCA are also of interest. The contractor stated that:

“The most striking observation in the audit was the small amount of food waste in most bags that were opened, with just a few bags having a significant impact on the results. 4 bags were heavily contaminated with food waste and we would estimate that these accounted for 50 per cent of the food waste.”

The table below shows this information. It is important to note that it is just an observation and that no comments were made during the baseline or subsequent WCAs about the number of bags that had food waste present. It is included for information only.

Table 8: Residual waste bags containing food

	Number of bags	Per cent
Heavily contaminated with food	4	4.9%
Lightly contaminated with food	43	53.1%
Bags with no food waste	34	42.0%
Total residual waste bags	81	100%

In summary, looking at the data from both sites, the table below shows the average reduction in residual waste achieved by households fitted with FWD.

Table 9: Comparing volumes of residual waste in Abbey Foregate (control), Riverside Meadow (pilot 1) and Abbey Wharf (Pilot 2)

	Abbey Foregate round data (control)	Waste composition analysis data from Riverside Meadows	Waste composition analysis data from Abbey Wharf	Difference between control and pilot (total reduction)	Difference between control and pilot (total reduction)
Month	**kg/hh/week**	**kg/hh/week**	**kg/hh/week**	**kg/hh/week**	**per cent**
Oct-12	6.85	-			
Feb-13	7.05	-			
Oct-13	6.13	3.52		2.60	42.50%
Feb-14	6.57	3.94		2.63	40.09%
Feb-14	6.57		2.96	3.61	54.90%
Average residual waste	**6.63**			**2.95**	
Total annual average residual reduction				**153.31**	
Average percentage reduction in residual					**44.45%**

Assuming that FWD were fitted to 50 per cent of the 134,997 households in Shropshire, and this level of impact were sustained, this could lead to a reduction in residual waste of 10,348 tonnes a year across the county.

4.4 Module C: householder behaviour

Riverside Meadow has an on-site sales office that has been open seven days a week. The sales team at Riverside Meadow has an FWD fitted to the show flat and is consistent in telling purchasers that their homes are fitted with FWD and the basics of how to use them.

Abbey Wharf does not have an on-site sales office that is open seven days a week; rather it has sales staff that is there intermittently. The show home was fitted with an FWD but the sales team was less consistent in advising purchasers about the FWD and how to use them.

Householders were not obviously encouraged to use the FWD. The information about how to use an FWD and the types of food that could be disposed of, were included in the welcome packs for both sites. These packs contain all the brochures for all white goods, other warranties and general information from the developer. Consequently they can be large and contain a large amount of information. No extra effort was made to highlight the FWD or project information that was included.

4.4.1 General attitudes to FWD and FWD use

An external company was contracted to design and conduct attitudinal surveys. Surveys were sent out in August 2013 to the residents of Riverside Meadow. An Open Day was organized on Monday 2 September 2013 where the contractor interviewed householders and collected additional surveys. This was accompanied by a demonstration from Insinkerator in the show home and wine and cheese. At the time of the event, 32 properties were occupied and 21 completed surveys were received. The table below shows the results of the survey with respect to householder attitudes to FWD.

Table 10: Results of attitudinal survey at Riverside Meadow

	Agree strong-ly	Agree slightly	No opin-ion	Disagree slightly	Disagree strongly	Total respon-ses
I find the FWD easy and convenient to use	14	2	1	0	1	18
Using the FWD means I don't have to put so much in the bin	8	0	0	1	1	10

Using the FWD means my bin doesn't smell	13	2	1	1	1	18
Using the FWD means I worry about how much water it uses	1	9	5	0	3	18
Putting food down the FWD means I have to clean the sink more often	1	6	2	6	3	18
Using the FWD makes my drains smell	1	1	4	4	8	18
When I use the FWD I worry that the sink will block	2	5	2	3	6	18

- In total 66 per cent of households surveyed completed the questionnaires, of which 81 per cent, or 17 out of the 21 households use the FWD.
- 89 per cent of respondents said that they found the FWD easy and convenient to use.
- 83 per cent of respondents agreed that using the FWD meant that their bin did not smell.
- The greatest concern with FWD was its water usage, with 56 per cent of respondents agreeing that they worried how much water they use.
- There was little concern about FWD causing the drain to smell, with 11 per cent of respondents believing this to be an issue.
- 39 per cent of respondents agreed with both the statements that using FWD means having to clean the sink more often and that it might cause the sink to block. In both cases, half the respondents did not believe this to be an issue, with more feeling strongly that the sink would not block as a result of FWD use.

The respondents that do not use their FWD gave the following reasons:

- "Unsure about them so not using it."
- "Wasn't sure it was working."
- "It wasn't working initially and I wasn't satisfied with use when working."
- "Used waste disposers 30 years ago – various sorts and had them all take out because of blockages and smells."

Abbey Wharf residents were surveyed in late January and early February 2014. The development was behind schedule and only 18 of the 22 properties were occupied. Surveys were hand-delivered and collected in order to increase the response rate and 7 completed surveys were received. The table below shows the results of the survey with respect to householder attitudes to FWD.

Table 11: Results of attitudinal survey at Abbey Wharf

	Agree strong-ly	Agree slightly	No opin-ion	Disagree slightly	Disagree strongly	Total respon-ses
I find the FWD easy and convenient to use	2	1	0	1	0	4
Using the FWD means I don't have to put so much in the bin	1	2	0	1	0	4
Using the FWD means my bin doesn't smell	0	3	0	0	1	4
Using the FWD means I worry about how much water it uses	0	1	0	3	0	4
Putting food down the FWD means I have to clean the sink more often	0	1	0	3	0	4
Using the FWD makes my drains smell	0	0	0	3	1	4
When I use the FWD I worry that the sink will block	1	0	0	2	1	4

- Most of the respondents (75 per cent) agreed with the first three statements that offered positive comments about FWD and their use. Only one respondent strongly disagreed with the statement that using an FWD meant the bin does not smell.
- There was less concern at Abbey Wharf about the water usage of FWD, with 1 respondent (25 per cent of the sample) slightly agreeing with the comment.
- There were no respondents who thought that using the FWD made the drain smell.

The respondents that do not use their FWD gave the following reasons:

- Did not know how to use it.
- Rarely ate at home, so did not feel the need to use it.
- Did not know what it was there for.

Additional comments about the FWD were:

- "Takes up space in the cupboard."
- "Is a bit loud, but works fine."

- “Is a good idea, but doesn’t seem to work properly.”
- “Not sure if it’s working properly as blocks up all the time and doesn’t seem to pull the food through properly.”

In terms of usage, all the Riverside Meadow residents who used their FWD used it at the end of every meal or food preparation period. Nobody saved food waste to dispose of at the end of the day. The same applied to the Abbey Wharf residents, however they used the FWD on a more occasional basis. All residents reported using the FWD for vegetable peelings and small food scraps. In Riverside Meadow, there were comments from residents who did not use the FWD for citrus fruit, bones or meat. There were no comments from the Abbey Wharf residents about food wastes they did not dispose of through the FWD.

4.4.2 Awareness of FWD process

Residents at both sites were asked if they knew what happened to the food waste when it was disposed of by FWD. None of the residents at Abbey Wharf knew that food waste is processed with sewage using anaerobic digestion that produces green energy.

It was found that 86 per cent of residents at both sites said they would use the FWD more if they knew that the waste might be converted into compost or electricity.

4.4.3 Confidence in FWD use

- Almost a third of the residents at Riverside Meadow that completed surveys said that they had not received an instruction pack about the FWD. Of those who read the pack and replied (14 people), 64 per cent said the information was OK with only 14 per cent saying it was clear and easy to follow. Through having discussions with residents at the open day, it became clear that many people were not confident in using the FWD fitted in their sinks.
- Only one of the seven residents at Abbey Wharf that completed the survey was aware of receiving an information pack and thought that the information was ok. Two residents were confident they did not receive a pack with the remainder not being sure. Again the residents were not confident in using the FWD and the food types they could dispose of with it unless they had seen a demonstration, used one before, or found the information provided clear and easy to follow. These people were in the minority.

4.4.4 Feedback from other organisations

Calls have been monitored at the Insinkerator customer service centre and there have been no queries or calls made concerning problems with FWD at either site.

Calls and incoming enquiries have been monitored at the local Environmental Health office and there have been no problems regarding FWD at either site.

Calls and incoming enquiries have been monitored at the local Environment Agency office and there have been no problems regarding FWD at either site.

There have been some issues flagged up by the developers themselves. As construction is still on going at the sites it appears current residents are taking any queries to the sales office or back to the developers directly.

At Riverside Meadow:

- one FWD has been replaced due to a suspected fault
- two FWD have broken and been either removed or replaced
- two have been removed from the properties at the request of the residents.

At Abbey Wharf:

- Five FWD have broken in five different properties. Of these, two were taken out altogether and three were replaced. One of the replacements also broke and was taken out.
- At least two of the breakages were a result of the residents not running water while disposing of items such as pasta in the FWD. This caused the motor to burn out in the FWD.

4.5 Module D: conveyance of food waste in the sewer

4.5.1 CCTV results

The CCTV results from Riverside Meadow have shown no evidence of blockages as a result of food waste at the site. However there is evidence that debris from the construction site is entering the sewers.

If we look at some specific sewer sections in Chart 7 we can see that beginning in August the debris begins to accumulate enough to stop the cameras recording any further down the sewer. This means that at this point there is approximately over 40 per cent cross sectional area loss.

Information received from the ground crews suggests that where identifiable the debris is made up of material from the on-going construction at the Riverside Meadow site. It should also be noted that the sewers on the site would need to be jetted fully once the development is completed before the sewers are handed over to the sewerage company operating in the area.

At the Abbey Wharf site a CCTV survey was carried out in June and the results showed no blockages in the sewers leading up to the development.

4.5.2 Flow rates

Two flow monitors were installed on the Riverside Meadow site covering two inflow pipes that were accessed via a manhole at the entrance to the development. One of these came directly from the Riverside Meadow and the second came from a separate development. The flow monitors were at the furthest end of the development's sewer network and the aim was to gauge the level of flow and therefore the best times for sampling.

The two Charts below show the flow rate from the development over a three-week period, and the flow rate for two days, Tuesday 4 June and Wednesday 5 June 2013 specifically.

Chart 7: Sewer flow rate over a 3-week period

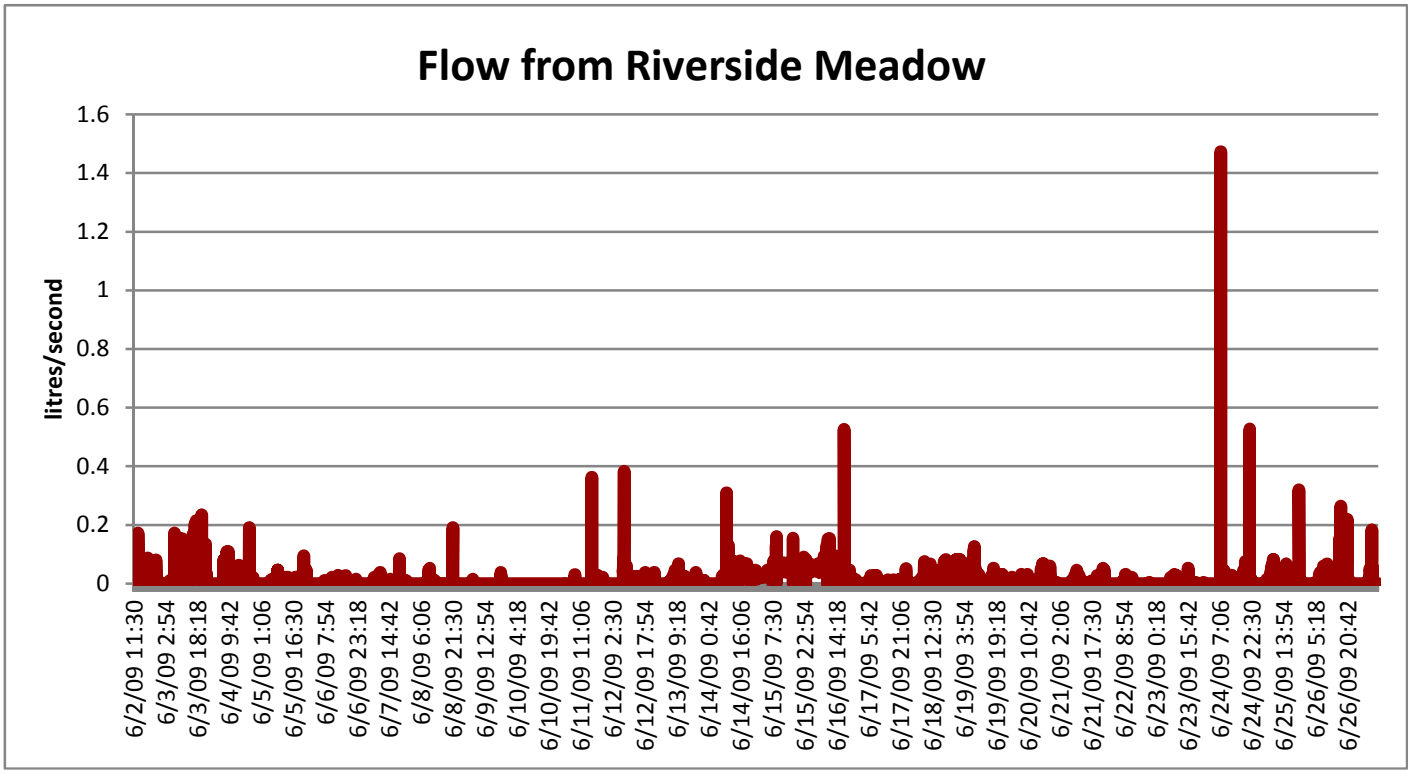
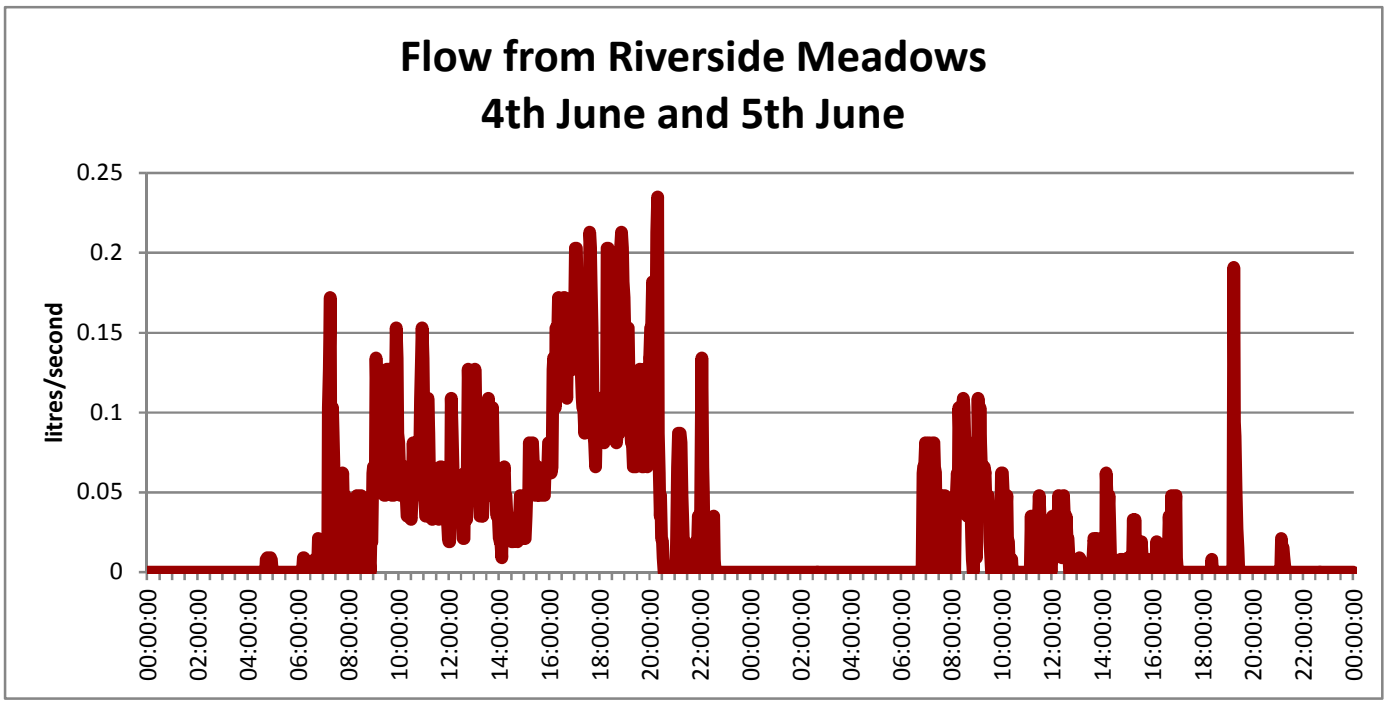


Chart 8: Sewer flow rate over a 2-Day period, summer 2013



The flow monitors showed average flows were low which impacted negatively on the ability to take sewer samples. This meant manual spot samples were taken for most of the monitoring period. The peak flow times were in the morning and at the end of the day when residents return home from school and work, as expected.

4.5.3 Sewer sampling: spot sample results

Spot wastewater samples were taken every month starting from April 2013 until March 2014 at the Riverside Meadow pilot site. This means that a single sample was taken on one day in the month. The samples tended to be taken on a weekday and generally in the morning, although two of the samples were taken late at night. These water samples were then analysed for the parameters described in the methodology section, ie those that have an effect on wastewater treatment. An example of the sewer sampling results can be found in Appendix 2.

The table below details all the results for each month from April 2013 until March 2014. Most samples were taken during the morning high-flow period. As the table shows, there was a wide range of values for all the different samples. The outlying values may be a true record, but they may also result from an error in the sample. The problem with low flow rates and having a spot sample is that it can be disproportionately

affected by a single incident, such as a washing machine discharging, for example. July 2013 is a good example of this, recording the highest values for all samples except NVM and phosphorus, suggesting that the samples were taken at the same time as an unusual discharge.

Table 12: Results of wastewater sampling April 2013-March 2014

	Apr 2013	May 2013	Jun 2013	Jul 2013	Aug 2013	Sep 2013	Oct 2013	Nov* 2013	Dec 2013	Jan 2014	Feb 2014	Mar 2014
Time sample was taken	Unknown	0930	0845	0840	0850	1145	1000	0935	1000	0845	2300	2300
Nitrogen, Total as N (mg/l)	34.8	63.9	27.5	126	84.3	38.2	25.6	39.8	22.4	70.5	29	74.8
Phosphorus, Total as P (mg/l)	5.2	7.4	7.5	18	13	5	4.9	5.7	30	8	4	9.5
Total Suspended Solids (mg/l)	560	400	358	1210	734	108	342	208	308	210	104	183
Suspended Solids (1 hour settle) (mg/l)	144	80	78	204	120	54	36	38	68	48	36	78
Settled Solids (After 30 mins) (mg/l)	172	98	110	268	202	52	62	42	96	54	59	94
BOD + ATU (5 Day) (mg/l)	183	164	397	583	490	87	86	199	359	269	90	244
COD (Total) (mg/l)	743	388	655	1300	1160	309	269	643	783	326	209	587
NVM (mg/l)	6	0**	11	9	14	11	9	7	0**	0**	0**	27.7

*** November results were taken in early December due to the way the weeks fell in 2013.**

**** Less than 4 is indicated as 0.**

Table 13: Benchmark values for wastewater sampling (Burks and Minnis, 1994)

Constituent	Unit	Range (Burks and Minnis)[11]	Typical (Burks and Minnis)	Range (UN)[12]	Medium (UN)
Total Nitrogen	mg/l	15-90	40	20-85	40
Total Phosphorous	mg/l	6-20	12	6-20	10
Total Suspended Solids	mg/l	100-400	220	100-350	200
Settable Solids	mg/l	50-200	100	-	-
BOD	mg/l	100-400	250	100-300	200
COD	mg/l	200-1,000	500	-	-
Grease/NVM	mg/l	50-150	100	50-150	100

In analysing the results of the wastewater sampling it is useful to know the typical range and values for the chosen parameters. The table below is taken from Burks and Minnis 'Onsite Wastewater Treatment Systems' and outlines the range and typical values for Total Settled Solids, Settable Solids, Suspended Solids, BOD, COD, Total Nitrogen, Total Phosphorus and Grease.

Using the benchmark table above it is possible to analyse the average of the results for each parameter over the pilot period and calculate how much they diverged from the typical values. However the problem with this approach is that outliers can skew the average when there is a small sample size, as there is in this case. The table below demonstrates this effect, using the Burks and Minnis typical values.

[11] Burks, B.D. and M.M. Minnis. 1994. Onsite Wastewater Treatment Systems. Madison, WI: Hogarth House, Ltd
[12] UN Department of Technical Cooperation for Development (1985)

Table 14: Divergence of parameters over the pilot period from typical values

Parameter	Unit	Pilot mean average value*	Typical value	Per cent above or below typical value
Total Nitrogen (N)	mg/l	53	40	33% above
Total Phosphorus (P)	mg/l	9.85	12	18% below
Total Suspended Solids	Mg/l	394	220	79% above
Settable Solids	mg/l	109	100	9% above
BOD	mg/l	263	250	5% above
COD	mg/l	614	500	23% above
Grease/NVM	mg/l	9.89	100	90% below

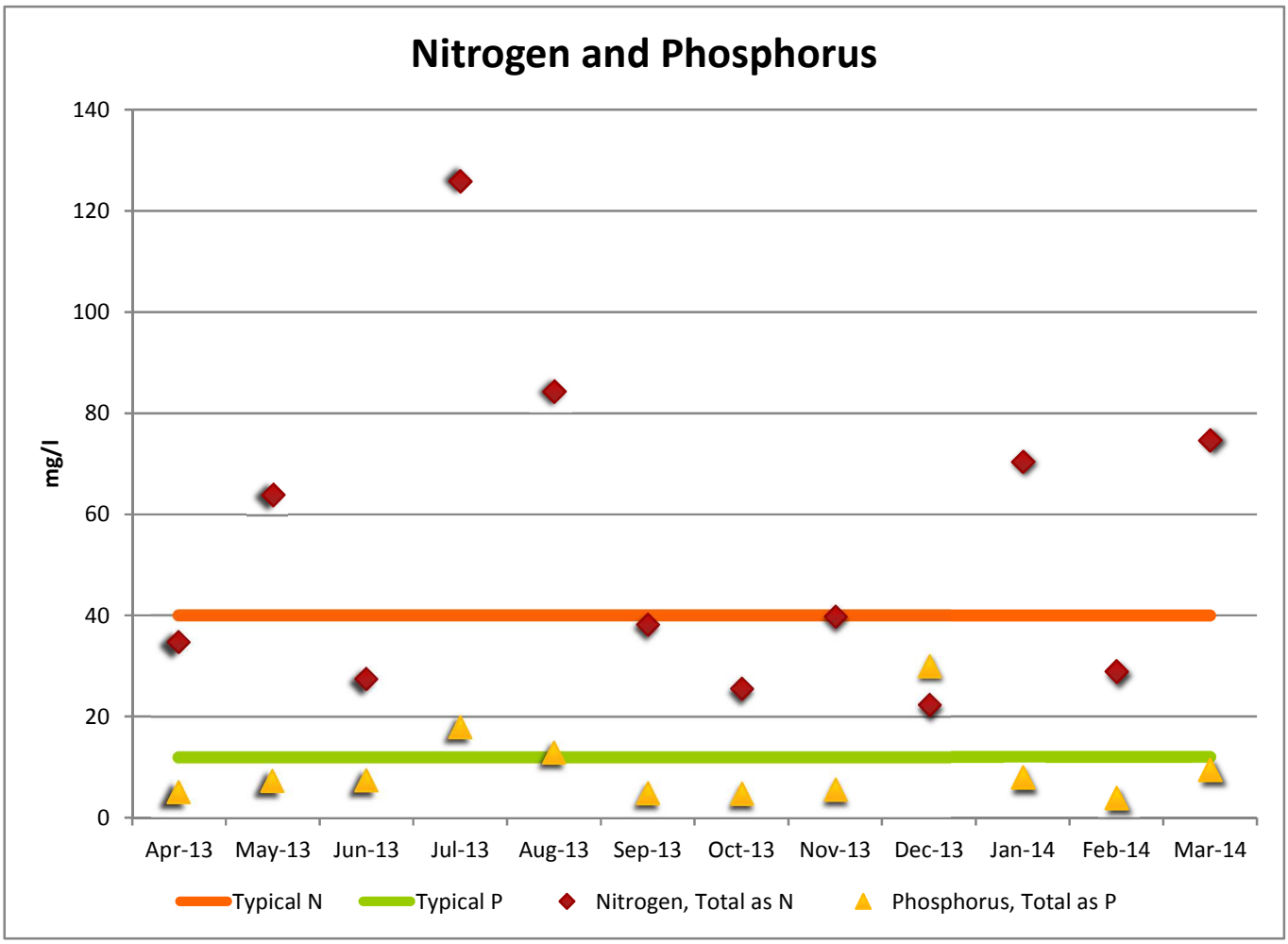
Over the entire pilot period from April 2013 until March 2014 with samples taken once a month.

Nitrogen and phosphorus

The table above shows average phosphorus levels during the monitoring period to be below the typical value. The diagram below shows this more clearly, with phosphorus sitting comfortably around the typical range, with only the December 2013 sample falling outside. Both the mean and the median averages are below the typical value.

Nitrogen levels fluctuate to a greater extent, but again stay within the typical range apart from the July 2013 sample. If the outlier in July 2013 is removed, the average level falls from 53 to 46, just 15 per cent above the typical value but well within the range. In this instance the median is a better reflection of the average than the mean because of the skewing effect of the outlier. The median average is 39, below the typical value.

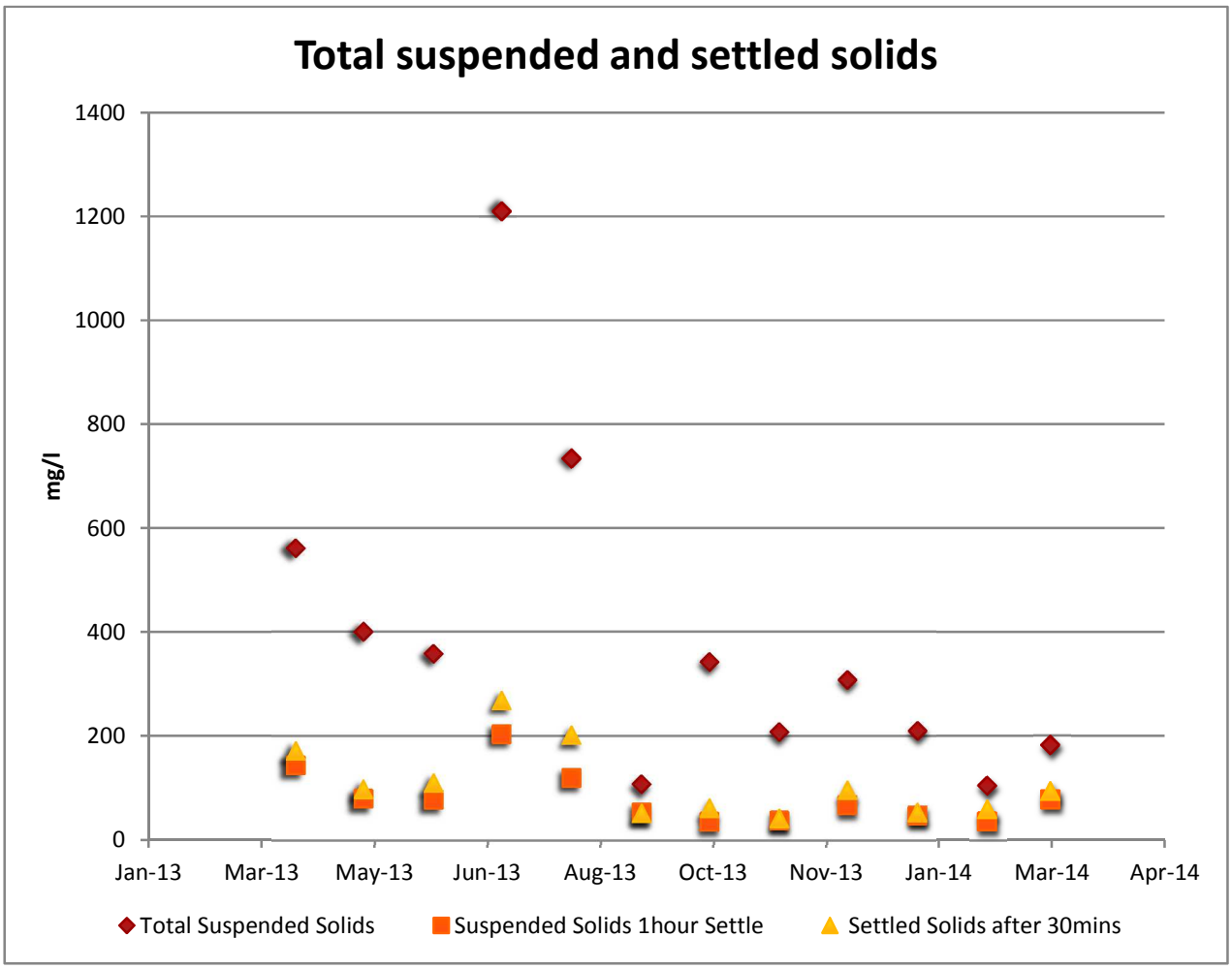
Chart 9: Nitrogen and phosphorus wastewater analysis



Suspended and settled solids

The literature review revealed that the general consensus is that suspended solids can be expected to increase with the use of FWDs. The level of suspended solids will affect the level of treatment the wastewater needs. The chart below shows the spot sample results for total suspended solids, solids after one hour and settled solids after thirty minutes.

Chart 10: Total, suspended, and settled solids wastewater analysis



Again, July 2013 is an outlier and brings the mean up to 394, 79 per cent above the typical value expected for suspended solids. If the median is considered, the average falls to 325, still above the typical expected value. The typical range for suspended solids is 100-400: the chart shows 3 of the 12 readings are outside this typical range.

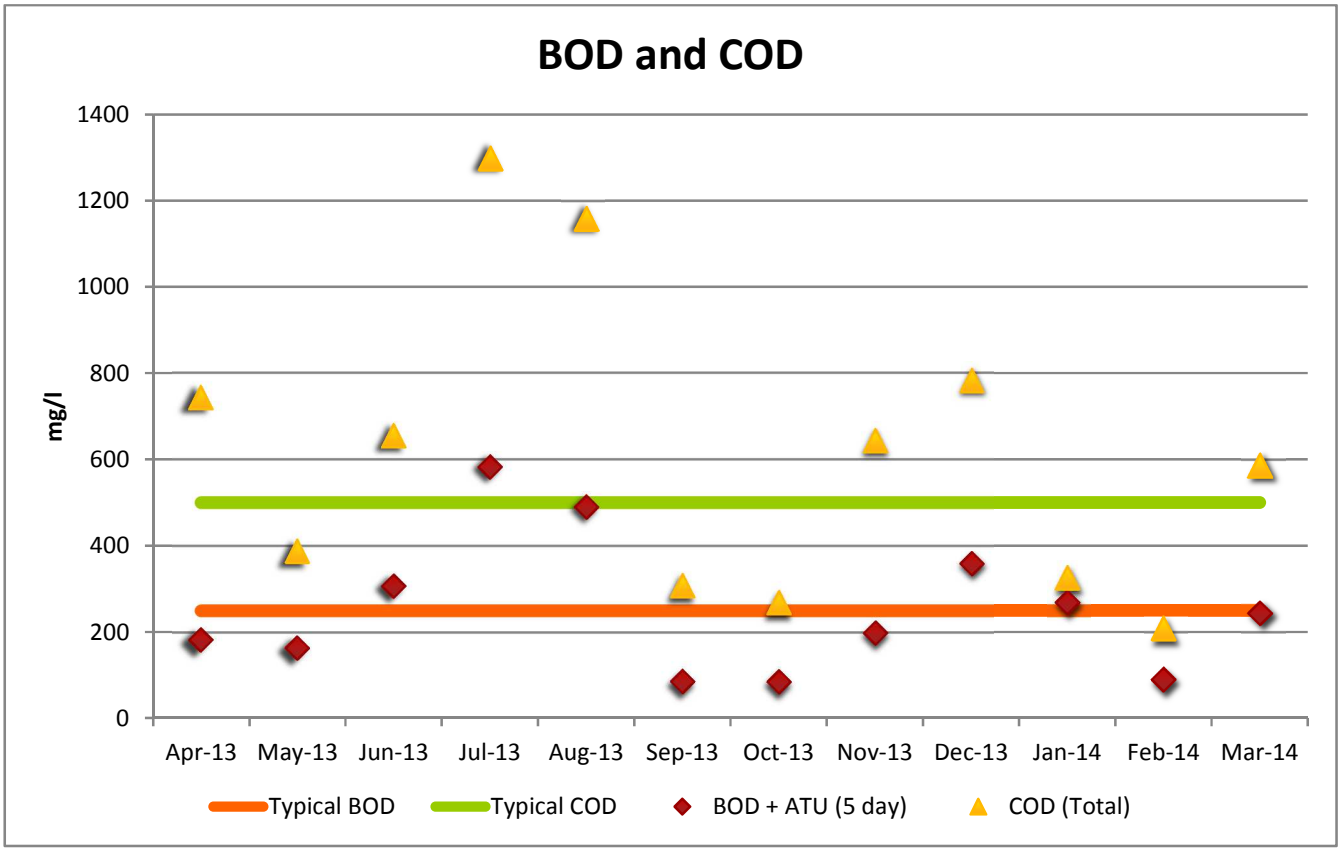
Both suspended solids after one hour and settled solids after thirty minutes follow similar patterns to each other and to the total suspended solids samples. As wastewater takes time to travel along the sewer network to the treatment plant, the suspended solids after one hour gives another indication of the level of treatment needed. The settled solids samples show the level of material that potentially is sitting in the sewer, although most of this will be flushed along by the continuous use of the sewer system. It is an indicator of the level of sludge treatment that will be needed at the treatment plant. Sludge is treated in AD, which could have a positive or negative cost to the operator, depending on the level of biogas yield and therefore energy generated. AD produces a final product, the digestate, and currently there is a cost for the

spreading of this to land in both dry and wet forms. Therefore the disposal of sludge is considered a cost to the treatment plant operator.

BOD and COD

The literature revealed that as for solids, both BOD and COD are expected to increase with the use of FWDs in wastewater. The chart below shows the sample results against the typical values.

Chart 11: BOD +ATU and COD wastewater analysis



Again the July 2013 BOD sample lifts the mean average, bringing it to 255, just 2 per cent above a typical value. When the median is considered instead, this drops to 221. They July sample is the only one that falls outside the typical range.

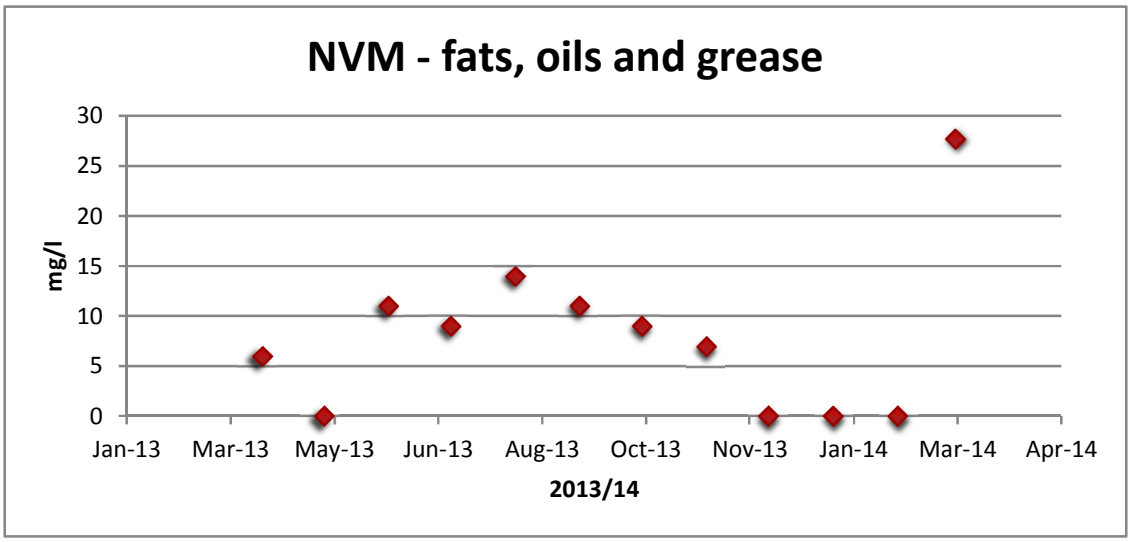
COD in July is also outside the typical range, as is the August sample result. The mean COD reading is 614 with the median being 615. Both these figures are higher than the typical value by 23 per cent.

NVM

NVM, is a measure of fats, oils and grease within the sewer. This is an area of concern for many, with the issue being that high levels of FOG may come into the sewer as a result of FWD use. The spot sampling during 2013/14 does not appear to have been representative of normal household use. There are, as the chart below shows, 4 months where the level was at zero. All samples were considerably below the expected typical value of 100, with the average being just 8.

It is not known whether the low flow rates contributed to the unusual sample results, or if spot samples are inadequate for this type of analysis. It is therefore suggested that consideration be given to the composite sample results, rather than the spot sample results illustrated below.

Chart 12: NVM wastewater analysis



4.5.4 Sewer sampling: composite sample results

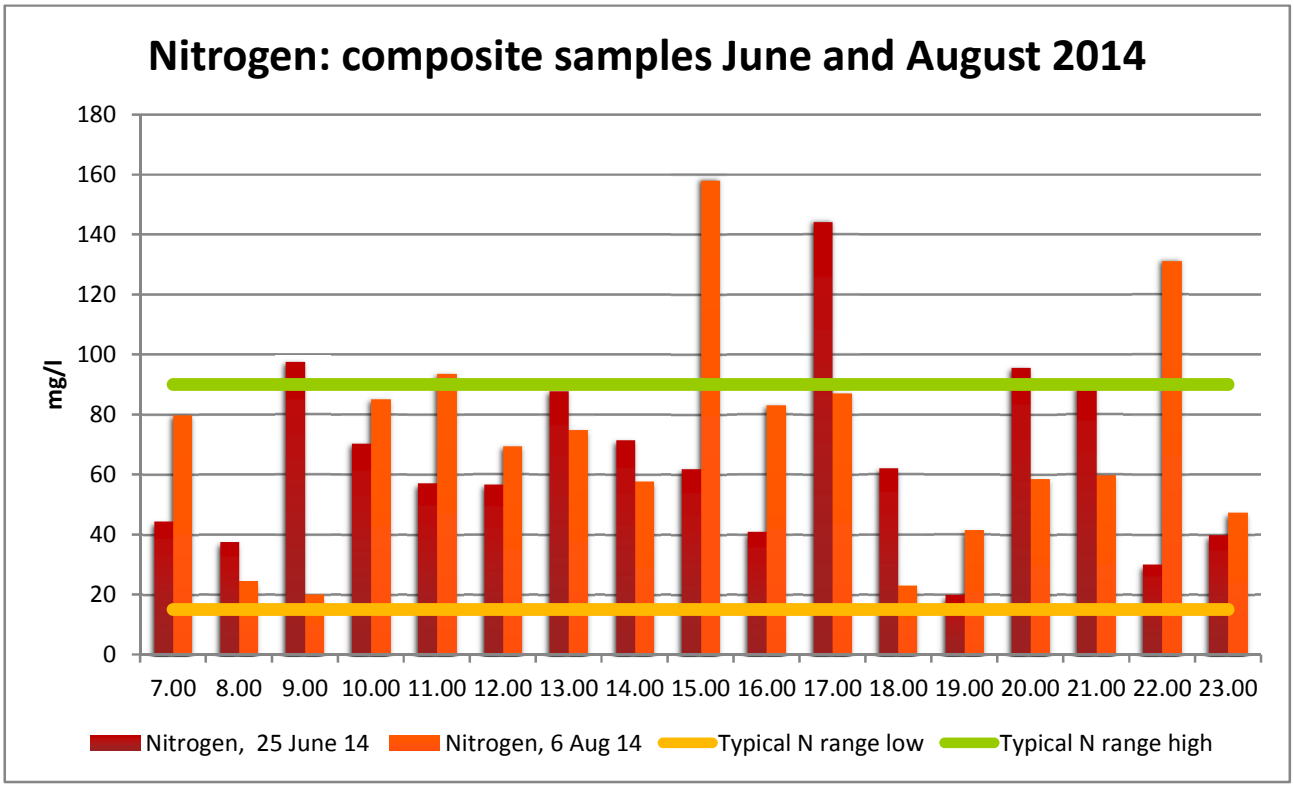
As the results above demonstrate, there can be considerable fluctuations in samples, especially when flow rates are low and can therefore be disproportionately impacted by a single event. For this reason, composite sampling took place in June and August 2014, with samples being taken every hour over a 17-hour period.

The same methodology was used for all samples except NWM. The sampling changed from using a petroleum substance to using infrared spectrometry.

Nitrogen

The chart below shows the nitrogen levels from 7am till 11pm at Riverside Meadow on two dates: 25 June 2014 and 6 August 2014. There are a small number of samples were the levels were outside the typical range. However both the mean and median averages fall well within the typical range.

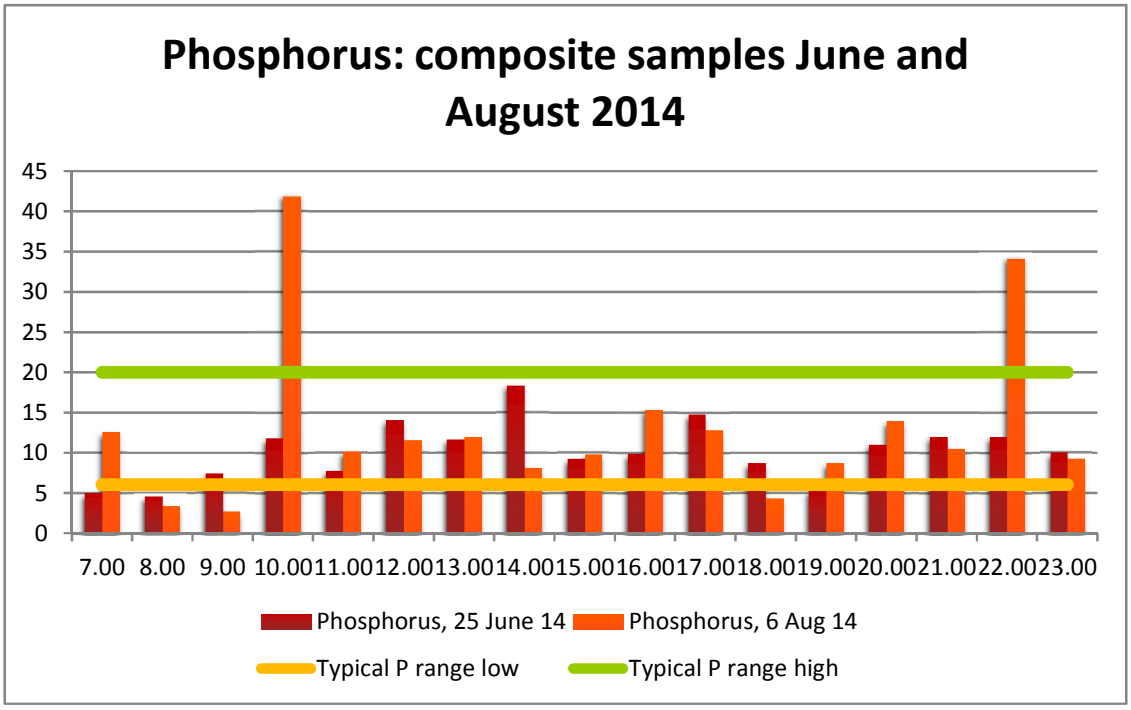
Chart 13: Nitrogen composite sample results



Phosphorus

As the chart below shows, phosphorus levels fell within the typical target range on both days, except for two instances. Mean and median averages are between 10 and 13 and are well within the typical range.

Chart 14: Phosphorus composite sample results

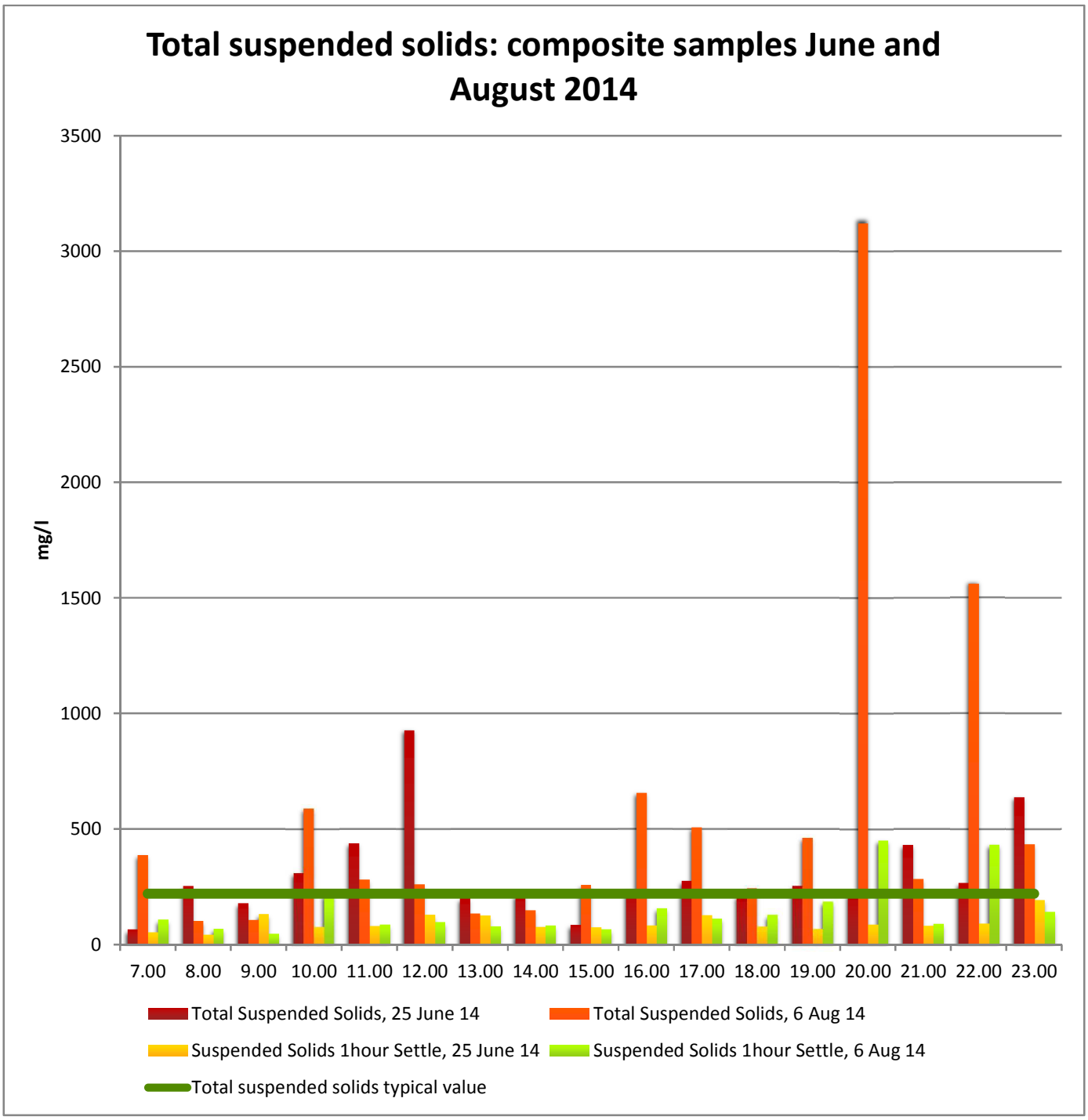


Suspended solids

The averages for total suspended solids are skewed by three samples: 12noon on June 25 and 8pm and 10pm on 6 August. Mean for 25 June is 307 and for 6 August is 561. The typical range is between 100 and 400, so 6 August falls outside these parameters. However if the median is considered, these are 252 and 282 respectively.

Although the development had a greater occupancy at this stage in the project, samples were still taken manually because of the low flow rates. As these results show, samples are clearly affected by what is most likely a single incident on the development, such as the use of a FWD.

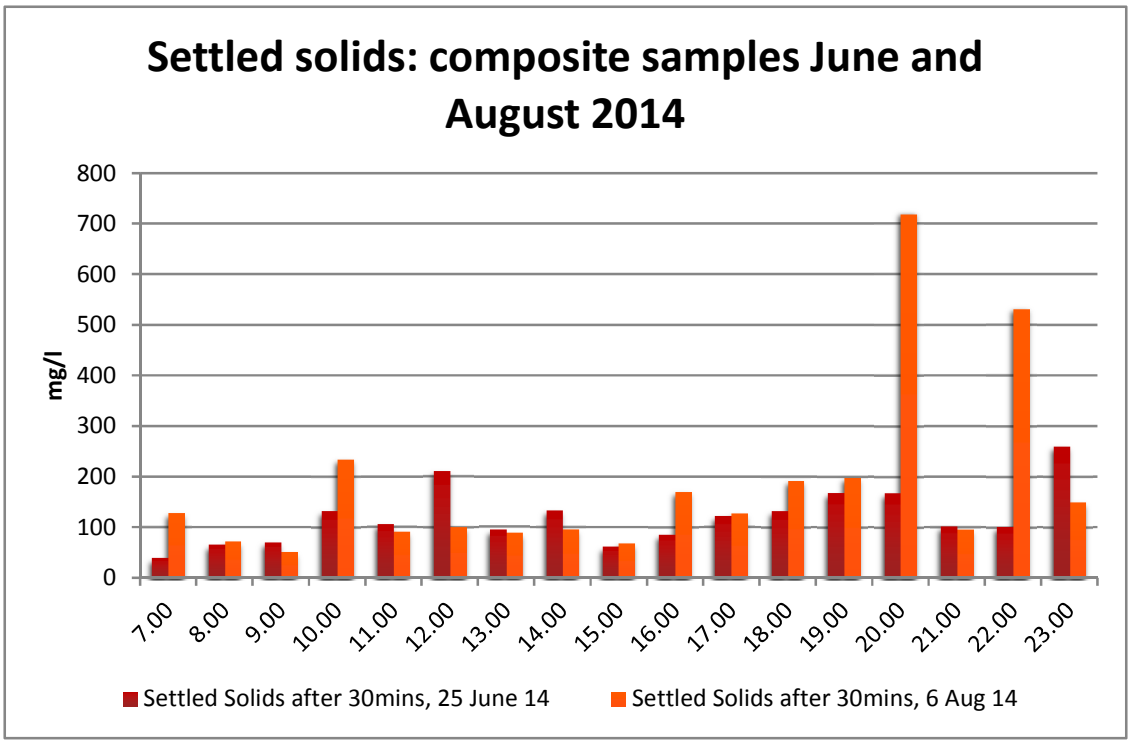
Chart 15: Suspended solids composite sample results



Settled solids

Settled solids can be seen in the chart below. Again, one or two samples will disproportionately raise the mean average. The sample results are largely within a range of expected values.

Chart 16: Settled solids composite sample results



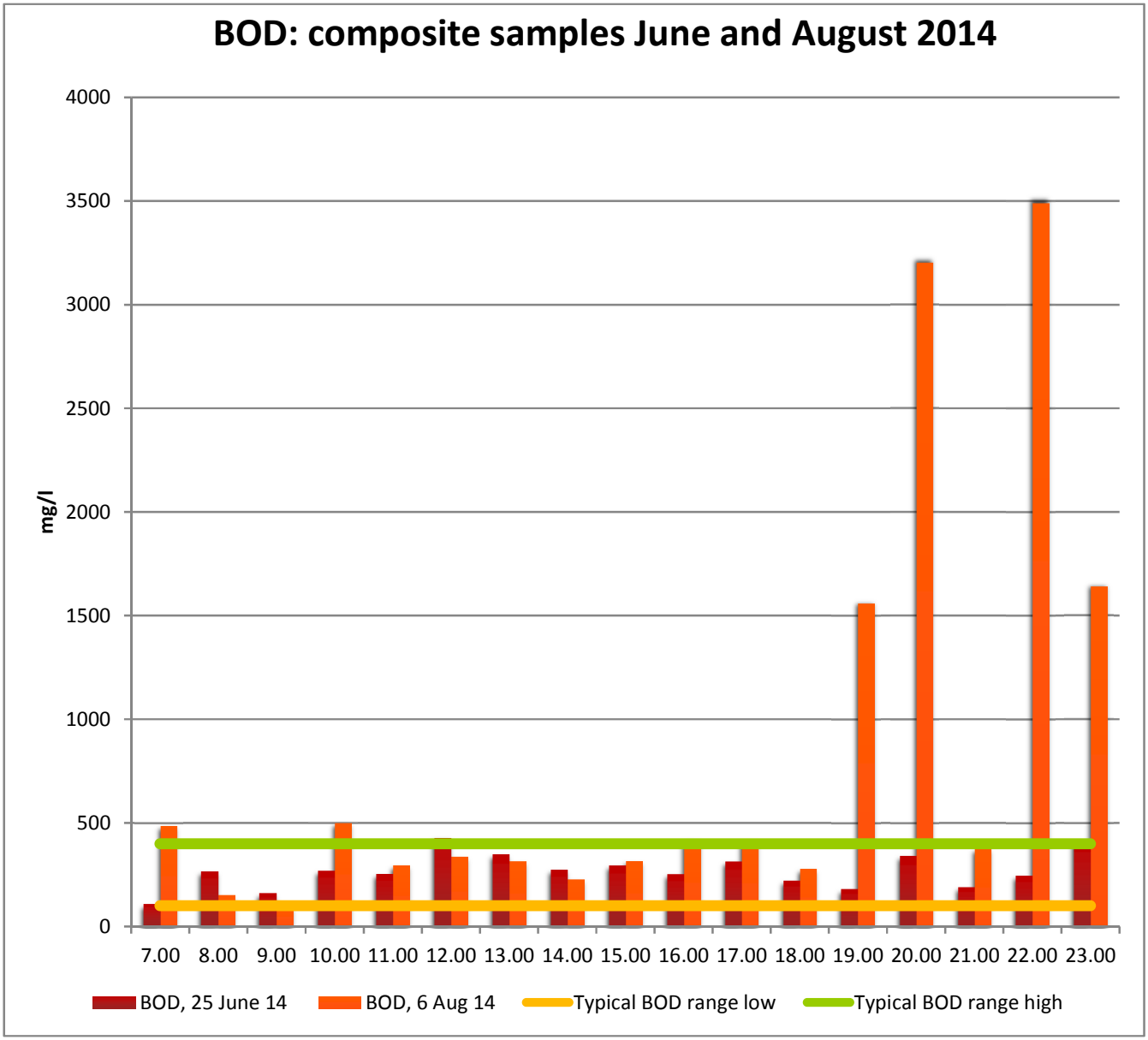
BOD

BOD levels on 25 June were within the normal range with a mean of 268 and a median of 265 against a typical value of 250. However the levels on 6 August fluctuate more widely. There were 8 out of the 17 samples that were above the upper typical range value of 250. This includes four samples over 1,000 and one at nearly 4,000.

There was an integrity breach between BOD and COD testing for samples taken on 6 August at 7pm, 10pm and 11pm. The laboratory states that the BOD result was confirmed by a raw data check and the COD confirmed by repeat analysis.

The chart below shows the results for BOD for 25 June and 6 August.

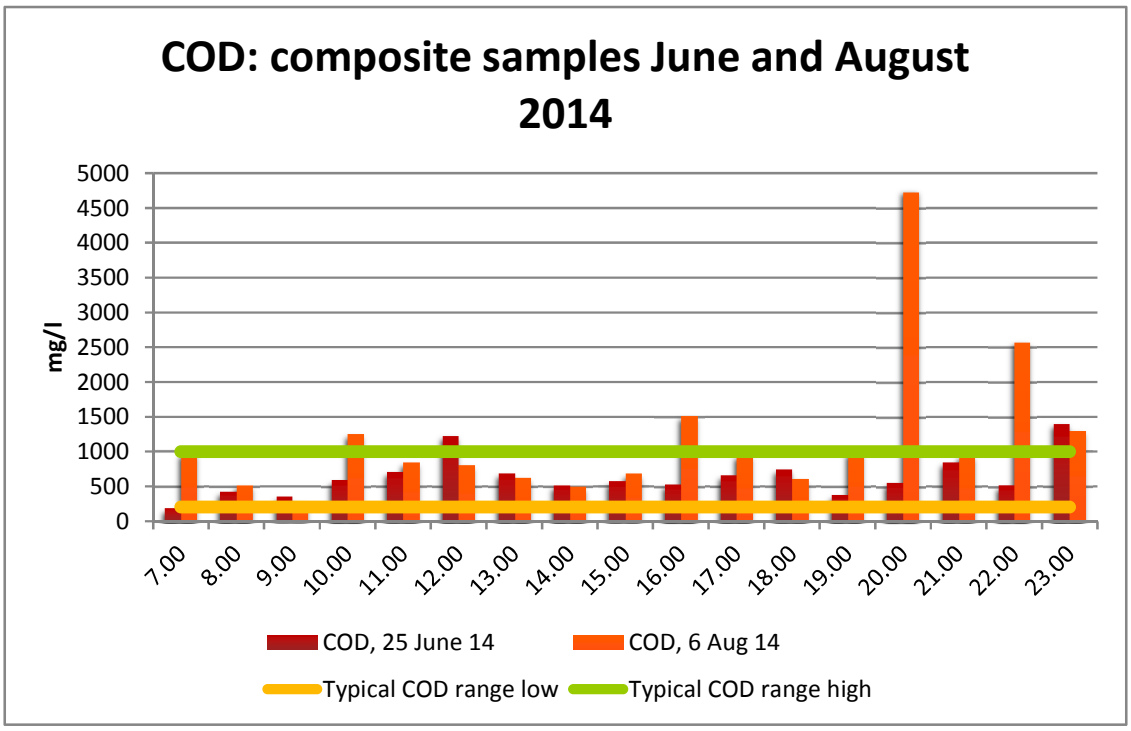
Chart 17: BOD composite sample results



COD

COD levels again fluctuate during the 17-hour monitoring period on both days, as can be seen in the chart below. The mean average was 643 and 1181 for 25 June and 6 August respectively, with the median being 572 and 939 for those days. Again, the impact of outlying data points can be seen in the difference between the mean and the median. The high points are again in the evening of 6 August.

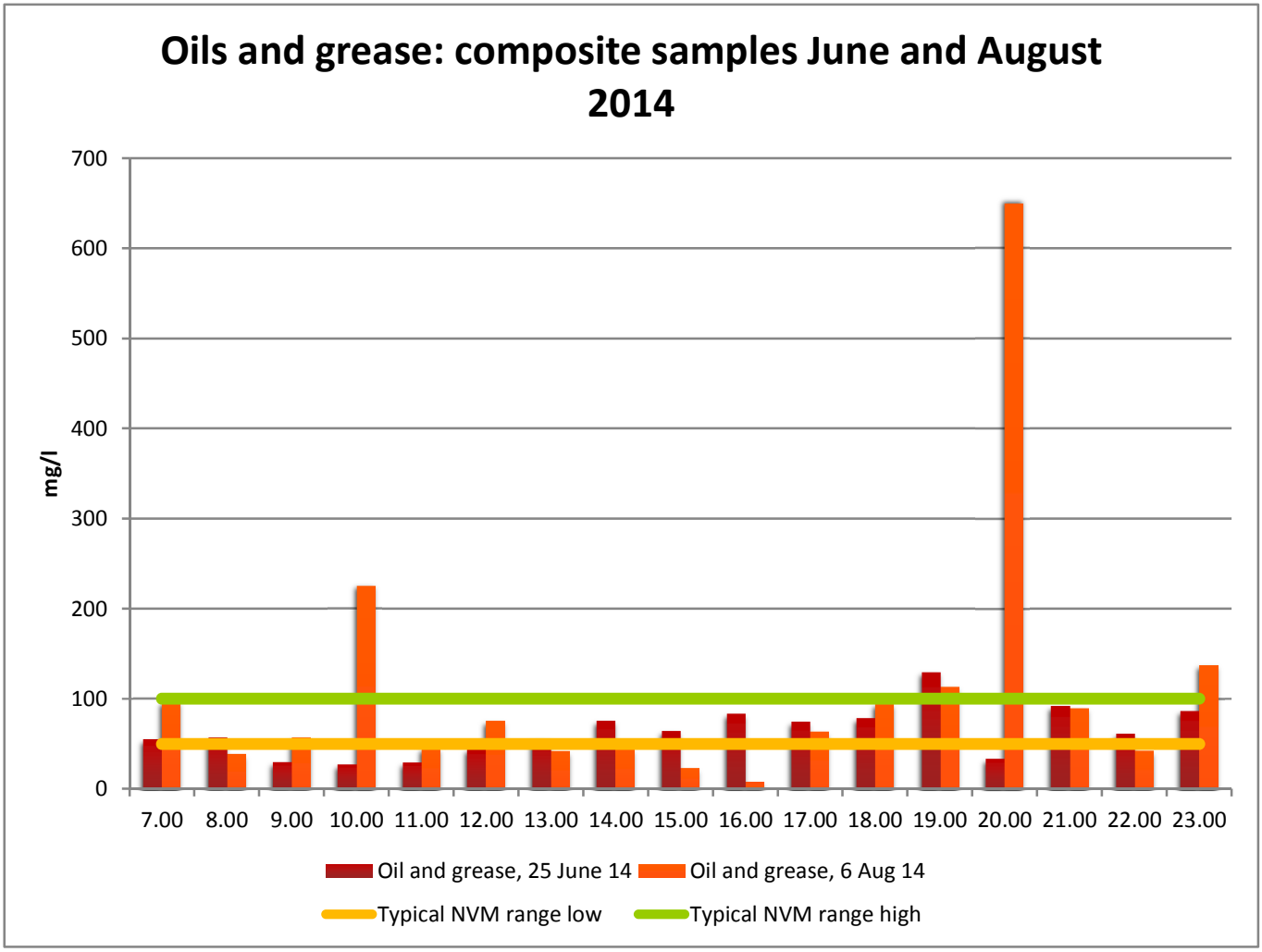
Chart 18: COD composite sample results



Oils and grease

The testing changed from the spot samples to the composite samples. The new testing methodology resulted in sample results that were within the expected range when compared with the very low results of the spot tests. Oils and grease averaged at 63 mg/l on June 25 and 108 mg/l on 6 August, with median averages of 61 and 63 for those two dates respectively. All these averages are within, or just outside the boundaries of the typical range of values. As the chart below indicates, there were just two spikes in samples, one of which was again in the evening and could have been the result of a FWD, or a householder using the sink to dispose of grease and oils from a meal, it is not possible to tell.

Chart 19: Oils and grease composite sample results



4.6 Pump information

The pump installed is an APS Foul Water Packaged Pump Station Series 400 Model H445 with a 45,500-litre capacity.

5.0 Cost-benefit analysis

The cost-benefit analysis focuses around the reduction in residual waste and the cost of providing and operating an FWD. It has not been possible to calculate the costs, if any, to the relevant water companies as a result of FWD due to the lack of active participation by the water companies in this pilot project.

5.1 FWD running costs

The FWD model fitted in the homes in Shrewsbury was an Evolution 100. This model ranges in price from £399.99 at Screwfix to £227.00 at B&Q[13]. Shropshire Council ran a procurement exercise and was able to purchase 150 FWD units, at a preferential trade price.

The total annual running costs per householder have been calculated based on a household with a water meter, and can be seen in the table below:

Table 15: Annual household FWD running costs

Item	Total cost per year
Electricity	£0.46
Water	£2.80
Sewage	£1.74
Total householder running costs	£5.00

5.2 Local authority cost savings

This intention of this project was to investigate whether FWD would reduce the volume of residual waste and bring about cost-savings to local authorities.

The evidence gained from the pilot studies in Shropshire suggests that a reduction in residual waste is possible. The average reduction during the pilot period was 153.31kg per household per year when comparing the pilot area against the most compatible waste round. This is Scenario 1. Assuming a disposal cost of £100 per tonne, this would equate to a saving of £15.33 per household per year. There are 135,000 households in Shropshire. The USA has a market penetration of 50 per cent for FWD disposer use, so assuming this became the same in Shropshire, then the total cost saving as a result of reduced residual waste would be £1,034,843 per year, based on these assumptions.

[13] Prices checked online 2 April 2015.

However both the control waste round and the pilot area have below average levels of residual waste for Shropshire. Therefore rather than look at kg per household, it is also possible to look at the percentage reduction in waste. This is Scenario 2. Average waste was 6.63kg per household per week for the control round during the pilot period. During the same period it was 2.95kg per household less in the pilot areas, which is a reduction of 44 per cent.

The average cost of disposal for Shropshire Council is £55.56 per household per year. Again assuming 50 per cent usage, the total saving in disposal costs per year would be £1,666,875 in this scenario.

The reduction in residual waste will have an impact on the how the waste is collected. Currently, the average waste collection vehicle will have a payload of approximately 8 tonnes. Based on the waste reduction expected in Scenario 1, this would mean 50 less tips each fortnight. While each bin would still need to be collected from each household, this could result in a time saving for certain rounds if it means they do not need to return to the depot to tip midway through a round. Although the tonnes saved are large, it is uncertain whether this would in practice mean any reduction in collection vehicles or crew. The response from Shropshire Council was that because each household would still require a collection, the time spent doing those collections means that that it is not likely to mean a vehicle or crew reduction in their case.

The impact of FWD if the usage across Shropshire Council was limited to 25 per cent has also been modelled. The results of this can be seen in Appendix 1 and the table in the summary section below.

5.3 Additional cost to water companies

There are two main areas of additional cost to the water companies. The first is in the processing of the sewage, particularly the treatment for the sewage sludge. Based on the sewer sampling undertaken as part of this project, there may be an increase in the volume of suspended solids. These, and the settled solids, will be treated at the sludge treatment stage and may increase the energy requirements of the process, which is mainly anaerobic digestion.

As anaerobic digestion is an energy generating process, there may be an increase in energy production as a result of the inclusion of extra food waste. This is because food waste is high in methane, the gas used in energy production in AD.

The second additional cost is in the disposal of sewage sludge. The actual cost of disposal can be considered in two parts: transport and spreading to land. The cost of transport is variable depending on the location of the plant. The cost of spreading is believed to be low, between £0 and £2 per tonne. Ofwat's

report into competition in the sewage market referred to occasional cases where the sludge had a negative cost of £1 or £2 per tonne[14].

As a result of the lack of participation from Severn Trent at this stage of the project, it has not been possible to put reliable figures on the costs to the water company. However it could be assumed that the £1.74 charge per householder for sewage services as a result of the increased water usage from the FWD covers the cost of sewage treatment, transport and disposal. This may then be a fair cost that the water companies could levy back on the local authority.

The cost saving per household as a result of reduced residual waste is between £15.33 and £24.69 a household a year. Assuming the local authority had to pay £1.74 to the water company to cover the extra costs of processing, this would result in a net saving of between £13.59 and £22.95 per household a year.

5.4 Cost savings summary

The table below summarises the cost savings that can be made to Shropshire Council as a result of FWD use. The table collates information about both scenarios and FWD usage at 50 per cent and 25 per cent. Full information can be found in Appendix 1.

Table 16: Cost savings summary

Scenario	Total waste reduction per year (50 per cent usage)	Total waste reduction per year (25 per cent usage)	Disposal cost saving	Reduction in loads tipped per fortnight	Total cost savings to Shropshire after water company charge
Scenario 1 (50% usage)	10,348		£1,034,843	50	£917,679
Scenario 2 (50% usage)	16,669		£1,666,875	80	£1,549,711
Scenario 1 (25% usage)		5,174	£517,421	25	£458,839
Scenario 2 (25% usage)		8,334	£833,438	40	£774,856

[14] Ofwat *Competition in upstream sewage and sludge markets. Feb 2010.* p47-48.

6.0 Practical lessons learnt

- FWD cannot be fitted to all properties. In Riverside Meadow, those who upgraded to a granite work surface in their kitchens could not have FWD as the work surface was thicker and could not accommodate the equipment within the kitchen design.
- The FWD takes up space beneath the sink, which is an issue in smaller properties where space is at a premium. For this reason FWD could not be fitted to the apartments in the apartment block.
- Much more convenient to get the disposers out to the developments before the kitchens are fitted, though development timescales are not always accurate and it can be difficult to forward plan.
- Kitchen sinks can have plugholes of varying sizes: ensure that the plughole size matches that of the FWD.
- Planning the monitoring of FWD impacts is dependent on properties being occupied. This is difficult to timetable as in new build developments this depends on the sales rate, which cannot be predicted. This is not the case for housing association properties as these are occupied as soon as they are built.
- Responses to householders in the attitudinal surveys show that residents feel more confident about what they can put in the FWD and are therefore more likely to use them, when they have had clear guidance.

7.0 References

Burks, B.D. and M.M. Minnis. 1994: Onsite Wastewater Treatment Systems. Madison, WI: Hogarth House, Ltd.

Defra, 2012: Waste water treatment in the United Kingdom – 2012. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69592/pb13811-waste-water-2012.pdf

Insinkerator 2012: Evolution Specification. Available at https://www.insinkerator.co.uk/sites/default/files/product/Evolution per cent20100 per cent20Specification.pdf

WaterUk 2009: Waste Macerators – the impact on sewers. Available at http://www.water.org.uk/home/policy/positions/waste-macerators-position-paper/wateruk-macerator-statement-feb09-rev9.pdf

Ofwat, Feb 2010: Competition in upstream sewage and sludge markets. pp47-48.

8.0 Appendices

- Appendix 1: Cost-benefit analysis spreadsheet and waste composition analysis results
- Appendix 2: Sewer sampling results example
- Appendix 3: Attitudinal survey

Appendix 1: Cost-benefit analysis spreadsheet and waste composition analysis results

	Abbey Foregate round data (control)	Waste composition analysis data from Riverside Meadows	Waste composition analysis data from Abbey Wharf	Difference between control and pilot (total reduction)	Difference between control and pilot (total reduction)
Month	**kg/hh/week**	**kg/hh/week**	**kg/hh/week**	**kg/hh/week**	**%**
Oct-12	6.85	-			
Feb-13	7.05	-			
Oct-13	6.13	3.52		2.61	42.58%
Feb-14	6.57	3.94		2.63	40.03%
Feb-14	6.57		2.96	3.61	54.95%
Average residual waste	**6.63**			**2.95**	
Total annual average residual reduction				**153.40**	
Average percentage reduction in residual					**44.49%**

Report Summary

UKAS TESTING
1314
0897
4409

ALS Environmental

Mr Kevin Jenkins
Enviromontel Ltd
Henwick Mill
Martley Road
Worcestershire
WR2 6RG

Date of Issue: **08 November 2013**

Report Number: **COV/964822/2013** Issue **1**

Job Description: Waste Water Analysis

Job Location: FI303439

Number of Samples included in this report **1**

Job Received: **30 October 2013**

Number of Test Results included in this report **8**

Analysis Commenced: **30 October 2013**

Signed:

Name: **J. Fell** Date: **08 November 2013**

Title: **Chemistry Operations Manager**

ALS Environmental Ltd was not responsible for sampling unless otherwise stated. Sampling is not covered by our UKAS accreditation.

Information on the methods of analysis and performance characteristics are available on request.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. The results relate only to the items tested.
Tests marked 'Not UKAS Accredited' in this Report/Certificate are not included in the UKAS Accreditation Schedule for our laboratory.

Certificate of Analysis

UKAS TESTING
1314
0897
4409

ALS Environmental

Report Number: **COV/964822/2013** Issue **1**
Laboratory Number: **13764114** Sample **1** of **1**

Sample Source: **Enviromontel Ltd**
Sample Point Description:
Sample Description: **Sample 1**
Sample Matrix: **Not Specified**
Sample Date/Time: **30 October 2013** **10:00**
Sample Received: **30 October 2013**
Analysis Complete: **06 November 2013**

Test Description	Result	Units	Accreditation		Method
Nitrogen, Total as N	25.6	mg/l	Y	Cov	WAS022
Phosphorus , Total as P	4.9	mg/l	Y	Cov	WAS049
Total Suspended Solids	342	mg/l	Y	Cov	WAS006
Suspended Solids 1hour Settle	36.0	mg/l	N	Cov	WAS006
BOD + ATU (5 day)	86	mg/l	Y	Cov	WAS001
COD (Total)	269	mg/l	Y	Cov	WAS040
NVM, light petroleum extract	9	mg/l	Y	Cov	WAS026
Settled Solids after 30mins	62.0	mg/l	N	Cov	WAS006

Analyst Comments for 13764114: No Analyst Comment

Accreditation Codes: Y = UKAS / ISO17025 Accredited, N = Not UKAS / ISO17025 Accredited, M = MCERTS.
Analysed at: Cov = Coventry(CV4 9GU), Run = Runcorn(WA7 1SL), S = Subcontracted, Trb = Subcontracted to Trowbridge(BA14 0XD), Wak = Wakefield(WF5 9TG).
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. The LOD for the Legionella analysis will increase where the volume analysed is <1000g (1g is approximately equivalent to 1ml for sample volume analysed).
I/S=Insufficient sample For soil/sludge samples: AR=As received, DW=Dry weight.

Signed: JFell

Name: **J. Fell** Date: **08 November 2013**
Title: **Chemistry Operations Manager**

ALS Environmental Ltd
Torrington Avenue, Coventry, CV4 9GU
Tel:+44 (0)24 7642 1213 Fax:+44 (0)24 7685 6575

Dear Residents of Riverside Meadows

What do you think of your Food Waste Disposer?

Please could you take a few minutes to answer these questions and drop your completed questionnaire off at the on-site Sales Office by Friday 19th July. There is a small gift for all completed forms! If you would like to know more about the Food Waste Disposer research that we are conducting please do not hesitate to get in touch. Many thanks!

Alison Thomas, Alison@cwmharry.org.uk, 01686 626234, 07972 858313

---

1. Do you have a Food Waste Disposer (Food Waste Disposer) in your property? **Yes / No**
2. Do you use the Food Waste Disposer? **Yes / No** If No, please tell us why and skip to Question 4

3. What sort of thing do you put down the Food Waste Disposer?

4. What do you think about your Food Waste Disposer?

Please tick the box that most accurately describes your opinion.	**Agree strongly**	**Agree slightly**	**No opinion**	**Disagree slightly**	**Disagree strongly**
I find the Food Waste Disposer easy and convenient to use	☐	☐	☐	☐	☐
Using the Food Waste Disposer means I don't have to put so much in the bin	☐	☐	☐	☐	☐
Using the Food Waste Disposer means my bin doesn't smell as it doesn't have food waste in	☐	☐	☐	☐	☐
Using the Food Waste Disposer means I worry about how much water it uses	☐	☐	☐	☐	☐
Putting food down the Food Waste Disposer means I have to clean the sink more often	☐	☐	☐	☐	☐
Using the Food Waste Disposer makes my drains smell	☐	☐	☐	☐	☐
When I use the Food Waste Disposer I worry that the sink and pipes will block	☐	☐	☐	☐	☐

Do you have any other comments about your Food Waste Disposer?

5. How often do you use the Food Waste Disposer?

I keep all my food waste to dispose of at the end of the day	☐
I dispose of my food waste at every meal/food preparation time	☐
I don't use the food waste disposer	☐
Other (please explain)	

6. Are there any types of food that you wouldn't put in the Food Waste Disposer?

7. How much do you recycle?

Not at all	A bit	I recycle as much as I can	I go out of my way to recycle
☐	☐	☐	☐

8. How useful was the instruction pack that came with the Food Waste Disposer?

Didn't receive a pack	Poor	OK	Clear and easy to follow
☐	☐	☐	☐

If Poor please explain what needs to be improved?

9. Did you know that using your food waste disposer means that your food waste may be converted to compost and electricity at the sewage works? **Yes / No**

10. How does this affect your attitude to the food waste disposer?

More likely to use FWD	Not Interested	Less likely to use FWD
☐	☐	☐

Thank you very much for your time!

Please return your completed questionnaire to the on-site Sales Office and collect your thank-you gift

Local Government Association
Local Government House
Smith Square
London SW1P 3HZ

Telephone 020 7664 3000
Fax 020 7664 3030
Email info@local.gov.uk
www.local.gov.uk

For a copy in Braille, larger print or audio,
please contact us on 020 7664 3000.
We consider requests on an individual basis.

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