Thames Farm Development

FRA and drainage proposal review

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Executive summary

Purpose of this report

HR Wallingford has been commissioned by Henley-on-Thames Town Council to undertake a review of the draft report “Flood Risk Appraisal and Drainage Study” by Enzygo (Enzygo, 2021) and the “Drainage statement” by ALP (ALP, 2021) for the proposed Thames Farm development on the A4155 at Shiplake.

Professional advice is sought on whether there is likely to be an increase in flood risk and also water quality impact on the water course of the Harpsden catchment into which the surface water runoff is proposed to be pumped.

The review

The review has assessed the contents of the Enzygo 2021 draft report “Flood Risk Assessment and drainage study” and also the ALP 2021 Drainage Statement which draws together a number of reports dealing with site investigations as well as covering the issue of the site drainage design.

A site visit has been made to the Harpsden catchment to look at all aspects of the site and the visit extended to the adjacent catchments of relevance.

A check has been made on the catchment flood flow rate estimates to help in assessing the additional flood impact of the proposed surface water pumped flows.

A review of both documents has been made and conclusions have been drawn relating to:

- The risk of enhanced flooding;
- The risk of water quality impact;
- The assessment of the options made in justifying the selection of the option to pump the surface water flows to the culvert which serves the Harpsden catchment;
- The drainage proposals for the site (which includes a check on criteria and derived design limiting flow rates).

Conclusions

There are a large number of conclusions which have been drawn and only the key points are summarised here in the executive summary.

- The flooding assessment made by Enzygo is supported by appendices giving details of the modelling work and the hydrological analysis. Although there are a number of minor points to make regarding the flood analysis, the headline message of minimal flood impact during extreme flood events as a result of adding a pumped flow of 8.5 l/s is correct when assessed against the theoretically derived extreme flood flows which might be generated by this catchment.
- The Harpsden catchment has no defined watercourse until the outfall from Harpsden Court and there is no baseflow in normal dry conditions even at the confluence with the drainage channel 100m to the east of the railway line. It is clearly an ephemeral stream. Existing flood flows from short intense rainfall is due to local road drainage and will occur around 100+ times a year (i.e. every time it rains). If the proposed

development is connected to this catchment, the flow rate will increase, but more importantly, the flow volume will significantly increase.

- The pumped flows from the proposed development, due to their attenuated storage, will extend after rainfall long after the other road runoff ceases. Although the drainage statement claims to be applying SuDS, this is not the case and therefore there are likely to be significant water quality implications with regards to this pumped flow. It is estimated that the volume of runoff from the development impermeable surfaces could increase by around a factor of 3.5 due to the proposed development runoff.
- It is important to note from visual evidence that the base flow of the stream which passes by Mill Lane is apparently generated by what is termed the north-east catchment (and not the Harpsden catchment). This base flow is thought to be associated with the groundwater and aquifer that lies under the development site. It is not clear what changes might occur to this base flow if the current grouting proposals go ahead on the site, nor the impact on yield or water quality for Thames Water's abstraction for its water supply.
- The lack of established stream or even dry river channel until downstream of Harpsden Court (which taps into the groundwater flows) and the knowledge that runoff estimates for such permeable catchments are highly uncertain, means that considerable caution should be given to a theoretical assessment of flood flows. The frequency of rainfall events which might generate a significant amount of rural runoff (as well as paved surface runoff) from the Harpsden catchment is likely to be of the order of only a few times a year. Long term monitoring of the catchment would be needed to obtain greater certainty regarding the behaviour of the catchment.
- Nevertheless the modelling of the estimated flood flows and the methods of assessing the catchment runoff has been carried out in accordance with current methods and practice. However there is one significant apparent error in the model which is that it is shown to outflow to the Thames upstream of the weir rather than connecting to the stream passing down beside Mill Lane and joining the Thames downstream of the weir (which it is believed to do). This means the Thames Water modelled levels are based on the wrong location. It also means that the flood extent modelling downstream of the railway line should extend north to include the houses along Mill Lane.
- Currently the culvert under the A4155 is virtually blocked; this has a very important effect on protecting the sports ground downstream of the road, by flooding the field on the upstream side. The development flood flows, if the culvert remains in this state, could add significantly to the flooding of this field. However any change made to improve the culvert (by removing the sediment) will risk increasing flows transferred downstream.
- The proposed site drainage system is not designed to provide treatment to the surface water runoff and is not in accordance with best practice. The water quality of the pumped flows will reflect the lack of treatment provided.
- The proposed grouting and compaction of the site has not been considered and taken into account in the design of the drainage system in terms of the additional runoff that would be created, nor in terms of the potential effects of flows from uphill which could develop as springs on the site during wet winter periods.
- The limiting discharge rates proposed for the site in the Drainage statement (ALP 2020) report were far higher than compliance with the stated greenfield criteria as claimed. However the revised version (ALP 2021) has corrected this in proposing 8.5 l/s. There has been an addition of a concrete storage tank to the plans and it is assumed that the increase in storage which would be needed for this lower maximum flow rate has been catered for, but this has not been checked.

Recommendations

As soakaways are used universally in the area it would seem that the appropriate use of SuDS and infiltration, taking into account the limitations associated with the geology of the site, may still be the most appropriate approach to take.

The water quality impact of the currently proposed drainage solution which will take place for every rainfall event. The long term cost implications for pumping all the runoff is not in keeping with the principles of sustainability nor the declared intention by all water companies to be Net Zero by 2030.

Justifying this scheme based on the minimal additional flooding during very rare extreme flow conditions, but accepting a very large increase in volumes of contaminated road runoff for every rainfall event is not a reasonable basis for accepting this proposal as being the most sustainable drainage solution.

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1. Introduction

HR Wallingford has been commissioned by Henley-on-Thames Town Council to undertake a review of the draft report “Flood Risk Appraisal and Drainage Study” by Enzygo (Enzygo, 2021) and the “Drainage statement” by ALP (ALP, 2020) for the proposed Thames Farm development on the A4155 at Shiplake, and provide professional advice on the flooding analysis and drainage proposals. The reason for the commission is that the developer proposes to discharge the surface water, including some highway runoff, via a rising main to the A4155 culvert serving the ‘River Harp’ immediately upstream of the Henley football grounds.

A revised version of the Drainage statement (ALP 2021) has been issued and this has also been reviewed. Much of the ALP 2021 version is the same as 2020. The main changes appear to be related to the proposed surface water pumped flow rates.

The commission requires HR Wallingford to consider both the potential flood risk and pollution impact of these drainage proposals.

The structure of this report is as follows:

- Chapter 1 provides an overview of the development and the evolution of the surface water management proposals;
- Chapter 2 provides an assessment of the Flood Risk Appraisal submitted by Enzygo (dated March 2021, but submitted June 2021);
- Chapter 3 provides commentary on various aspects relating to the surface water drainage design and the proposal to pump surface water to the north catchment;
- Chapter 4 provides commentary on the impact of the current surface water management proposals on the Henley community.

1.1. Overview of the development proposals with respect to surface water runoff management

The Thames Farm site obtained outline planning permission in 2017, following an appeal, for up to 95 homes on a 5.6Ha site. The appeal overturned the original planning application refusal. The refusal was not related to drainage issues. However the appeal decision, in line with normal practice, requires that “*No development shall commence until a drainage strategy, detailing all on and off site surface and foul drainage works, has been submitted to and approved…….”.*

The developer had originally proposed to drain the site to infiltration basins, permeable paving and trench soakaways (CEC, 2016). The geology of the site is that of Taplow Gravel of varying depths of 2 to 10m overlying Chalk. Groundwater depths are variable (due to the steep falls of the site which is at a gradient of around 1:30), but are generally in the range of 12m to 16m.

However, on carrying out soakage testing (ALP 2020) to determine the infiltration rates, a ground collapse took place and a number of subsequent ground investigations identified that the site has a large number of sub-surface voids formed by dissolution of the underlying chalk bedrock.

The current proposal is to grout and vibro-compact the site in order to stabilise it for construction. In addition the original proposal to use infiltration as the mechanism of surface water disposal is not considered viable. The drawings in the ALP Drainage Statement (ALP, 2020 and 2021) still show the use of permeable pavements, though these do not seem to be being utilised as part of the drainage system, but there is insufficient information to know how these fit into the drainage system. SuDS and drainage proposals are discussed later in this report.

An added complication of the site is that it is in an aquifer categorised as Source Protection Zone (SPZ) 1 which is surrounded by an SPZ category 2. The Chalk is categorised as a Principal aquifer while the Taplow Gravel is categorised as being a minor aquifer. The SPZ category is due to Thames Water having an abstraction borehole immediately to the north-east of the site. This has resulted in a conclusion (after extensive negotiation with Thames Water and the Environment Agency) that deep bore soakaways cannot be used as an alternative to shallow infiltration systems.

The amended surface water strategy in 2020 proposed grouting of the site and a pumped discharge of attenuated surface water to the Lash Brook (ALP, 2020). Shiplake Parish Council and the residents were unhappy with this on the grounds of:

- The potential for increased flood risk from the Lash Brook;
- The risks to the water supply aquifer from the proposed grouting operation;
- Disruption and nuisance caused by the need to construct a rising main through the village.

Following actions taken by Shiplake Parish Council and the Thames Farm Action Group (TFAG), and further consideration by Taylor Wimpey after negotiations with South Oxfordshire District Council (SODC), the Environment Agency (EA) and Thames Water Utilities Limited (TWUL), a revised proposal has been put forward.

A revised Flood Risk Assessment and Drainage Study (Enzygo 2021) now proposes that the surface water, instead of being pumped to the Lash Brook, should now be pumped to the Harpsden catchment, to a point upstream of the culvert serving the A4155.

It should be noted that the Harpsden catchment does not have a watercourse and there is no indication on maps to a stream.

1.2. Relevant key documents

As with many developments which encounter difficulties in gaining planning approval, there are now a plethora of documents following various investigations and analyses relating to it. This report lists all documents in a reference section if they are referred to in the text. However a short section here is provided to help provide an overview of the more relevant ones in the context of the various activities that have been undergone to date. This information is provided in tabular form in Table 1.1.

Table 1.1: Key documents associated with seeking planning approval for Thames Farm development

Year	Study / Activity Organisation	Description
2016	Flood Risk Assessment for Proposed Residential Development Thames Farm, Shiplake. Cole Easdon Consultants Ltd (CEC)	Proposal to use infiltration on site for surface water disposal.
2017	The Planning Inspectorate (2017) Appeal Decision: Appeal Ref: APP/Q3115/W/16/3161733	Decision unrelated to drainage issues

Year	Study / Activity Organisation	Description
2020	Thames Farm Shiplake, Drainage Statement Abley Letchford Partnership Limited (ALP)	Proposal to pump surface water to Lash Brook
2021	Thames Farm Shiplake, Drainage Statement Abley Letchford Partnership Limited (ALP)	Proposal to pump surface water to the north catchment
2021	Flood Risk Appraisal and Drainage Study. Thames Farm, Shiplake Enzygo	Assessment of the flood impact on the R. Harp for surface water discharge, and summary of the surface water drainage proposals on site. Consideration of four surface water disposal options: - The use of infiltration SuDS on site; - Pump surface water to Lash Brook (south catchment); - Drain surface water to north-east catchment; - Pump surface water to north catchment (to the culvert serving the catchment under the A4155). The preferred option being the northern route.
2021	Review of Drainage Strategy for Thames Farm, Shiplake: Hydrogeological review of drainage proposal. JBA Consulting	Raises hydrological questions and drainage efficacy regarding the proposal to grout and compact the site.
2021	Review of Drainage Strategy for Thames Farm, Shiplake: Flood Risk Appraisal and drainage study. JBA Consulting	Review of the draft FRA by Enzygo (2021).

2. The catchment area

2.1. The Harpsden catchment

The Harpsden valley has been inspected (to help understand the hydrology of the catchment) from Sonning Common along the road Devil's Hill through Harpsden Bottom down to the A4155. In addition, the section of the A4155 road which falls to the River Harp culvert from Bolney Lane was also inspected. Bolney Lane is less than 100m from the northern boundary of the Thames Farm development.

A detailed inspection has been made of all the hydraulic features along the route of the watercourse from the culvert serving the A4155 through to the outfall to the River Thames at the foot of Mill Lane.

The Thames bankside path upstream of Mill Lane has also been walked.

In addition, the road over the top of the development, Woodlands Road has also been walked. This is because there is a small, but significant catchment which falls towards the site from the west.

An inspection of the road drainage in the area around the site has also been made (Bolney Lane, Woodlands Rd and the A4155 adjacent to the development).

Figure 2.1 shows the plan of the Harpsden catchment. Appendix A provides a summary of the site visit which looked at the Harpsden catchment area as well as the area around the development. The site visit notes include many photographs along the route of the River Harp and the hydraulic features along it.

It is also useful to see the pluvial flood map which is available on the Environment Agency website showing the flow paths of the surface water flood flows for this catchment. Figure 2.2 shows the whole catchment area while Figure 2.3 shows the details in the region of the A4155 and downstream. Figure 2.4 shows the flood extents of the fluvial (river) flooding which indicates flood risk from the River Thames right up to Harpsden Court.

The area of the catchment is 40 km^2. In spite of this, the catchment has no defined watercourse until it gets down to Harpsden Court, where, at the outfall from the large manmade pond, a small dry watercourse commences.

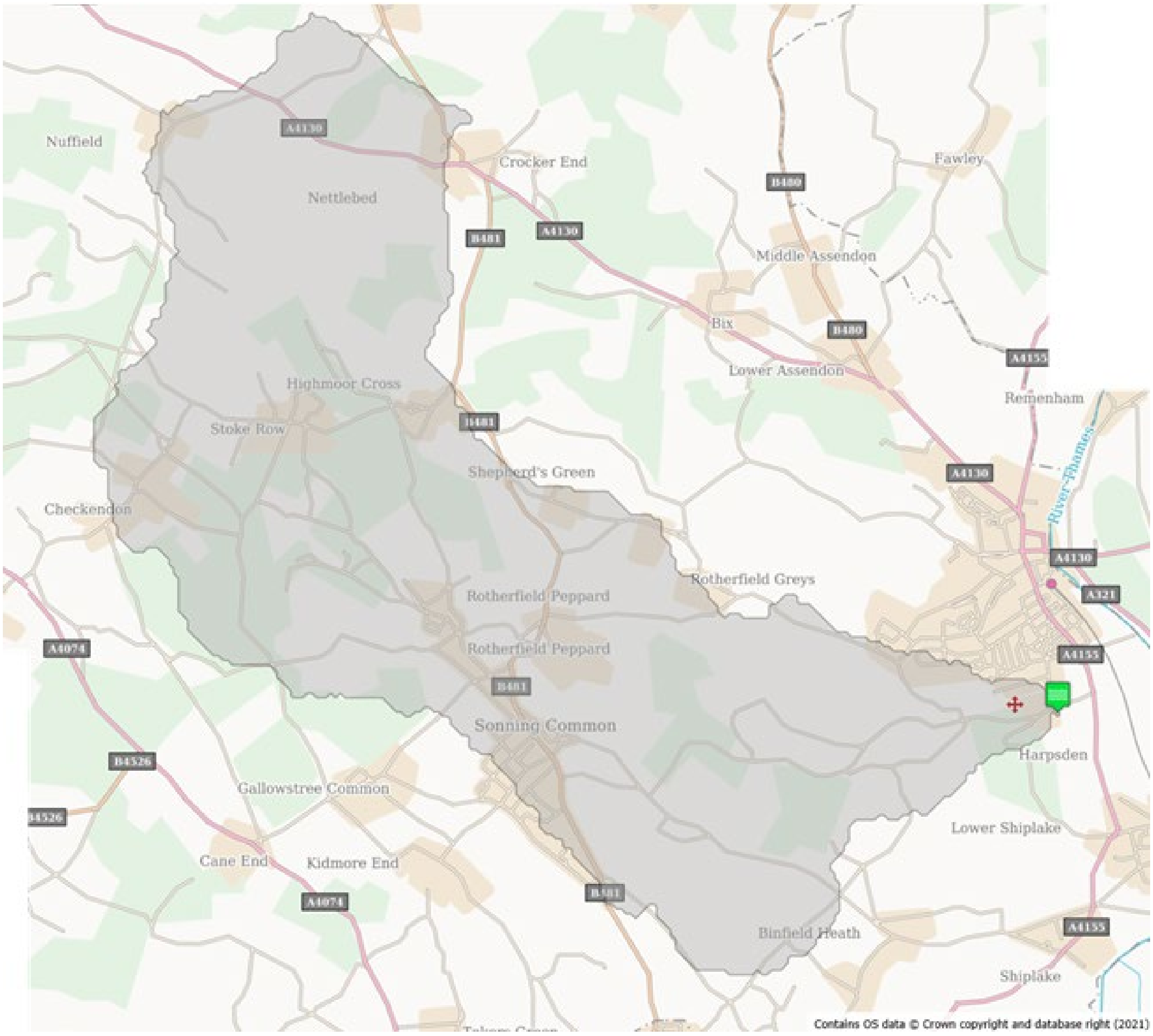


Figure 2.1: The catchment of the River Harp upstream of the AA4155 culvert

Source: Flood Estimation Handbook web service (https://fehweb.ceh.ac.uk/)

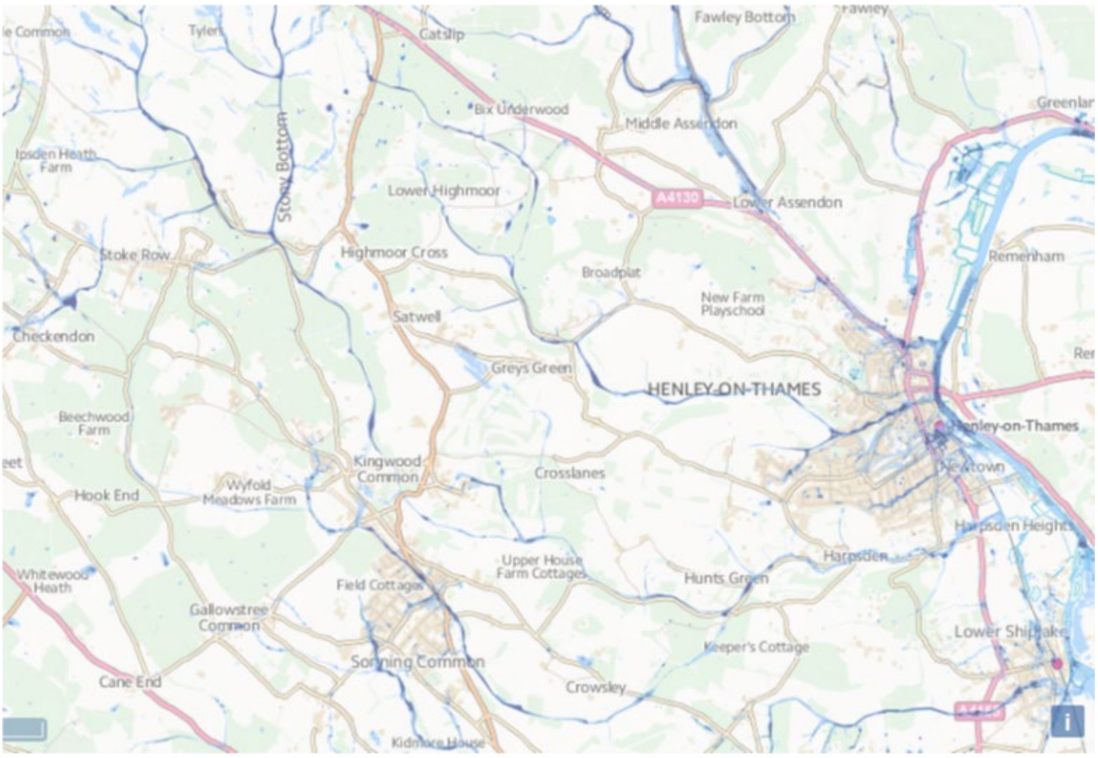


Figure 2.2: Flood map for surface water for the Harpsden catchment

Source: https://flood-warning-information.service.gov.uk/long-term-flood-risk

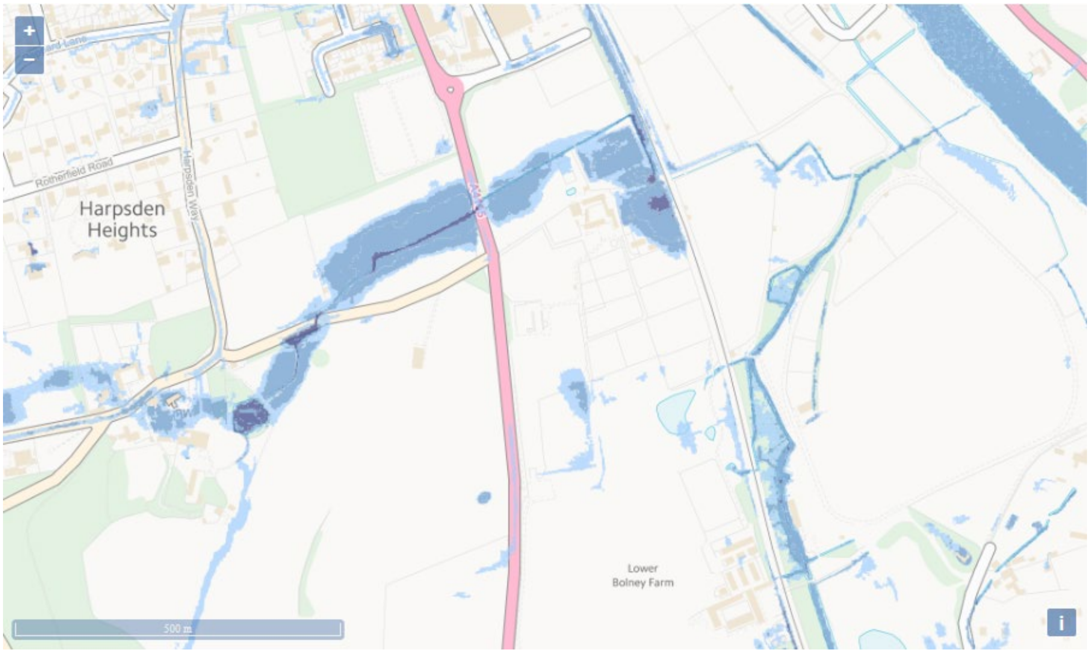


Figure 2.3: Flood map for surface water for the lower part of the Harpsden catchment

Source: https://flood-warning-information.service.gov.uk/long-term-flood-risk

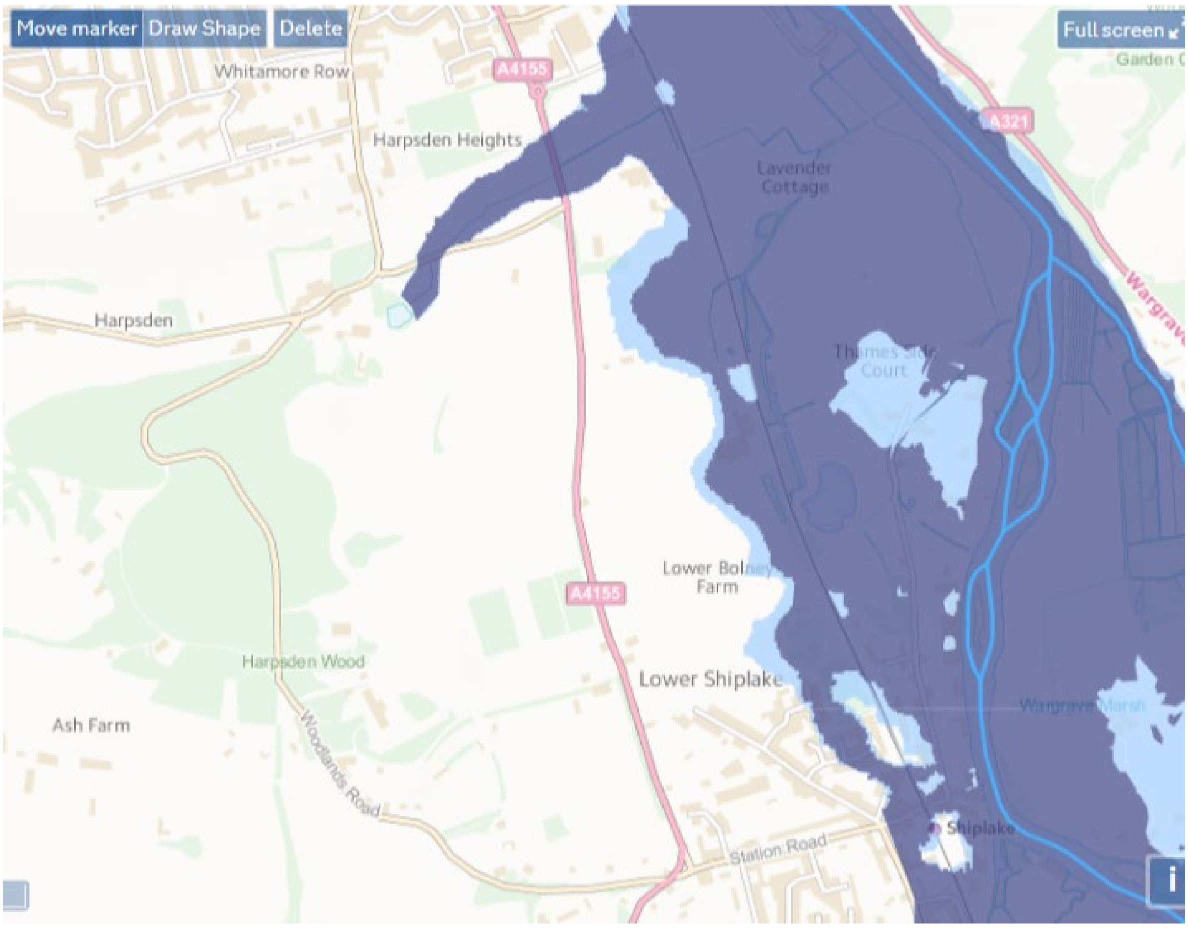


Figure 2.4: Fluvial flood map between Shiplake and Henley, showing the flooding up into the Harpsden catchment

Source: https://flood-warning-information.service.gov.uk/long-term-flood-risk

2.2. Other catchments relevant to the study

There are five drainage catchments of note that need to be considered with regards to this development. These are:

- The drainage catchment referred to by Enzygo as the North east catchment;
- The South catchment;
- The Lash Brook catchment;
- The North catchment; and,
- The catchment above (to the West of) the development.

The North east catchment includes the catchment upstream of the site, but the two are distinguished because there are drainage implications for the site of this uphill catchment which has not been addressed in the Enzygo or ALP reports.

These catchment areas are each briefly detailed in the context of the study. Although these are detailed here, this study does not go into any depth on their hydraulic or hydrological characteristics.

2.2.1. The North east catchment

The north east catchment is effectively delineated by where pluvial (surface water) runoff would drain (i.e. the natural flow path across the development site and two other local flow paths that drain eastwards before passing northwards beyond the railway line to join the Harpsden catchment before it drains to the River Thames. There are effectively three separate flow paths upstream (to the west) of the A4155. Figure 2.5 illustrates this.

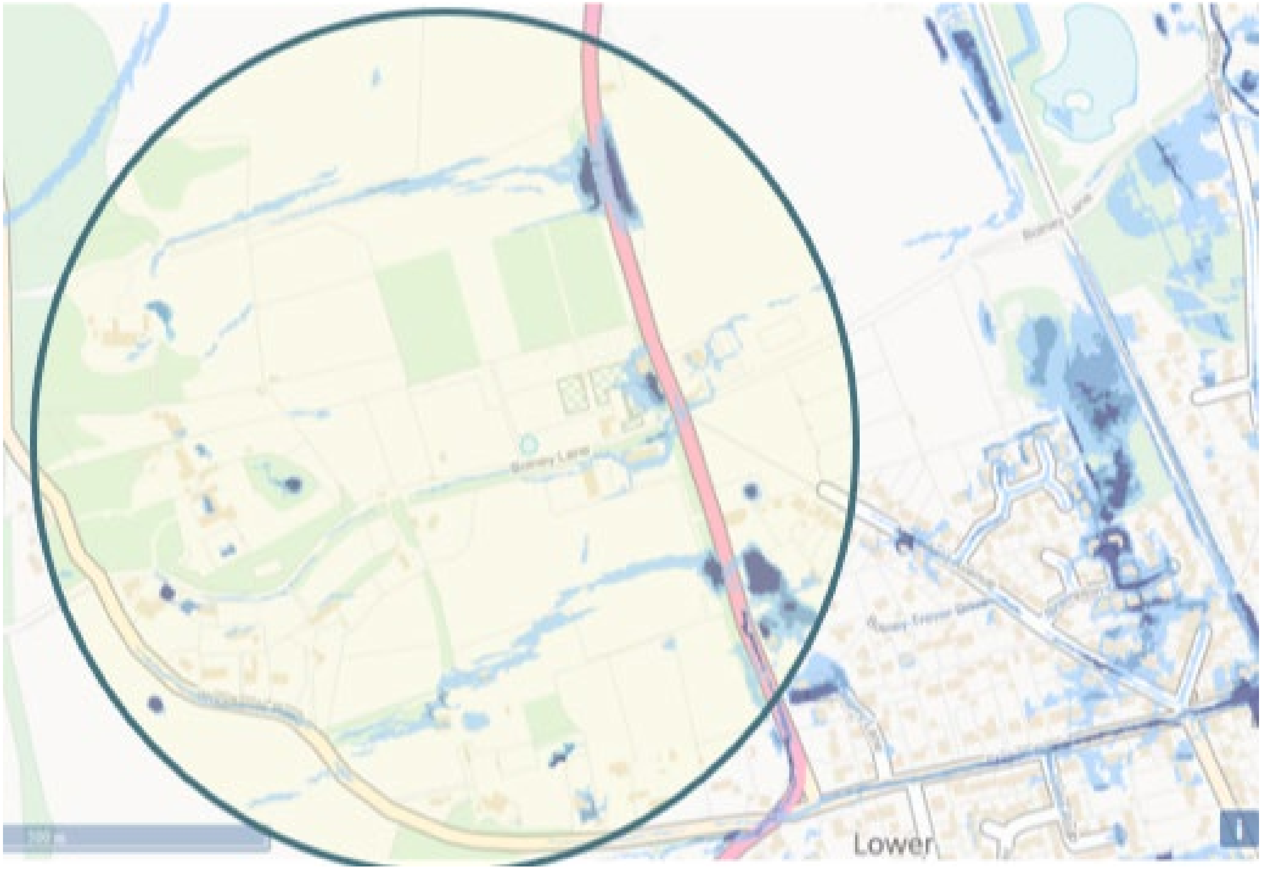


Figure 2.5: North east catchment flood map for surface water

Source: https://flood-warning-information.service.gov.uk/long-term-flood-risk

The northern most flow path is short and rises at Woodlands House on the east side of Woodlands Road and falls to the A4155 where it ponds. In practice any flood flows to this point are probably picked up by the piped road drainage which is conveyed to the A4155 culvert serving the Harpsden catchment to the north. The natural flow path would have continued east down to the Black Bears Polo club and hence through a culvert under the railway line to the drainage channels flowing north beside the River Thames. These join the Harpsden catchment drainage channel a short distance to the east of the railway line under which it is piped, prior to discharging to the River Thames below the weir at Mill Lane.

A second flow path slightly further south also originates on the east side of Woodlands Road and passes alongside part of the northern development boundary before arriving at the A4155. Unlike the first flow route, this flow path is shown continuing east to join the drainage channel and small pond within the Polo Club grounds before passing through the railway line, hence joining the same route of channels by the Thames flowing north before joining the Thames downstream of Mill Lane.

The third pathway routes directly through the development. It rises just to the west of Woodlands Road and joins runoff from the road before passing through the site and drains down to the A4155. Flooding is then shown on the east side of the road in the upper part of Shiplake. Figure 2.6 delineates the extent of the catchment (in black) which is upstream of any part of the development (indicated in red). Although small, it is about 4 times the size of the development with steeply sloping falls towards it.

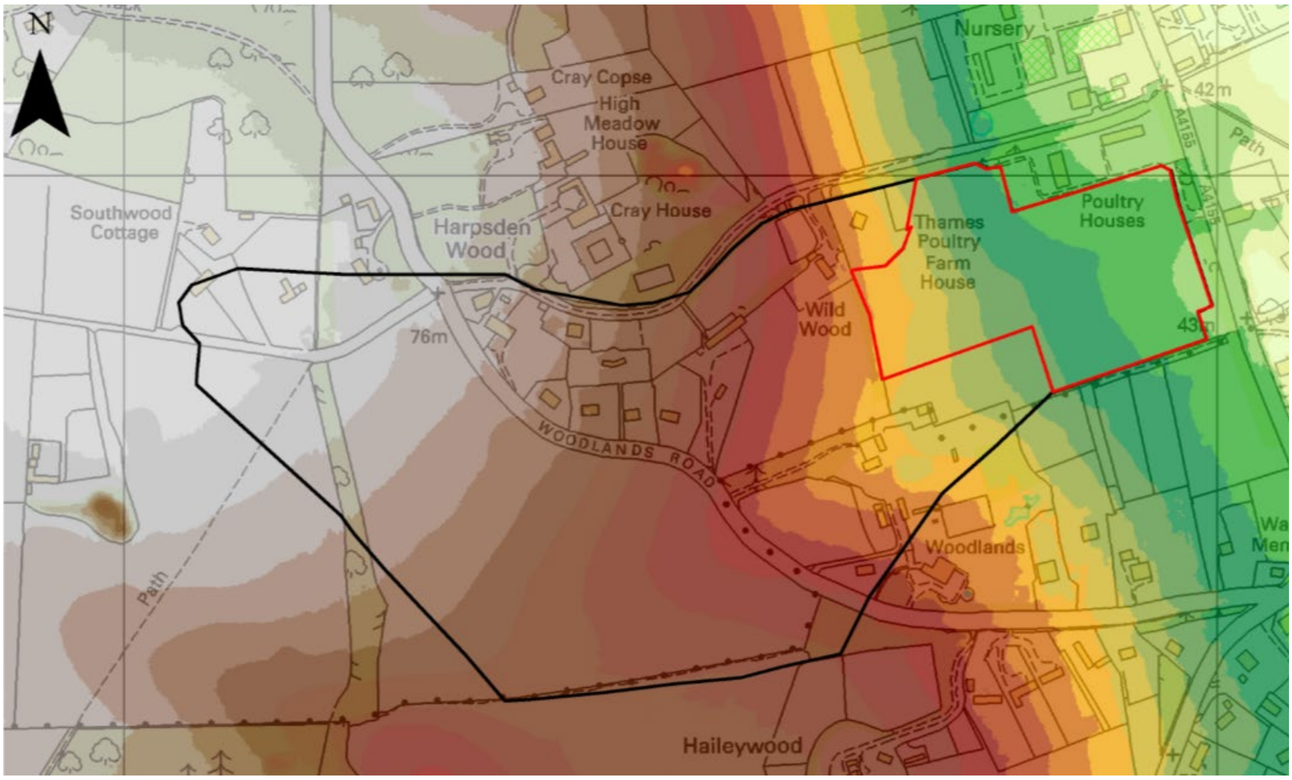


Figure 2.6: The upstream catchment above the development site

Source: Derived from Environment Agency LiDAR data

2.2.2. The South catchment

The south catchment is large compared to the north east catchments. It rises in King's Common about 5km west of Lower Shiplake (see Figure 2.7). It passes through Lower Shiplake before, possibly, joining the Lash Brook which comes from the south west and hence to the River Thames. Details regarding its drainage routing are not known.

This flood flow path passes several hundred meters to the south of the development. It is not mentioned in the Enzygo report and it is not known how this potential flooding is addressed in Lower Shiplake.

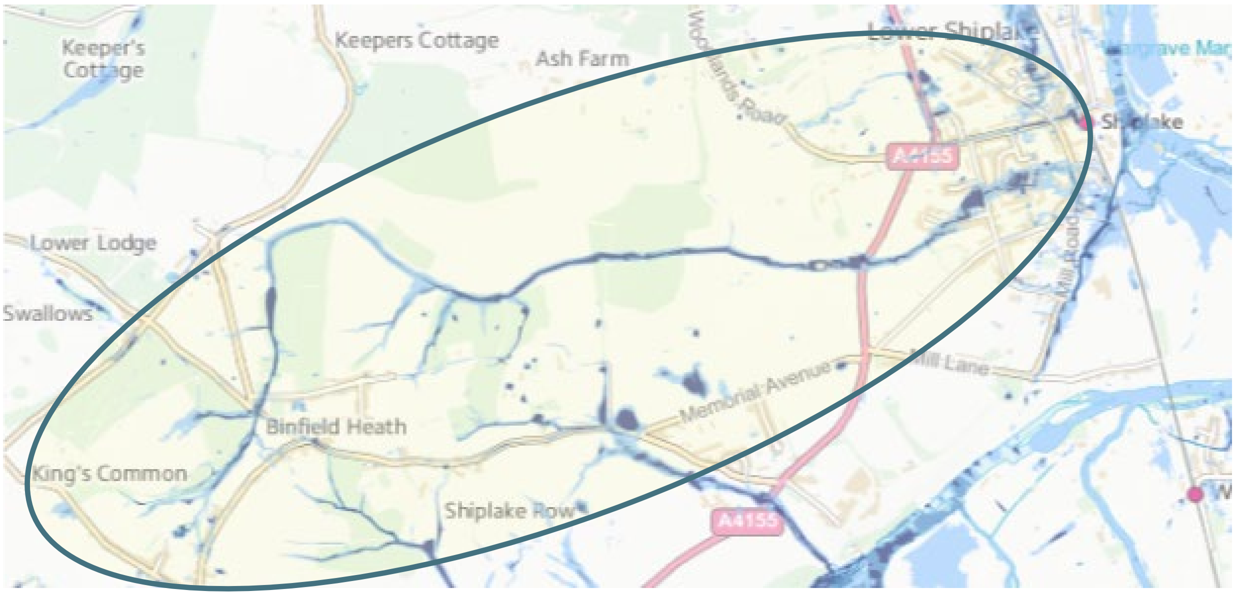


Figure 2.7: The flood map for surface water for the south catchment

Source: https://flood-warning-information.service.gov.uk/long-term-flood-risk

2.2.3. The Lash Brook catchment

The Lash Brook is shown in Figure 2.8. It can be seen to cut off a bend in the River Thames. It seems to be generally acknowledged as being a Mill Leat.

The ALP 2020 drainage proposal for the site was to pump surface water flows 2km to the Lash Brook. This decision has been changed by Taylor Wimpey with the intention now of pumping the surface water flows to the A4155 culvert serving the Harpsden catchment.

Details of the Lash Brook have not been investigated by this study.

Figure 2.8: The pluvial map for the Lash Brook

Source: Environment Agency

2.3. Hydraulic features along the drainage route

A brief outline of the hydraulic features which are relevant to the Thames Farm development drainage proposal is provided here in this section. Appendix A provides notes on the site visit with photographs taken of many of these features.

2.3.1. Upstream of the A4155

A visit to the Harpsden catchment has shown that the roads are largely served by Grips (channels taking flows off the road into the hedge or field. There are a few gullies at low points and these are likely to drain to a local soakaway.

There is no evidence of a stream alongside the road from Sonning Common down to Harpsden Court, even though this valley serves much of the catchment.

The area of the junction of Harpsden Way with Woodlands Road and the unnamed road connecting to the A4155 has several gullies and it is understood that these had been served by soakaways, but were now (inappropriately) connected into the private drainage of Harpsden Court and into the pond.

The culvert serving the unnamed connecting road under which the ditch from Harpsden Court passes under is reasonably sized, but it is stated that the road floods regularly. This may be due to the flow rates in the stream during rainfall, but is more likely due to the low point created in the road due to the road rising up to pass over the culvert.

2.3.2. The A4155 drainage

The existing A4155 drainage serving the 1.2km of road downhill from Bolney Lane is all drained by a single piped drainage system which is connected to the culvert.

The low point of the road is close to the A4155 culvert and has four gullies. These gullies appear to connect together and do not drain to the upstream side of the culvert, but have a separate outfall to the ditch in the sports grounds. Due to the road gradient quite a lot of water is drained to this point and peak flow rates are reported to be high coming from this outfall point.

2.3.3. Downstream of the A4155

The culvert under the A4155 is virtually completely blocked with sediment. This, together with the road level and upstream field level, results in protection of the sports ground and those further downstream, but means the field upstream is regularly flooded. Removal of this sediment would have implications for flooding of the sports field and the adjacent properties.

The channels downstream of the railway line in the floodplain area (serving both the Harpsden catchment and the catchment areas to the south), have a baseflow provided by groundwater.

The flow in the channel which passes through the properties along Mill Lane (after a short dry period at the end of March) is currently estimated at around 100 l/s. From discussion it would seem that this flow might drop to around 25 l/s or 30 l/s in summer, but it never dries up. Note that a regular and extended flow of 8.5 l/s after rainfall of urban runoff from the proposed development of 8.5 l/s is a significant additional flow rate and also a significant reduction in water quality.

Regular flooding takes place along Mill Lane and can be up to 0.5m deep in places. From feedback it seems likely that although flows are enhanced coming downstream from the contributing catchments, generally the mechanism for the flooding is driven by the River Thames flood level below the weir which is 200m upstream of the stream outfall at Mill Lane. However the water levels in the Thames above the weir is held very close to the bank threshold and there is a suspicion that for some flood events there may have been over-bank spillage which enhanced flows in the stream.

3. The predicted Harpsden catchment flow rates

The Harpsden catchment has been independently assessed for design flood flow rates using the ReFH2 rainfall runoff estimation method (the latest evolution of the Flood Estimation Handbook) which is considered to be the approved method for estimating river flows. In addition, a peak flow estimate has been carried out using an older method IH124 (IH 1994) that was specifically developed for small catchments and the FEH Statistical Method (FEH, 2008).

It should be noted that the use of ReFH2 is known to be less accurate for pervious catchments than for other types of catchments. It is therefore useful to show the estimates using other methods.

3.1. The Harpsden catchment flow rate analysis by HR Wallingford

The peak flow rates for the runoff have been calculated using ReFH2 and are shown in Table 3.1. The critical duration (storm duration that gives the highest peak flow) for the stream is 15 hours. Runs at both longer and shorter durations have been made and flows are very similar for a wide range of durations. This is an important consideration as it means that flood state and water level in the River Thames might be high at the same time as peak flood flows take place in the Harpsden catchment.

These flows are predicted for the point immediately upstream of the A4155, approximately where the pumped flow from the development will be added. There is not a significant additional area draining to this catchment between this point and the junction with other catchments just below the railway line prior to discharging to the River Thames.

Table 3.1: ReFH2 flow rates for the Harpsden catchment at the A4155 culvert

Return period (years)	Critical duration peak flow at 15 hours. (m^3/s)
1:1 year	1.7
1:2 year	2.0
1:5 year	2.7
1:10 year	3.2
1:50 year	4.6
1:100 year	5.5
1:200 year	6.7
1:500 year	11.0

Source: ReFH2 calculations

The peak flow at 100 years is 5.5m^3/s for the present day at 15 hours, but only reduces to 5.4 m^3/s for the 30 hour duration event. Critical durations of the floods in the River Thames are of the order of three days and therefore it is quite likely that flooding could be taking place in both catchments at the same time.

The peak flow estimates for the 1:100 year present day design even using the other two equations is also given below. To make these estimates comparable with the ReFH2 estimate, the soil runoff parameter value (SPRHOST) and the river baseflow parameter value (BFIHOST) have been taken from the values generated by ReFH2 assessment. For both estimates, a 'growth' factor of 3.19 has been taken to calculate the 1:100 year figures:

- IH124: Qbar (mean annual peak flow rate, approximately a 1 in 2 year event) = 2.3m^3/s, 1:100 year peak flow rate = 7.3m^3/s;
- FEH statistical method: Qmed (median annual peak flow rate, approximately a 1 in 2 year event) = 1.6m^3/s, 1:100 year peak flow rate = 5.15m^3/s.

This check on the ReFH2 1:100 year flow estimate using these other methods, although showing some differences, provides a reasonably consistent view that the 1 year flow is probably around 1.5m^3/s and the 1:100 year flow is around 5m^3/s.

4. Enzygo FRA review and evaluation

Enzygo produced an FRA in March 2021 (submitted in June 2021) for the Harpsden catchment to support the proposal for pumping the surface water from the Thames Farm development to the upstream side of the culvert serving the A4155.

This chapter summarises the Enzygo report associated with the FRA that was carried out and then considers and evaluates various aspects of the statements made in the report. This document is supported by three appendices which includes the hydraulic modelling and hydrology reports. There are no indications of any inappropriate methods have been applied to this analysis in terms of the physical representation of the network (except the outfall location to the R. Thames), or the use of the hydrological method of approach. However comment is made on what has been done and assumed.

4.1. Information provided by Enzygo

The Enzygo analysis is based on a hydraulic model of a section of the river from Harpsden Court down to the outfall on the River Thames. The model is stated to be a TuFLOW 1D/2D model, which is an appropriate tool. Details of the hydraulic model are provided in Appendix 1 (of the Enzygo report). Details of the hydrology analysis is also provided in Appendix 1.

The model was also used to carry out a 'soft bed' analysis to assess the current high level of blockage of the culvert under the A4155.

The Enzygo analysis provides a flood outline for two scenarios:

- A 20 year event on the River Harp with a 100 year (plus 20% climate change) water level for the River Thames;
- A 1000 year event on the River Harp and a 20 year water level for the River Thames.

A flood image is provided in the report which is included in Figure 4.1 for ease of reference.

The flood outline indicates (what is believed to be) an incorrect outfall point to the River Thames.

The flood image from the modelling work is very similar to that from the Environment Agency mapping.

The reported conclusions are that:

- There is a 1mm rise in water levels for the 20 year run when an additional flow rate of 8.5 l/s (the assumed development peak discharge rate) is added to the flow at the upstream side of the culvert; and,
- There is no measurable flood level increase for the 1:1000 year run.

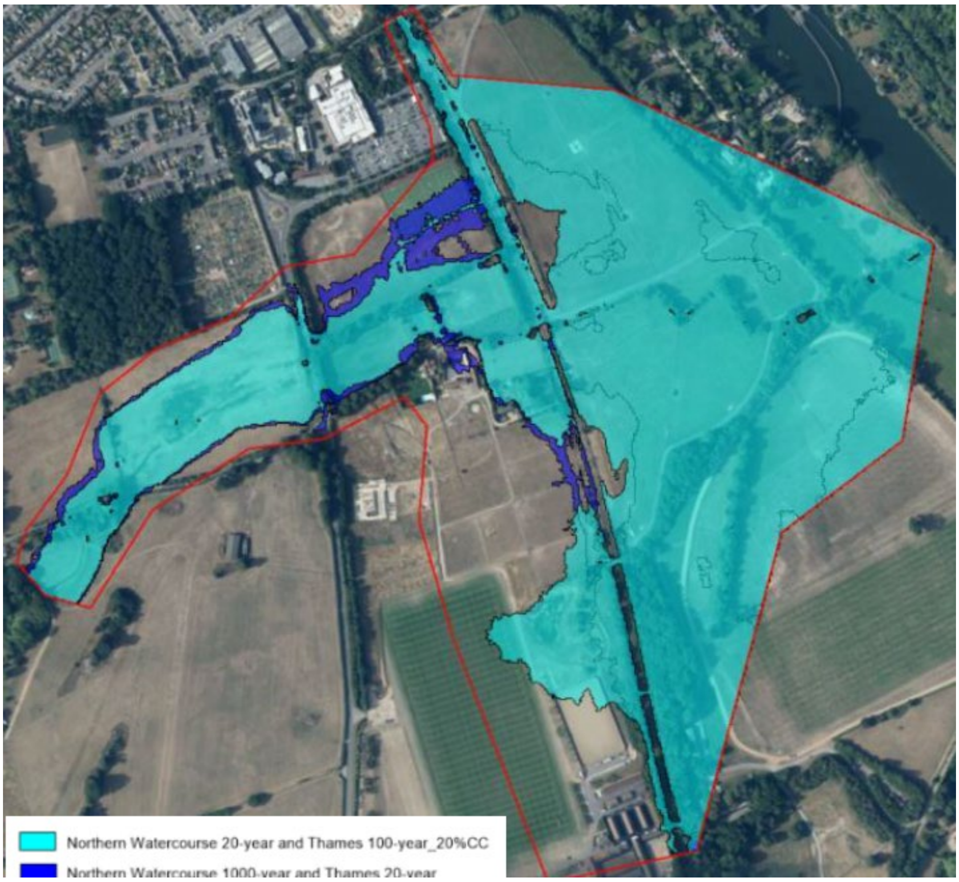


Figure 4.1: Enzygo flood outline for 20 year and 1000 year model runs

Source: Enzgo draft report – Flood Risk Appraisal and Drainage Study, Feb' 2021

4.2. Comments on the flood analysis

The hydrological analysis of flows made by Enzygo is very similar to those made by HR Wallingford. Although flow rates differ and particularly the pooling process resulting in the 50% difference in flows between the ReFH2 and the Statistical FEH method, the order of magnitude of the theoretical flow rates are similar. Enzygo has chosen to use the higher flow rates (as this is claimed to be more conservative), but in fact for the purpose of this FRA in so doing they are assessing a smaller impact for the effect of any added flows.

There are a number of issues that need to be made regarding the approach taken by Enzygo for this flood risk analysis, but the fundamental conclusions of the analysis are incontrovertible; the addition of 8.5 l/s of flow to peak flood flow rates of 1.5 m^3/s or 5.0m^3/s (or any other high flood flow rate), will be very small and the flood water levels for such events upstream of the railway will not be measurable. For flood levels and flooding behaviour below the railway it will have even less impact as many events (and therefore flood levels) will be dominated by flooding from the River Thames.

Hydraulic controls

The A4155 culvert is a major hydraulic control. At present it is 80% to 90% blocked. This culvert (if it was not blocked) has a far greater capacity than the two relatively small pipes through the railway culvert. The current level of blockage is resulting, at present, in the use of the field to the west of the A4155 and perhaps part way up to Harpsden Court pond as a massive attenuation (flood storage) basin (which would then spill across the A4155 if there was a sufficiently large extreme event). It is currently effectively protecting the Sports grounds from being flooded. Maintenance of the culvert (removal of all the sediment) would result in greater flooding impact on not only the football grounds, but also adjacent properties.

Although the culvert capacity under the railway would partially attenuate this increase in flood flow rate, a release of the A4155 control (i.e. removal of sediment) would enhance flows significantly in the Mill Lane section of the stream during extreme events.

Ephemeral stream and flood flow predictions

It is notable that the Harpsden catchment does not have a permanent watercourse. In fact the water course only becomes delineated as a very minor ditch downstream of the pond at Harpsden Court. There is no baseflow during dry weather conditions even though many Chalk streams are near their highest levels at the end of March (when the site survey was made) due to the build-up of water in aquifers over the winter.

In the recent pond renovation at Harpsden Court, excavation broke into the “underground stream” on one edge of the pond which explains the existence of the pond. What this indicates is that the traditional assessment of flood flows may well be far from correct as flows are effectively largely underground. It is notable that the flows into the pond are not supported by any canalising of the runoff form the main catchment but only a spring from a very small catchment to the south.

Therefore although flooding should undoubtably take place down the valley during extreme events, evidence of this is very limited. It is worth noting that Harpsden Court, which is in the low part of the valley, is a large Victorian building which has been there for close on 150 years and has not apparently suffered from being flooded.

All this suggests that extreme caution should be taken on assuming the theoretical flow analysis using of standard flow estimation equations provide anything like the correct assessment of the flood runoff rates. This means that the flows seen downstream of the A4155 culvert are, for 95% of rainfall events, just the surface runoff from the road drainage serving the A4155 for around 1.2km plus some runoff contribution from the small lane connecting Harpsden Way to the A4155 and possibly from Harpsden Way itself.

This means that, if the surface water from the Thames Farm development site was discharged to the same culvert location, then the area contributing to the normal rainfall runoff response at this point would increase from around 1ha of impervious surface to around 3.5ha of surface (with the concomitant increase in pollutants as the site drainage system is not an effective SuDS design). Peak flow rates would still only increase a small amount due to the attenuation provided on site, but total volumes would go up by a factor of around 3.5 with much longer periods of flow downstream of the A4155.

Flow rates from short duration heavy thunderstorm events are unlikely to elicit any response from the Harpsden catchment, so flows generated by the A4155 drainage system and the proposed development should be considered as the primary flood flow impact.

4.3. Conclusion on the flood flow analysis for the North (Harpsden) catchment

The conclusions that can be made from the flow analyses and comments made above, are that:

1. Rural flood flows estimated by the normal methods of analysis may well severely over-estimate flood flows for this catchment.
2. Irrespective of the uncertainty of extreme flow estimates for the Harpsden catchment, the contribution in flow rate of an additional 8.5 l/s from the proposed development will have minimal impact on flood levels at any point downstream of the A4155 for very severe rainfall events - as current road runoff draining to this location is not attenuated.
3. There has been no assessment made of the possible flooding associated with a short intense event with a response just from the A4155 drainage together with the additional 8.5 l/s (i.e. with no assumed response from the Harpsden catchment - which would represent the normal condition of the catchment. This might indicate a measurable degree of additional flooding in the shallow ditch in the AFC grounds and probably a measurable increase in flows in the stream for properties near Mill Lane.
4. The A4155 culvert serving the Harpsden catchment is acting as a throttle, attenuating flows downstream and is therefore protecting the sports pitches and local adjacent properties as well as controlling the flows in the section of the stream beside Mill Lane.
5. The response of the catchment to regular rainfall (100 or more events a year) and any short extreme events that take place, is purely a function of the A4155 and other road runoff. All such highway runoff, together with the proposed development runoff, will contain pollution which is discharged untreated to the watercourse.
6. The addition of the surface water flows from the development for ordinary events would result in peak flows increasing by a small amount (depending on the rainfall event characteristics), but the volume of runoff would be around three times the current amount and the duration of discharged runoff will extend considerably.
7. The current baseflow of high quality water from the North-east catchment in the stream beside Mill Lane (which probably originates from the aquifer over which the proposed development is located) will have much less diluting effect due to the large increase in polluted flows if the development takes place.

4.4. The Enzygo options evaluation for the surface water drainage of the development

A brief summary of the Enzygo drainage options analysis for addressing the surface water runoff from the development is made here. This is followed by comments and conclusions on these options and the choice made by Enzygo.

This section only addresses the disposal of surface water. Chapter 5 addresses the details of the on site drainage proposals; drawing on both the Enzygo report and the ALP drainage statement (2021).

The Enzygo stated options are:

- Option 1 – Infiltration to ground using infiltration SuDS;
- Option 2 – Sewer requisition (pumped flows) to Lash Brook;
- Option 3 – Outfall to the North-east catchment via third party land;
- Option 4 – Pumped flows to North (Harpsden) catchment to the A4155 culvert.

The report does not list another option of deep borehole soakaways that were considered and rejected after extensive negotiations with the Environment Agency and Thames Water. It is presumed that this was on the grounds of risk to the water quality of the aquifer.

The report does make mention of the hierarchy of preference for surface water discharge based on Part H3 of the Building Regulations 2000.

The following sections briefly describe each option which is then followed by a conclusion section.

Option 1 – infiltration SuDS

Although the area of the development is sands and gravels overlaying Chalk, due to the karstic nature of the chalk across a significant portion of the site, infiltration has been ruled out as an option due to the risks of voids developing.

Option 2 – Pumped flows to Lash Brook

A conclusion has been reached that the Lash Brook is an inappropriate destination for the pumped flows. The reasons given for not passing flows to Lash Brook include:

- Lash Brook is a relic leat and not a watercourse;
- The outfall would be discharged in a surcharge state during a flooding event in the river Thames;
- Additional flows will be added to the River Thames and so exacerbate flooding.

Option 3 – Outfall to the northeast catchment

Passing surface water flows to the northeast catchment have been discounted on the basis that the drainage provision would need to be 5m deep. It is not clear from the Enzygo report whether this is because it is nearly 5m deep due to the current arrangement of the drainage system and pump station, or whether it is a constraint elsewhere.

The ALP report 2021 explains that there is a topographic constraint of trying to pass under the railway line and outfalling at a suitable level in the R. Thames.

Option 4 – Pumped flows to an outfall to the Harpsden catchment alongside the A4155

A rising main for some or all the distance is considered to be the best option. This is based on the minimal impact on flood levels downstream of the discharge point for extreme flood events (the 1:20 year and 1:1000 year in combination with selected flood levels of the River Thames).

4.5. Evaluation of the Enzygo drainage options analysis

The options assessment made by Enzygo leaves a lot to be desired.

The reference to Part H of the Building Regulations is aimed at the requirements of the drainage of individual properties. More recent guidance in the Non-statutory Technical Standards (NSTS) for sustainable drainage systems and the SuDS Manual, although very similar, should have been referenced.

In particular the principle of not pumping surface water is a very important one, and that pumping should be avoided or minimised if at all possible. No comment has been made on this aspect.

Pumping introduces risks of failure, additional operational costs and is contrary to the target of zero carbon.

Option 1 – infiltration SuDS

The use of infiltration SuDS is being discounted in spite of the fact that all properties and roads around the area are nearly all based on the use of soakaways. There is a development on the other side of the A4155 which is currently being built with using soakaways.

Although there are implications for voids creation, the speed at which chalk dissolves is such that it is likely that the development drainage could have been planned around this constraint - using soakaway elements at a safe distance from the dwellings. A lower density development, taking into account the geological investigations (see Figure 4.2) may well be possible. Figure 4.2 shows that there are a number of areas of reduced or minimal occurrence of voids (ALP 2020).

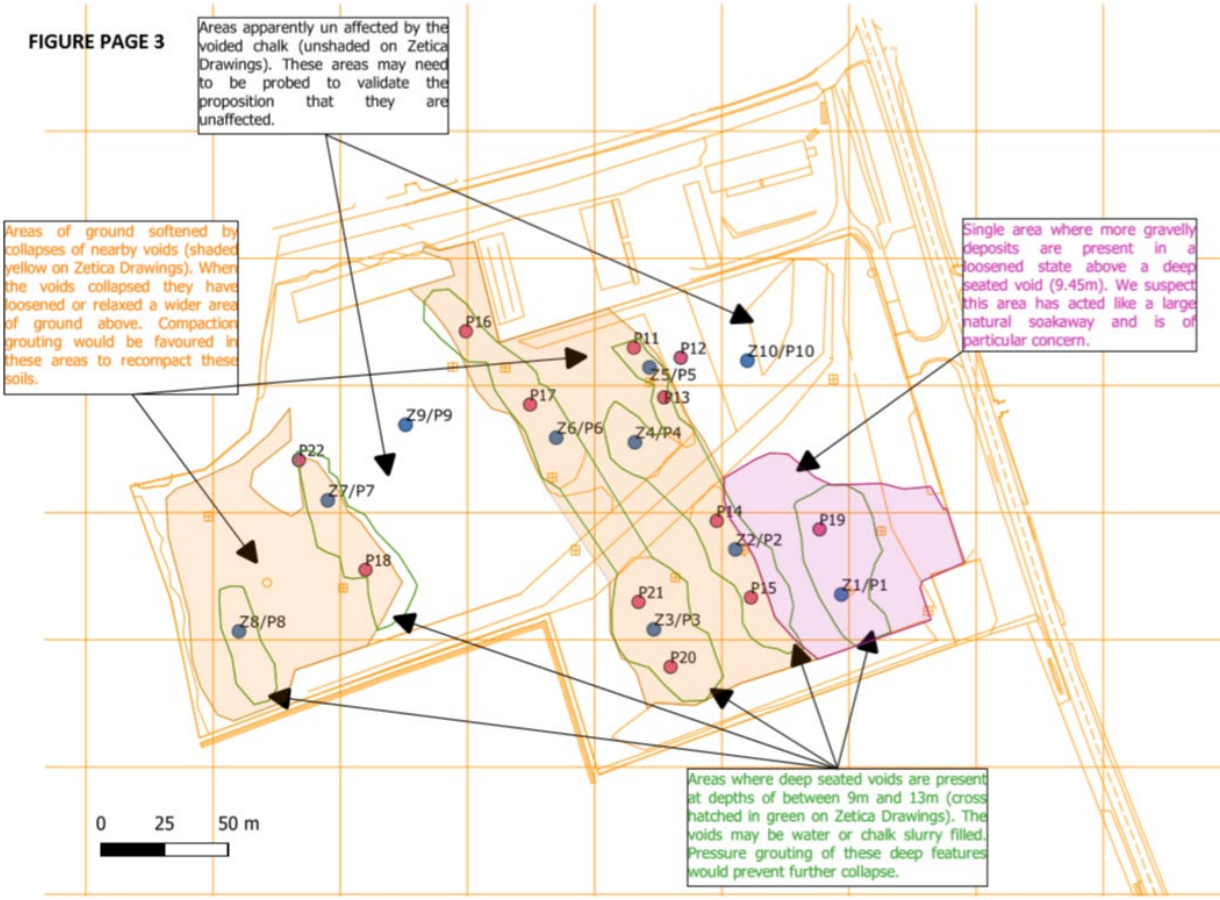


Figure 4.2: Geological voids investigation showing ground characteristics of the site

Source: ALP drainage statement 2020

Option 2 – Pumped flows to Lash Brook

The arguments presented against Lash Brook are weak.

The fact that the channel is a historic leat is of no relevance in terms of its hydraulic viability. At 8.5 l/s the pumped flow rates would result in finding the same minimal amount of flood impact (around 1mm or less) during extreme flood conditions.

There is no comparative information provided as to the flood risk associated with passing the surface water to the leat to compare with the impact assessment made for the preferred (North catchment) option.

It is quite possible to discharge flows under surcharged conditions. It is worth noting that this might also occur for the north (preferred) option when the field is in a flooded state.

The argument that additional flows to the River Thames may cause a flood impact while arguing that there is no impact for the Northern catchment option is contradictory. The scale of the difference in catchment sizes is several orders of magnitude.

Option 3 – Outfall to the northeast catchment

The arguments for rejecting this option is also weak.

It should be noted that Bolney Lane is close by and goes downhill (and is therefore a gravity option) and water features exist on the northern side of this lane both upstream and downstream of the railway line. Negotiations would be needed with land owners to get agreement for a discharge at these locations.

A second alternative option is provided in the ALP 2021 Drainage statement (which is not mentioned by Enzygo) which could also drain by gravity to the R. Thames. This has been rejected due to the need to provide 2m of cover for the railway line. Although this might mean discharging to the river in a surcharge condition for much of the year (though details such as river water levels and bed levels are not provided), there is no intrinsic difficulty for discharging to the river in this hydraulic state.

The argument presented by Enzygo that there is a need for a 5m pipe depth which precludes consideration of this option needs further explanation. Several points can be made:

- Putting in pipes at 5m is feasible. It is not clear how far a deep pipe would be required;
- This does not align with the Drainage Statement (ALP 2021) where this constraint is not mentioned;
- If it is due to the depth of the drainage in the development, then this would also be true for the Northern / Harpsden catchment option if a pump station was not used, or a pump station could be used to lift it to the head of a gravity drain for the North-east route.

Option 4 – Pumped flows to an outfall to the Harpsden catchment alongside the A4155

The issues associated with this (currently preferred) option have been discussed earlier. Nevertheless it is worth repeating that the reasons given for rejecting the Lash Brook option are equally applicable to the north catchment option.

This option has not been evaluated for its normal operating runoff conditions of road drainage flows and water quality impact.

4.6. Conclusions on the Enzygo options analysis for surface water destination

The Enzygo assessment of the options is very weak. The report does not carry out a rigorous assessment of the relative merits and difficulties associated with each option. In particular the rejection of infiltration SuDS is discounted on the basis that the housing density proposed must be maintained rather than designing around this constraint.

The north east catchment discharge should be compared like for like with the Northern catchment option. This should be with both being pumped and both being drained by gravity. The gravity option would have a shorter deep sections of pipework for the North-eastern route than the Northern option.

One of the North-eastern options has not been mentioned by Enzygo which would allow discharge directly to the R. Thames. This would seem to have no reason to be rejected other than the fact that the outfall would be operating in surcharge which is not a constraint.

5. The drainage proposals of the development

A brief outline of the site drainage proposals are detailed here along with comments on the proposals.

5.1. The catchment area and drainage characteristics

Figure 2.5 shows the site area, along with colouring to show the steep terrain and the upstream catchment area. The ground comprises sands and gravels overlying Chalk. Rainfall will therefore pass through the sands and gravels as it flows down towards the site and hence into the chalk. Groundwater levels are said to be at least 12m below the surface.

Therefore, apart from the solution voids, the ground is ideally suited to infiltration which has been shown by soakage tests and is used universally across the local area to serve property drainage.

5.2. The planning drainage proposals

The initial planning proposals (CEC, 2016) were limited in detail, but proposed the use of infiltration SuDS of soakaways, permeable pavements and infiltration basins. This was proposed prior to finding the voids on site.

Outline calculations for SuDS design storage volumes are given (ALP 2021 Appendix 1). It is notable that the storage appears to have been designed using FSR rainfall data (which should not be used) while other elements of the drainage analysis has been carried out using FEH13 (which is the correct data to use). A detailed evaluation of the drainage modelling has not been carried out.

A check has not been made to compare the results given in the Microdrainage and the storage actually provided on the drawings. It should be noted that there has been an increase in storage volume required as the limit of discharge from the site has been corrected (and reduced to 8.5 l/s) since ALP2020.

The ALP 2021 Drainage Statement claims a comprehensive SuDS based design. The drawings show a few permeable pavement areas and a basin. However it is not clear how these permeable pavements have been used as part of the storage system (though it appears they are not being used as storage systems) and the basin is being used as an offline unit and therefore will not fill for regular small storms and therefore it is not treating runoff. It is not clear how frequently it will come into operation.

In summary the drainage arrangements appear to be the use of an oversized low level pipe to provide storage at the bottom of the site which discharges into a pump station. Two vortex flow control units are used to create a backing up of flows into the geocellular unit, the concrete storage tank and into the SuDS basin. This means that there is effectively no treatment provided for the surface runoff and there is minimal use of SuDS.

The SuDS principles of amenity, biodiversity and water quality have not been applied appropriately (see Appendix B of this report).

The A4155 road along the eastern boundary of the site has been included into the drainage of the site, but is drained via a separate storage system. These flows join the development runoff in the final section of pipework as it passes to the pumping station.

5.3. The ground compaction proposals

It is proposed to carry out widespread use of grouting and ground compaction to make it safer for the construction of the dwellings and roads.

There appear to be several consequences that have not been considered. These are:

Groundwater flows

As there is a significant amount of steep ground uphill of the site and also several properties introducing surface water into soakaways, the risk of surface springs developing across the upper part of the site if the flow through the ground is impeded should be considered and evaluated.

If the compaction and grouting takes place at regular spacings, but there are spaces where the ground remains pervious, the risk of the voiding and settlement effect that remains across the site presumably might remain an issue.

It is possible that there will be no hydro-geological consequences of this activity, but these additional risks should at least be considered to ensure the proposals are robust.

Aquifer impact

There is no mention of discussions with the Environment Agency (only Thames Water) regarding the use of grouting on the risks to polluting groundwater in this category 1 SPZ area. It would seem that the behaviour and recharge of the aquifer would change, as well as difficulties in being sure in avoiding contamination of the groundwater. The Environment Agency are usually very concerned to protect such zones, even to the extent of requiring special precautions in the use of SuDS systems.

It should be noted that this aquifer is probably the main source for the base flow in the stream which passes through the properties on Mill Lane. It seems quite possible that this base flow might well be affected by the proposed ground stabilisation for the development.

In addition it should be noted that lining of structures such as geocellular units is often fraught with problems of making them water tight, either due to sealing round inlets and outlets or puncturing during the construction process. Leakage and therefore infiltration taking place from such structures, without the added protection of surface soils, is therefore a high pollution risk.

Overland flow management

The pluvial (surface water flood risk) map of the site Figure 2.4 identifies the overland flow route across the site from the hillside above the site. Drainage designs should cater for any overland flows likely to enter the site, and route such flows safely through the site. Overland and exceedance (events that exceed the capacity of the drainage system) flow management should be considered as part of the design. At the very least the arrangement of roads and houses on the development should facilitate an overland and exceedance flow path that is safe and minimises the risk of property flooding.

Runoff from compacted ground

The issue of design criteria is addressed in the next section. However it is important to note that this design has used the long standing erroneous usage of a 75% runoff factor to represent flow from paved (impervious) development areas and a 0% runoff factor to represent flow from pervious (landscaped/green) areas will be particularly inappropriate for this site. Impervious surfaces are likely to generate a higher proportion of runoff for extreme events, and the pervious surfaces, particularly where they are steep and compacted as a result of the ground stabilisation operations, will generate runoff. It is therefore likely that the storage volumes calculated for the control of the runoff from the site will be under-estimated (and the system therefore under-designed).

5.4. The drainage design criteria

The ALP 2020 Drainage Statement has been modified for the ALP 2021 version.

The site area is still claimed to be 5.6 ha. However the limit of discharge has been reduced from 32.6 l/s to 8.5 l/s. Therefore whether the site is 4.6 ha (as approximately measured by this study) or is actually 5.6 ha, this limit of discharge meets current best practice of limiting it to Qbar or 2 l/s/ha whichever is the greatest flow rate.

On other aspects of good SuDS practice from a hydraulic perspective, the drainage proposals do not attempt to mitigate the runoff volume being pumped. There is no design to meet the recommended requirements for Interception (reduction of 5mm from every event reduces annual total runoff volumes by around 75%) by using rainwater harvesting or lined swales or other SuDS features.

5.5. Water quality

For water quality treatment, runoff that occurs from regular (everyday) rainfall should pass through basins (or other SuDS components) as on-line systems. Off-line systems, as designed here, will only be utilised in extreme events and therefore do not serve the purpose of providing water quality improvement. A more detailed examination of the scheme with a focus on water quality and SuDS treatment is given in Appendix B.

The current drainage proposals for surface water from the development together with an additional ~200m of A4155 significantly increases pollutants in the runoff as there is no SuDS treatment being provided for this either.

Although traffic loading is much less on the site than the A4155, the cold starting of cars adds more pollutants than cars travelling along a road. In addition, the potential for residents to use herbicides, changing car oil, use of paint solvents and other undesirable practices, is obvious and may take place.

In the longer term there is often a problem with errors in connections from the wastewater systems to the surface water systems. This is commonplace and a well-known occurrence. As SuDS (open vegetated systems such as swales) are not being used, these instances will probably not be visible and therefore not seen and dealt with.

5.6. Highway drainage

The highway drainage along the frontage of the development has already been developed and it is understood it is being disposed of by infiltration (as there is no pumping station at present). It is unclear why this approach is acceptable as a temporary measure and not as a permanent one.

There is a private road opposite the site where road gullies already exist which appear to pass road runoff to the north. This flow may be picked up in a highway drain slightly to the north on the asset plan shown in the ALP Drainage statement. It is unclear why the development would not develop this as the drainage strategy for the highway runoff rather than incorporating the runoff it into the site drainage with the associated requirement for additional pumping.

5.7. Sewers adoption by Thames Water

It is understood that Thames Water is to adopt the surface water network (excluding the SuDS features) in spite of the high proportion of highway runoff and the fact that all flows are pumped and there is no mitigation of the runoff volumes. This is unusual as water companies are not keen to take on responsibility for drainage systems where there is a very high proportion of highway runoff.

The adoption of this system is not in line with the declaration made by all water companies being net zero carbon by 2030, nor is it in keeping with applying the SuDS principles which are espoused by the water companies and Ofwat. The water industry commitment to net zero by 2030 has been endorsed by Thames Water https://www.thameswater.co.uk/about-us/responsibility/climate-change.

5.8. Conclusions on the development drainage design

It would appear that:

- No consideration has been given to overland runoff from uphill of the site or management of the flows that exceed the capacity of the drainage system - either in terms of protecting the new dwellings from flooding or in terms of increasing the runoff passing into the drainage system;
- There is no consideration of the impact of compacting the ground on groundwater flows coming into the site from the small uphill catchment;
- There is no SuDS treatment of surface water runoff and therefore the SuDS design is not in accordance with best practice.

It is considered that infiltration SuDS are likely to provide the most appropriate drainage solution and this approach should be considered further, with the development being designed to take account of the geological constraints of the site.

6. Conclusions

The following conclusions are presented in two parts: the first cover the likely impact of the current drainage proposals on the Henley community; the second cover the short-comings of the current drainage design.

6.1. Impact review of the Thames Farm development drainage proposals on the Henley community

These conclusions are divided into two parts; hydraulic impact followed by the water quality impact.

6.1.1. Flood assessment

1. The Enzygo FRA assessment results generally tally with the pluvial flood maps of the Environment Agency and their conclusions relating to the minimal change in flood extents for very severe floods due to adding 8.5 l/s are incontrovertible.

2. The theoretical assessment of the flood flows is in accordance with general practice, but in this case the degree of uncertainty as to the actual flood flow rates generated by the catchment is very high. All the evidence on the ground suggests that overland flow of this ephemeral stream from the catchment as a whole is very rare and that flows and the flooding normally experienced are largely associated with road runoff.
3. Notwithstanding this assessment, it is worth noting that the highway drain serving the A4155 along with the additional flows pumped from the site, will arrive at the culvert long before any flood flows from the Harpsden catchment (if and when this takes place).
4. There has been no assessment made of the likely impact of flows from the development on flow rates and flooding when considering only runoff from the A4155 and other contributing road drainage systems (i.e. with zero or minimal runoff from the Harpsden catchment). This should be done as short duration intense thunderstorm events will generate major flow rates, which will occur much more often than any major flood that could come down the Harpsden catchment from long duration extreme events.
5. The current state of the A4155 culvert is that it is 90% blocked with sediment. The Enzygo model assessment with blocked and unblocked assumptions is appropriate. However the implications of the blockage and repercussions of removing the blockage were not effectively spelt out. As the capacity of the A4155 culvert appears to be greater than the railway culvert downstream (and the intermediate hydraulic structures), any removal of the sediment would transfer more flooding to the AFC grounds and other properties such as Lavender Cottage. However not clearing the sediment will continue to impact the owners of the properties upstream, possibly as high up the valley as the pond at Harpsden Court. Flooding at these properties is known to happen regularly. The field is effectively currently being used as an attenuation system (with the blocked culvert acting as a throttle).
6. The ephemeral nature of the Harp stream, which is supported by the evidence of the minimal channel through the field upstream of the A4155 and lack of any visible channel above Harpsden Court, may mean that overland flows and flooding are quite rare. In contrast, flows from the highway drainage and the proposed development drainage system will take place up to 100 or more times a year and will therefore constitute the majority of the flows along the ditch through the football grounds and downstream.
7. Flow rates and particularly volumes of runoff in the watercourse will therefore be measurably enhanced by the development pumped flows on many occasions and this will often be quite a significant increase in flow rates for the smaller rainfall events.
8. Flow volumes from all regular rainfall events will be increased by a factor of up to 3.5 based on the proportional increase in paved surface area as a result of the development. What this implies is that for large storm events the pumped flows will continue long after the direct highway drainage runoff and, due to the current blocked state of the culvert, significantly more local flooding will take place in the lower part of the field to the west of the A4155 for some events.
9. The flows down the stream in the vicinity of Mill Lane will regularly be enhanced by the additional surface water flow. As base flows in the stream at Mill Lane are 100+ l/s in winter and perhaps 25 l/s in summer, flow rates due to ordinary rainfall from the A4155 and the development will have a significant impact on the water quality.
10. The impact of the surface water runoff from standard rainfall events on Mill Lane properties will be more obvious if the A4155 culvert has the sediment removed. Until then, the field will act as a buffer to these flows as well as partially treating them due to settlement of the particulates.

11. The impact on the Mill Lane properties during extreme flood events depends on the nature of the rainfall, but it is thought that the high level of flooding that is occasionally experienced currently is more related to the levels in the River Thames backing up, or spilling out of bank from upstream, than the flood flows from the Harpsden Valley.

6.1.2. Water quality assessment

12. The highway drainage runoff from the A4155 is untreated and will be heavily polluted due to the highly trafficked characteristics of the road. At present sediments are deposited and building up at the A4155 culvert. It is also subsequently being partially treated as it passes through the drainage ditches of the AFC grounds. Although this will be having a material impact on the water quality of the flows along Mill Lane at present, this would probably be made worse when the culvert is cleared of this sediment.
13. The current drainage proposals for surface water from the development and an additional ~200m of A4155 significantly increases the pollutants in the runoff as there is minimal SuDS treatment being provided for the runoff by the development drainage system and none for the road runoff.
14. Although traffic loading is much less on the site than the A4155, the cold starting of cars adds more pollutants. In addition the potential for residents using herbicides, changing car oil, use of paint solvents and other undesirable practices finding their way into the surface water system, may take place.
15. In the longer term there is often a problem with misconnections from the wastewater systems to the surface water systems. This is commonplace and a well-known occurrence. As SuDS (open vegetated systems such as swales) are not being used, these instances will probably not be captured.

6.2. Other issues of note

16. The assessment made for the selection of the preferred option (the Northern catchment) has not been robust in considering the limitations and benefits of the other options.
17. The adoption by Thames Water (on the basis of the Design and Construction Guidance (Ofwat, 2020)) of a pumped based surface water system including a large proportion of highway drainage seems at odds with their position on both becoming carbon neutral and their position on avoiding adoption of highway drainage.
18. Although the site overlays geological voids and soft areas, the current development directly opposite the site downhill of the A4155 and all properties in the area and road drainage in the many locations are based on the use of soakaways. It may be appropriate to consider infiltration further as a drainage solution for this site, with the development layout adjusted based on the results of the geological investigations and appropriate risk management.
19. No consideration has been given to the effects of grouting and compaction on drainage into or from the site. The area uphill of the site might have a material impact on flows through the ground which perhaps could be forced up as a spring. A more robust evaluation of hydrogeological risks associated with substantial grouting is recommended.
20. There is no reference to discussions with the Environment Agency and their approval for the grouting regarding the management of risks of pollution and change in the aquifer recharge to the category 1 aquifer below the site.
21. There is no allowance for runoff from the pervious areas in the runoff calculations for the storage system – even though these areas are likely to be compacted as a result of the construction. This will mean the system is under-designed in terms of the storage provision.

Appendices

A. Notes and photographs from the site visit to inspect the Harpsden catchment

Thames Farm Shiplake development

Site visit record photos – Location 1

Date: 29/3/2021

Attendees: Richard Kellagher (RK) – HR Wallingford

Sheridan Jacklin-Edward (SJE) - Town Clerk (Henley on Thames Town Council)

Location 1: town rugby pitches south of Tesco, east of A4155

Ditch to south of pitches receives water from the Harpsden valley to the west. Three inflows to the ditch at the edge of the road:

1) local road gullies receiving runoff from the road locally – a 375mm? outfall pipe,
2) A road drain local coming down from the south – 450mm? Draining to the culvert on the west side of the road.
3) A culvert serving the runoff from the field (and valley) to the west.

Edge of ditch built up to reduce flooding across pitches at A4155 end of the area.

Groundsman stated edge of field is always green up to 10m away from ditch – possibly historic route of stream prior to fields being made into sports pitches.

Comment:

Item 1. 375 dia for 4 gullies seems excessive – check on highways information

Item 2. Ditto for this 450 dia for road drain down the hill is large indicating a long length of road served (perhaps from the top some 1.2km away). Pipe nearly completely blocked.

Item 3. Twin 450/525mm? Dia culvert full of silt at upstream end. Pipes more than half blocked.

1. 375mm Culvert serving A4155 4 gullies at road low point. (Guessed).

2. Looking downstream. Dry small channel with embankment on north side to protect pitches.

3. Upstream side of culvert under A4155.

4. Upstream side of culvert under A4155 with road drain coming in from the south. (guess)

5. Downstream side of culvert under A4155

6. Looking north from culvert exit with ditch connecting to ditch 5m away beside AFC grounds.

Thames Farm Shiplake development

Site visit record photos – Location 2

Date: 29/3/2021

Attendees: Richard Kellagher (RK) – HR Wallingford

Sheridan Jacklin-Edward (SJE) - Town Clerk (Henley on Thames Town Council)

Location 2: downstream of Location 1, town rugby pitches south of Tesco to railway line culvert

Box culvert extended with two large pipes to pass over the ditch to another playing field. Smaller capacity than A4155 culvert.

450mm ancient brick circular pipe serving flood basin immediately upstream of railway culvert. Discharges 10m downstream close to twin pipe inlets for railway drain passing water. Very small capacity compared to A4155 culvert.

Railway culvert pipes 450mm twin(?)

Comment:

Box culvert: Stated as having been surcharged and forcing one of the pipes inwards.

450mm dia pipe must be a constraint. Flood risk to properties (Lavender cottage etc.) and pitch close by.

Railway culverts greater capacity, but less than A4155 and likely to be a constraint for a big flood event.

7. pipes entering box culvert half way along between A4155 and railway line in the AFC grounds

8. Box culvert half way along between A4155 and railway line in the AFC grounds

9. Very old 450mm culvert serving AFC ditch passing flows from ditch to railway culvert.

10. Very old 450mm culvert serving AFC ditch and ponding (waste) area.

11. Outlet from very old 450mm culvert serving AFC ditch near railway culvert inlet.

12. Railway culvert inlets. Twin 450mm?

Thames Farm Shiplake development

Site visit record photos – Location 3

Date: 29th March 2021

Attendees: Richard Kellagher (RK) – HR Wallingford

Sheridan Jacklin-Edward (SJE) - Town Clerk (Henley on Thames Town Council)

Location 3: downstream of railway line culvert to Mill Lane

Outfall from railway culvert downstream of sports pitches and Lavender Cottage.

Dry channel at railway becomes wet channel 100m downstream just prior to where it joins larger base flows from the south and goes off east and north towards Mill Lane.

Comment:

Although this is stated as being the river Harp, it has a much smaller baseflow rate compared to the baseflow from the direction of Shiplake. However all flows are low.

13. Railway culvert downstream outlet (smaller capacity than culvert under A4155).

14. Looking downstream to (small) pipe from railway culvert outlet. Single 450mm / 525mm?

15. Becomes a stream just before it joins the main stream from the south – in horses fields

16. Main stream junction with large culvert under railway below Black Bears polo club

17. Railway culvert from Black Bears Polo club

18. Flow in culvert from Black Bears Polo club. Origin of flows although there is a small pond on the west side of the railway line.

19. Stream coming from Shiplake to join culverted flow from Black Bears Polo club.

Thames Farm Shiplake development

Site visit record – photos Location 4

Date: 29/3/2021

Attendees: Richard Kellagher (RK) – HR Wallingford

Sheridan Jacklin-Edward (SJE) - Town Clerk (Henley on Thames Town Council)

Location 4: Mill Lane to outfall to the R. Thames

Open channel passing through private gardens.

Many small bridges and property roads for access which would influence flood depths through gardens as flows pass towards the outfall to the R. Thames.

Comment:

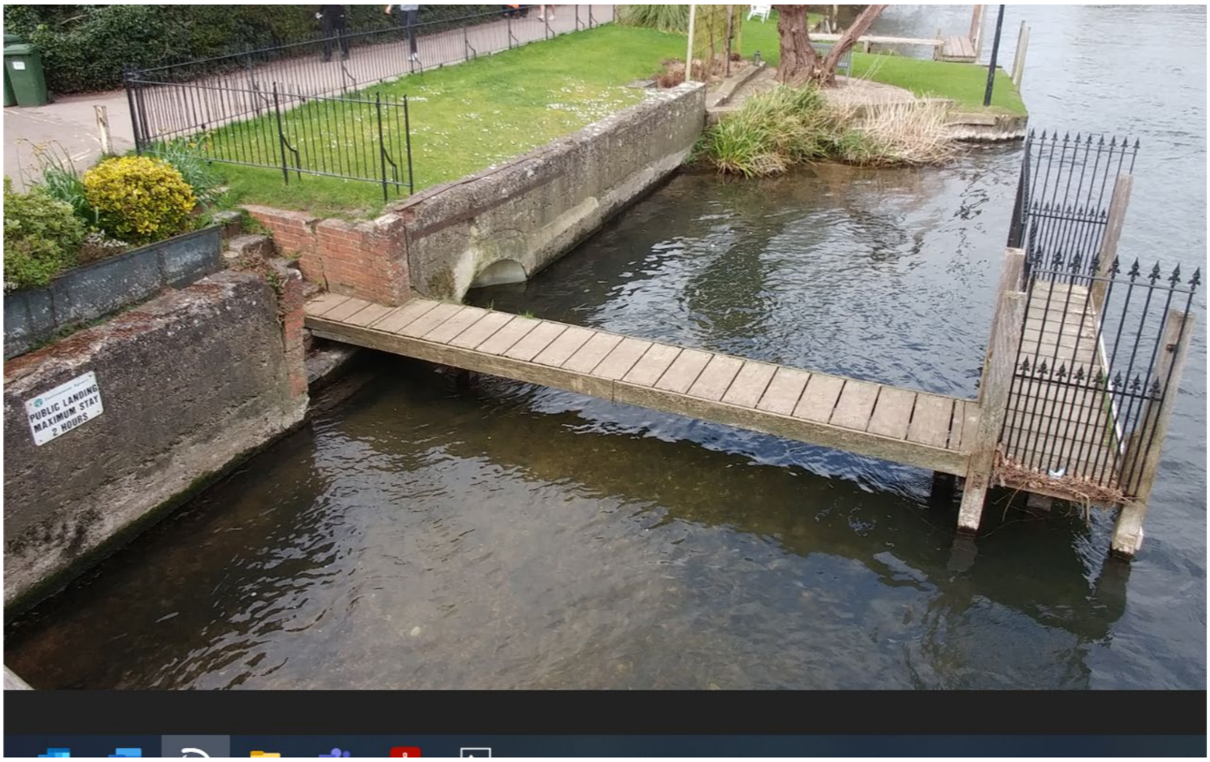
Mill lane also acts as a flow conduit during flooding though flooding often commences as a backwater effect from the R. Thames.

The flood events from the Harp valley and the R. Thames are often in sync due to the delay in runoff from the chalk response. However there is not complete dependency (not least because much of the R. Thames catchment is up to 100 miles to the west).

Images

20. Outfall to River Thames by Mill Lane.

21. Outlets into R. Thames – one low level pipe, one overflow level pipe.



22. Second low level outfall to R. Thames.

23. Water level weir control immediately upstream of outfall.

23. Stream in garden immediately upstream of outfall. On Mill Lane. Flow estimated at 100+ l/s. Garden is flooded quite regularly in flood events to ~500mm.

24. Many small bridges across stream along Mill Lane

25. Looking south – stream approaching Mill Lane.

Thames Farm Shiplake development

Site visit record photos Location 5

Date: 29/3/2021

Attendees: Richard Kellagher (RK) – HR Wallingford

Sheridan Jacklin-Edward (SJE) - Town Clerk (Henley on Thames Town Council)

Location 5: Uphill of A4155 in Harpsden valley towards Harpsden Bottom

Images.

25. Ponding of water downstream of culvert under road coming down from Harpsden Bottom to A4155.

26. Culvert under road (downstream side).

27. Ponding on upstream side of road.

28. Culvert under road (upstream side).

29. Route of flow (shallow channel) across horse field down to A4155 culvert.

30. Road above culverted stream route. Regularly floods

31. Harpsden court pond. 'Harp river' 1m below base of pond on right hand edge. Another spring coming in top left. Water level is aquifer water level.

32. Downstream outlet from pond 2 x 300mm pipes). Water in channel reflecting water level in pond?

33. Path and drainage depression? Into churchyard just above Harpsden Court.

34. Uphill from church looking up road to Sonning Common. Gullies connected to inflow to pond (to be rectified soon).

Thames Farm Shiplake development

Site visit record – photos location 6

Date: 29/3/2021

Attendees: Richard Kellagher (RK) – HR Wallingford

Sheridan Jacklin-Edward (SJE) - Town Clerk (Henley on Thames Town Council)

Location 6: The Thames Farm development and A4155 beside it

Beany block drainage along low point in road and believed to be drained by infiltration on site. The deep ditches beside the A4155 may have had a temporary role during construction.

Several gullies adjacent to private road opposite site. May take past road runoff to the east to existing highway drain (as shown in ALP Drainage Statement).

Comment:

Possibility that, in the past, flooding from the road passed over the bank on east side of road and under wooden fence at low point. This area is currently under development.

Soil cut from site so current state of site is likely to be more susceptible for generating flooding to the A4155.

Woodlands Road, properties above the site (and other areas uphill of the site) drain to grips and soakaways (probably).

Images in photos location 6.

35. Site workings at Thames Farm (steep site).

36. Deep ditch cut by developers beside A4155 – no apparent inlets or outlets.

37. Beany blocks drainage of A4155 (all along the road beside development site)

38. Deep ditch on opposite side of road beside private road probably serving existing few gullies locally. Possible drained to existing highway drainage to the east.

39. Downhill side of road. (new development site access – ongoing). Possible flood route from road if Beany Blocks don’t cope (or prior to their provision).

B. Detailed evaluation of the Thames Farm Drainage proposal

B.1. The current drainage proposal

The current drainage proposals for the site are understood to be those described in the drawings that comprise Appendix A of the ALP 2021 Drainage Statement. The system has been modified due to the additional storage requirements due to the reduction in the limit of discharge applied to the drainage system.

The scheme details are summarised and commented on in Table B.1.

Table B.1: Drainage scheme details summary

Scheme Element	Comment
Pervious pavement	There are a four areas of (private) parking and road surface designated as pervious block pavement. The majority of the road surface is not permeable paving. ***Although these areas will provide 'source control' and absorb some initial rainfall, there are no immediately downstream flow controls so the sub-base will not be utilised for storage.*** The surface layers and underlying sub-base will provide suitable treatment of pollutants deposited on the surface from the low level vehicular use.
Off-line storage basin	The number of basins have been reduced from two to one. The other has been converted fully into geocellular storage rather than providing part of it as a basin. ***The basin only comes into operation by off-line reverse flows when other forms of storage have been filled or partially filled.*** ***No treatment is therefore being provided by this SuDS unit.***
On-line storage in oversized pipes	The downstream sections of the drainage system (upstream of the flow control unit) includes a number of lengths of large diameter (1050mm) pipes. These are provided for attenuation storage prior to water levels in the system reaching the weir control levels that allow flow to pass into the storage basins. These lengths of pipe are laid at a shallow gradient (1:500) – so maximising attenuation opportunities at the expense of self-cleansing velocities. ***Runoff from impervious surfaces will have a sediment load and, without upstream management of this sediment, it is likely that this will settle out in the large, flat pipes as flows are backed up by the limited flow rate of the pumps. Eventually there will be a high volume of sediment settled in these pipes reducing storage capacity.***

B.2. Good practice for managing the quality of surface water runoff

Industry good practice for the design and construction of SuDS is set out in the SuDS Manual (CIRIA, 2015). Water quality management is one of the four design pillars, and its importance is reinforced by the Oxfordshire County Council Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire (November 2018).

Key principles of designing for water quality management are:

- To capture and retain all frequent/small events (up to approximately 5mm in depth) on the site (an approach known as Interception);
- To treat all runoff up to approximately a 1 year return period event;
- To ensure that captured pollutants are not re-mobilised and washed out of the system for more extreme events.

The ALP drainage strategy (2020, 2021) does reference SuDS good practice and the use of a 'train' – which implies consecutive SuDS components each gradually improving the quality of the runoff. However these principles have not been implemented in the design.

The amount of treatment required for surface water runoff depends on the site land use (i.e. the likely loadings of contaminants on the impervious surfaces) and the environmental sensitivity of the receiving waterbody.

The proposed land use is residential development only (95 dwellings) and the receiving watercourse is not designated as environmentally sensitive. Runoff from residential roofs, private driveways, residential car parks, and low traffic roads (e.g. cul de sacs, homezones and general access roads) are all categorised as 'low' in terms of pollution hazard by the SuDS Manual (see Table 26.2). This means that a single SuDS component (e.g. grass swale (channel), bioretention system, pervious pavement, storage basin, pond or wetland) is considered sufficient in providing suitable treatment of the runoff prior to discharge. Any wet features require sediment removal upstream in order to protect their treatment functionality and amenity and biodiversity value.

The only components of the proposed drainage system that will deliver Interception and treatment are:

- The pervious pavement areas (but these are only being implemented on a small proportion of the site);
- The storage basin (but these will only receive runoff for relatively extreme events and will be ineffective for events requiring treatment).

Although it is likely that some sediment may be trapped in either the pipes or the wet well at the pumping station, there is a risk that sediments and associated heavy metals, and hydrocarbons from vehicular discharges and deposits will be pumped downstream.

Tables 26.8 – 26.12 in the SuDS Manual summarise available pollution concentration data for suspended solids and some heavy metals and compare this to environmental standards. These tables are repeated below and indicate the likely raised concentrations compared to environmental standards.

These tables do not reflect behavioural activity such as the effects cleaning cars or changing oil or pouring away solvents after cleaning paint brushes.

TABLE 26.8 Total suspended solids: summary of a selection of monitoring datasets

	Reference	Land use	Total suspended solids concentration		
			25%ile (mg/l)	Mean (mg/l)	75%ile (mg/l)
Observed runoff data	Mitchell (2005)	Urban open	57	126.3	279.8
		Industrial/commercial	18.1	50.4	140.4
		Residential	37.6	85.1	192.5
		Main highway	62.2	156.9	396.3
		Multi-lane highway	110.1	194.5	343.5
	US BMP database (Leisenring *et al*, 2014)	Average across all studies	19.8	48.7	113.7
	WRc (2008)	Trunk roads and motorways		244	
Environmental standards	Minimum concentration causing observable biological effects[1,2]		25		
	Mean level in minimally impaired ponds[2]		19		

TABLE 26.9 Total cadmium: summary of a selection of monitoring datasets

	Reference	Land use	Total cadmium concentration		
			25%ile (µg/l)	Mean (µg/l)	75%ile (µg/l)
Observed runoff data	Mitchell (2005)	All	1.3	2.2	3.7
	US BMP database (Leisenring *et al*, 2014)	Average across all studies	0.2	0.3	0.6
	WRc (2008)	Trunk roads and motorways		0.63	
Environmental standards	Surface water standard: minimum concentration causing observable biological effects[1]	0.66			
	Surface water standard: environmental quality standard for dissolved cadmium[2,3]	AA (annual average) ≤0.08 (< 40 mg/l $CaCO_3$) 0.08 (40–50 mg/l $CaCO_3$) 0.09 (50–100 mg/l $CaCO_3$) 0.15 (100–200 mg/l $CaCO_3$) 0.25 (> 200 mg/l $CaCO_3$)		MAC (maximum allowable concentration) ≤0.45 (< 40 mg/l $CaCO_3$) 0.45 (40–50 mg/l $CaCO_3$) 0.6 (50–100 mg/l $CaCO_3$) 0.9 (100–200 mg/l $CaCO_3$) 1.5 (> 200 mg/l $CaCO_3$)	
	Groundwater standard: minimum reporting values[4]	0.1			

TABLE 26.10 Total copper: summary of a selection of monitoring datasets

	Dataset	Land use	Total copper concentration 25%ile (µg/l)	Mean (µg/l)	75%ile (µg/l)
Observed runoff data	Mitchell (2005)	Urban open	19.8	27.9	39.2
		Developed open	22.3	51.1	117.1
		All highways	43.2	80.3	149.5
	US BMP database (Leisenring *et al*, 2014)	Average across all studies	5.6	10.9	22.0
	WRc (2008)	Trunk roads and motorways		91.22	
Environmental standards	Surface water standard for dissolved copper: environmental quality standard[1,2]	1 (0–50 mg/l $CaCO_3$) 6 (50–100 mg/l $CaCO_3$) 10 (100–250 mg/l $CaCO_3$) 28 (> 250 mg/l $CaCO_3$)			
	Surface water standard: minimum concentration causing observable biological effects[3]	5			
	Surface water standard: mean level in minimally impaired ponds[3]	12			
	Groundwater standard: 0.75 × MAC for drinking water standard[4]	1.5			

TABLE 26.11 Total zinc: summary of a selection of monitoring datasets

	Dataset	Land use	Total zinc concentration 25%ile (µg/l)	Mean (µg/l)	75%ile (µg/l)
Observed runoff data	Mitchell (2005)	Urban open	102	203	403.9
		Industrial/commercial	84.7	188.6	420.2
		Residential	192.8	296.9	457.2
		Main highway	97.7	253.1	655.5
		Multi-lane highway	284	417.3	613.3
	US BMP database (Leisenring *et al*, 2014)	Average across all studies	28.7	55.9	111.6
	WRc (2008)	Trunk roads and motorways		352.6	
Environmental standards	Surface water standard for dissolved zinc: environmental quality standard[1,2]	8 (0–50 mg/l $CaCO_3$) 50 (50–100 mg/l $CaCO_3$) 75 (100–250 mg/l $CaCO_3$) 125 (> 250 mg/l $CaCO_3$)			
	Surface water standard: minimum concentration causing observable biological effects[3]	30			
	Surface water standard: mean level in minimally impaired ponds[3]	97			
	Groundwater standard: EPA[4]	5			

TABLE 26.12 Total nickel: summary of a selection of monitoring datasets

	Dataset	Land use	Total nickel concentration 25%ile (µg/l)	Mean (µg/l)	75%ile (µg/l)
Observed runoff data	Mitchell (2005)	Urban open	10.2	14.8	21.6
		Developed open	18.2	30.4	50.6
	US BMP database (Leisenring *et al*, 2014)	Average across all studies	2.8	4.6	7.9
Environmental standards	Surface water standard for dissolved nickel: environmental quality standard[1,2]	20			
	Surface water standard: minimum concentration causing observable biological effects[3]	5			
	Groundwater standard. 0.75 × MAC for drinking water standard[4]	15			

B.3. Good practice for other aspects of SuDS design

Amenity and biodiversity are also aspects of good SuDS practice. These are not considered or delivered by this drainage design.

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