A2Dominion Group

NW Bicester Eco Development - Exemplar Site

Spine Infrastructure and Phase One Development Drainage Strategy

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1 INTRODUCTION

1.1 Terms of Reference

Hyder Consulting (UK) Ltd. (Hyder) has been instructed by A2Dominion Group (A2Dominion) to provide engineering and infrastructure design in support of the the proposed new eco development on the north-western periphery of the town of Bicester, Oxfordshire. The proposed eco development site will comprise approximately 5,000 homes with supporting employment and education infrastructure. The Exemplar Site is the initial phase of the development, located at the north eastern end of the study area. For the Exemplar Site, an initial drainage strategy has previously been prepared (7501-UA001881-UP21R-02, Drainage Strategy - Exemplar Site). Initial construction phases will comprise the spine infrastructure and the phase one residential area of the Exemplar Site. The spine infrastructure incorporates the main road running through the site, including the services and drainage within it as well as adjacent Sustainable Drainage System (SuDS) features. The phase one residential area comprises 94 homes in the south east of the Exemplar site.

This report re-establishes the principles and strategy of both foul and surface water drainage across the Exemplar Site and contains details proposed to manage the surface water runoff and foul water generated by phase one and the primary infrastructure of the site.

1.2 Location

The town of Bicester lies approximately 24km to the north east of Oxford and 28km to the south east of Banbury. The M40 motorway lies 2km to the south west, with established access to the town from Junction 9.

The eco development will be situated on the north-western periphery of Bicester, beyond the A4095 (which forms part of the Bicester Ring Road), approximately 1.5km from the town centre.

The Exemplar Site is situated at the northeast end of the development and covers an area of approximately 21.1ha of Grade 3 agricultural land. To the west of the Exemplar Site is the village of Bucknell, with Caversfield located on the north-eastern Exemplar Site boundary, beyond the B4100 highway.

The locations of the eco development and Exemplar Site are presented on drawing 7006 within Appendix A. The areas of Phase 1 and the spine infrastructure are shown on drawing 7160 and 7161 within Appendix A.

2 EXISTING SITE

2.1 Topography

A topographical survey has been completed for the Exemplar Site.

Drawing 7013 (Appendix A) shows contours and topological details of the Exemplar Site produced from the topographical survey.

The existing topography of the Exemplar Site falls by approximately 4m from the north-western boundary to the south-eastern boundary (from ~92m AOD to ~88m AOD), with watercourses lying in central depressions reaching a depth of 82.5m AOD.

2.2 Ground Conditions

Ground conditions have been assessed within a desk study (Phase 1 Desk Study, document 2501-UA001881) and a factual report summarising the findings of onsite ground investigation (Exemplar Site Factual Report, document 2504-UA001881). Additional site investigation was conducted in July and August 2012 and detailed within a supplementary report (Supplementary Ground Investigation & Geotechnical Design Report, 0001-UA004014-UP32R-01-GI-F).

In summary, the investigations indicate that the site comprises stratum of sand and gravel overlying clay bands and limestone.

No significant contamination issues or risks have been identified within the reports and it is considered that ground contamination will not impact on the potential for drainage and ground infiltration.

2.3 Local Hydraulic Conditions

Drainage and Water Features

The Bure (an ordinary watercourse) flows in a southerly direction across the Exemplar Site from Caversfield House and Home Farm to a culvert beneath the A4095 before becoming a main river approximately 1km to the southeast. Downstream from this it flows in an open channel between Lucerne Avenue and Purslane Drive. There is an un-named tributary flowing in an easterly direction from Bucknell which converges with the Bure downstream of Home Farm. Ditches run adjacent to the roads bounding the Exemplar Site, accommodating runoff from the roads and adjacent areas and discharging to ground via infiltration. The existing water features are identified on Drawing 7019 within Appendix A.

Mapping obtained from Thames Water Utilities indicates that urban areas surrounding the eco development are drained by a positive drainage network of surface water pipes and manholes which discharge to nearby watercourses, and a network of foul sewers discharging by both gravity and pumped flows to Bicester Treatment Works.

Existing Drainage Mechanism

Rainfall on the Site discharges predominantly through the following mechanisms:

- Ground Infiltration - water seeps into the ground
- Surface Water Runoff – water discharges along the surface of the ground forming surface water features such as streams, rivers and ponds
- Evaporation and Transpiration – water evaporates from the surface of the ground or is taken up by plants

During large rainfall events, surface water runoff from the Site will contribute to flow in the watercourses, both on Site and further downstream, directly via surface water runoff and indirectly via ground infiltration.

Assessment of the hydrological conditions provides information regarding the proportion of water discharging by these mechanisms.

Greenfield Runoff Rates

The greenfield runoff rate is used to define limits on the permitted maximum discharge rates from the developed site.

The proportion of rainfall discharging as surface water runoff across the surface of the pre-development site to watercourses has been estimated using the IoH124 method. These results are expressed as greenfield runoff rates and have been agreed with the Environment Agency. The results are shown within Table 2.1 below.

The IoH124 method has been used to derive these figures, as recommended by the Environment Agency and set out within the SuDS Manual for sites up to 200ha. Further details of their derivation are provided within the Flood Risk Assessment (document 3501-UA001881).

Return Period	(l/s/ha)
Mean Annual Flood	2.29
1 in 30 year	5.12
1 in 100 year	7.29

Table 2.1 Calculated Greenfield runoff rates for the predevelopment site

Ground Infiltration Rates

Desk study of the hydrological conditions at the site indicates that the eco development has relatively low surface water runoff rates, with 1ha of land typically producing a peak discharge of only 7.29l/s during a 100 year rainfall event. The results indicate that the majority of rainfall discharges from the surface via ground infiltration and therefore infiltration rates at the site are considered to be moderate to good. Ground infiltration methods are therefore considered to be viable as part of the drainage strategy.

Surveyed data on site provides further evidence of the potential to discharge surface water from the development via ground infiltration. Tests were undertaken and completed in accordance with the requirements of BRE365 (Soakaway Design, March 2007, Building Research Establishment) and used to derive ground infiltration rates. To achieve ground infiltration rates that reflect the likely depth of soakaway features, the soakaway tests were conducted at depths of approximately 1m below ground level. The results indicate that ground infiltration is feasible within the superficial deposits and that soakage will also be feasible between depths of 1-2m below ground level. Table 2.2 sets out the ground infiltration rates derived which are of relevance to the spine infrastructure and phase one residential area. The results have been drawn from three different recent site investigations at the site. Appendix B contains the soakaway test results and test locations. The results reinforce the hydrological assessment and indicate moderate to good ground infiltration rates.

Discharge of surface water runoff via ground infiltration is considered feasible at the site. Although test SA5 did not return a satisfactory result, the remainder of the results are good and this may indicated a localised effect at SA5. However, there are no proposals for infiltration at this location.

Trial Pit	Infiltration Rate (mm/hr)
SP1	180
SP2	56
SP3	64
SA4	131
SA5	-
SA6	54
TP56b	38
TP58	67
TP59	51

Table 2.2 Ground infiltration rates

2.4 Planning Context

2.4.1 Cherwell District Draft Local Plan

The proposed submission Local Plan contains policies that seek to achieve a sustainable balance between water supplies and demand; and management of flood risk; including.:

- Policy ESD 6: Sustainable Flood Risk Management

  This policy identifies how the Council will manage and reduce flood risk in the district through using a sequential approach to development; locating vulnerable developments in areas at lower risk of flooding. Development proposals will be assessed according to the sequential approach and where necessary the exceptions test as set out in the NPPF. Development will only be permitted in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding.

  In addition to safeguarding floodplains from development, opportunities will be sought to restore natural river flows and floodplains, increasing their amenity and biodiversity value.

- Policy ESD 7: Sustainable Drainage Systems (SuDS)

This policy identifies that the Council will require all developments to use sustainable drainage systems for the management of surface water run off; protect groundwater and where possible provide landscape and wildlife benefits.

- Policy ESD 8: Water Resources

  This policy identifies how the Council seeks to maintain water quality, ensure adequate water resources and promote sustainability in water use. Development will only be permitted where adequate water resources exist, or can be provided without detriment to existing uses. Where appropriate, phasing of development will be used to enable the relevant water infrastructure to be put in place in advance of development commencing.

2.4.2 PPS 1

The supplement to Planning Policy Statement 1 states that Eco-towns should:

a Incorporate measures for improving water quality and managing surface water, groundwater and local watercourses to prevent surface water flooding from those sources;

b incorporate sustainable drainage systems (SuDS) and, except where this is not feasible, as identified within a relevant Surface Water Management Plan, avoid connection of surface water run-off into sewers;

c include a strategy at planning stage for the long term maintenance, management and adoption of the SuDS; and

d reduce and avoid flood risk wherever practicable through consideration of the location, layout and construction, whilst not increasing the risk of flooding elsewhere and using opportunities to address and reduce existing flooding problems.

3 SURFACE WATER DRAINAGE STRATEGY

3.1 Principles

The aim of this detailed design drainage strategy is to demonstrate that the exemplar site; including the initial construction phases of the spine infrastructure and phase 1 development, is designed to comply with the requirements of the Exemplar Site drainage strategy, demonstrating appropriate management of the flood risk associated with development of the site in accordance with the requirements of the Environment Agency and the requirements for Eco-towns as set out within PPS1, and to achieve level 5 of the Code for Sustainable Homes (CSH).

The drainage strategy takes forward the Exemplar Site drainage strategy and subsequent site investigations, and sets out proposals for key drainage features and the principles in line with which detailed design has been carried out.

The strategy includes proposals for a surface water drainage system based on Sustainable Drainage System (SuDS) principles, ensuring that following large rainfall events the developed site presents no greater flood risk to the surrounding area than the predevelopment site.

Residential property has been designed in accordance with the requirements of the CSH. Roads and drainage have been designed to meet the requirements of the adopting authority.

3.2 SuDS Strategy

The development has been designed to mitigate flood risk from surface water through use of SuDS, comprising a system of devices designed to manage both the quality and quantity of surface water runoff. The system would be used in conjunction with effective site management to prevent flooding and pollution.

The SuDS strategy is primarily based on discharge via ground infiltration, in accordance with the drainage hierarchy, minimising surface water discharges to nearby watercourses and the risk of flooding due to surface water. Ground conditions are suitable for use of ground infiltration methods as outlined in Section 2.3, excepting the pond within catchment 6, where a low infiltration rate was observed during site investigation. A conservative approach has been adopted and appropriate spaces have been set aside for open attenuation features within the site layout.

SuDS can be formed from a number of potential components, each having a variety of attributes and strengths which make them suitable or unsuitable for use in differing situations. The SuDS systems proposed comprise chains of linked SuDS components which complement one another and combined to form a treatment trains to ensure discharges are of appropriate quality.

The critical requirements of the SuDS system are to control water quantity and improve water quality. A number of treatment trains that meet the criteria are proposed and described within Sections 3.2.3 and 3.2.4.

The layout of surface water drainage infrastructure is shown on Drawings 7160 and 7161 within Appendix A. Key elements of the strategy are outlined further in this section.

3.2.1 Soakaways

During large rainfall events, hard paved areas have been designed to discharge surface water to soakaways at a greater rate than it is possible to discharge to the ground. Storage volumes will be provided to store accumulating surface water whilst it steadily discharges to ground. Further details of each type of soakaway proposed are set out in Sections 3.2.3 and 3.2.4.

3.2.2 Controlled Discharge to Watercourse

Discharge Rate

The controlled discharge of surface water to watercourses is required where inflow to a watercourse is desirable, where ground infiltration is poor and where an emergency overflow is provided for a soakaway. Discharge controls will be provided by flow control devices, restricting cumulative discharges to the mean annual greenfield runoff for the site for all rainfall events up to the 100 year event (including 30% allowance for climate change). During large rainfall events, surface water would enter the drainage system at a greater rate than can be discharged, requiring storage to accommodate the resulting volume of water.

The mean annual greenfield runoff rate has been derived using the IH124 methodology, as outlined in Section 2.3. The Exemplar Site comprises areas affected by the proposals and those which remain unaffected/undeveloped, such as the green corridor adjacent the watercourses. The areas affected by the proposals account for 17.5ha of the development and have been used to establish greenfield runoff rates for the developed areas, as shown in Table 3.1.

Return Period	Greenfield Runoff	
	(l/s/ha)	(l/s)
Mean Annual	2.29	40.1
1 in 30 year	5.12	89.6
1 in 100 year	7.29	127.6

Table 3.1 Greenfield runoff rates for the predevelopment site

Total discharges from the developed areas to watercourses will be limited to the mean annual greenfield runoff rate of 40.1l/s for the Exemplar Site, to significantly reduce flood risk as outlined in Section 3.2.7.

The total allowable discharge will spread between the discharge points achieving the discharges stated in Table 3.2 for each catchment. All discharge points would be constructed as part of the spine infrastructure and phase one works, with the exception of a pond located within Catchment 6, and the proposed distribution of discharge stated in Section 3.2.8. The catchment boundaries are shown on Drawing 7160 and 7161 within Appendix A.

Areas containing storage structures such as swales, ponds and basins will be landscaped and hydraulically designed to achieve an integrated layout suitable to the spatial requirements of both uses, meeting the functional and maintenance requirements of the soakaways and the aesthetic and amenity requirements of landscaping.

Discharge Volume

As set out in Section 3.1, CSH encourages SuDS to be designed such that the volume of surface water discharged during a 100 year rainfall event is not increased following development, through use of soakaways and rainwater harvesting. CSH recognises that many sites cannot achieve this due to unsuitable ground conditions and other overriding issues. In such cases, CSH recommends that the increased risk of flooding that increased volumetric discharge presents, is mitigated through additional restrictions on site discharge rates.

The existing site discharges approximately 1,270m^3 of surface water from the Exemplar Site during the 1 in 100 year event of 6 hour duration. This existing discharge volume is the equivalent to approximately 2.5ha of impermeable area. Calculations of this volume are provided within Appendix D.

Soakaways and ground infiltration are to be used at the eco development wherever feasible, which will combine with extensive rainwater harvesting and recycling to minimise the volume of water discharged to watercourses. As the site develops and additional phases are detailed, the total development runoff volume will become apparent. As a contingency for the scenario that the pre-development volume is exceeded, discharges to the watercourses during the large rainfall events that could cause flooding will be restricted to the mean annual greenfield runoff rate, in accordance with best practice and the Code for Sustainable Homes. Table 3.1 shows that the peak discharge rate for a 100 year rainfall event (plus 30% allowance for climate change) would be substantially lowered from 127.6l/s for the predevelopment Exemplar Site to 40.1l/s from the eco development.

Discharge Summary

The eco development has the potential to discharge a total volume of water less than or equal to the existing discharge volume. As a contingency for the event that the runoff volume has increased, the peak discharge rate has been significantly reduced to mitigate any increase in flood risk, in accordance with best practice and as set out in Table 3.2.

The spine infrastructure and phase one residential area is estimated to generate less runoff volume than predevelopment for the entire Exemplar Site, as demonstrated in calculation 7019 within Appendix D and summarised within Table 3.2, indicating it may be feasible to reduce the discharge volume below the pre-development rate following construction of future phases of the site. This would become apparent as site proposals develop.

		Post-development	
	Pre-development	Spine infrastructure and phase one residential only	Entire Exemplar Site
6hour duration 1 in 100 year discharge volume (m^3)	1,270	934	1,270[1]
1 in 100 year peak discharge rate (l/s)	127.6	30	40.1

1. Target figure for future development stages.

Table 3.2 Pre-development and post-development discharges

The discharge rate during large rainfall events will be reduced to 30l/s for the spine infrastructure and phase one residential areas, with another 10 l/s set aside as an allowance for discharges from future SuDS features.

3.2.3 Roads, Paved and Parking Areas

Adopted roads, including those within the spine infrastructure and phase one residential areas, will drain via a mixture of permeable and impermeable paving. The spine road is impermeable but utilises a number of roadside SuDS features which discharge runoff to ground via infiltration. Permeable block paving has been used where feasible across the site for the adopted roads within residential areas, allowing infiltration to the ground; along with channel drains discharging to infiltration blankets beneath road make up. SuDS features proposed are presented on drawings 7160 and 7161 within Appendix A. Community streets, parking, driveways and other areas of paving drain surface water via permeable block paving and soakaways within the housing areas.

Permeable Block-Paving

Permeable block paving are designed systems comprising block paviors underlain by a permeable sub-base. The block paving is spaced with permeable joining medium such as sand which allows rainfall to infiltrate and enter the sub-base, in which it is stored as it slowly infiltrates the ground beneath.

During normal rainfall events, areas of permeable paving discharge via ground infiltration alone, as described above. During exceptionally large rainfall events, beyond normal design horizons, and in the event of blockages and other such failures, water would overflow and flow to adjacent areas of permeable paving or flow overland following roads to a nearby channel, pond, swale or roadside SuDS feature.

Permeable paving provides a high level of treatment of runoff, with filtration trapping and biologically breaking-down particles and pollutants such as suspended solids and hydrocarbons.

Pond

A pond has been incorporated within the SuDS network as a permanent water feature at a central location in the site, located within catchment 6 as shown on drawing 7160 within Appendix A. The pond will accept runoff from the nearby road network and attenuated flows from future residential areas further to the north, parts of which may not be feasible to discharge to ground.

The pond is located in an area of limited ground permeability and will function primarily as a retention feature. Therefore, a flow control device will be used to control discharges and cause attenuation storage. Discharges will continue to the south through the drainage network and discharge via an enhanced swale adjacent to the receiving watercourse.

Enhanced Swales

Following large rainfall events, enhanced swales located around the Exemplar Site have been designed to receive and store some of the surface water runoff generated.

Enhanced swales are proposed adjacent to the watercourses and will receive runoff from adjacent areas and discharges from upstream SuDS features. The swales will incorporate a flow control device to control discharges to the required rates, as discussed in Sections 3.2.2 and 3.2.8.

The swales are incorporated into the landscaping proposals.

Roadside SuDS Feature

Infiltration trenches are proposed to be located adjacent the majority of the primary roads, comprising the majority of the spine infrastructure, within the site and comprise an excavation with permeable base, backfilled with granular filter and plant bedding material.

Particles would be trapped and removed by filtration as the water percolates down through the granular filter material. Surface water would discharge directly to ground, infiltrating the base and sides of the trench, with infiltration trapping and biologically break-down particles and pollutants such as suspended solids and typical road related hydrocarbons. In addition, in the north of the site, a flat vegetated verge will be incorporated between the road and infiltration trench, trapping and removing particles through filtration as the water passes through the vegetation before percolating the bedding material and filter material. Where roadside SuDS cannot be provided, kerb drains have been proposed as a substitute for conventional gullies to limit first flush impacts; draining to the enhanced swale features.

Village Street SuDS Feature

The commercial hub of the Exemplar site is the village High Street. A Roadside SuDS feature will be used to collect and discharge runoff from the adjacent areas. Landscaping proposals for future phases of development at the site will consider the enhancement of this feature.

Infiltration Blankets

Towards the fringes of the site, some areas of hard paving will use an infiltration blanket constructed beneath the hard surface to drain surface water runoff. Surface water runoff would be collected by channels at the edge of the hard paving, which would discharge to the infiltration blanket below. The infiltration blanket comprises a layer of highly voided material such as coarse stone, providing a storage medium for runoff whilst gradually discharging to ground through infiltration.

Online Storage

Oversized pipes are proposed to store highway drainage in the central site area within catchment 8, shown on drawing 7161 within Appendix A. A length of oversized pipe is also proposed to allow attenuation of runoff from a section of kerb drainage to the east of the Bure within catchment 9, shown on drawing 7161 within Appendix A. In these areas, runoff will be collected and conveyed by kerb drains to the storage. A flow control device will restrict discharges from the pipes. The pipes will discharge to the Bure through enhanced swales, providing additional enhancement to water quality. Such areas would be expected to receive regular inflow and would provide a valuable contribution to Green Infrastructure.

3.2.4 Property

Surface water runoff from the roofs and paved areas of residential and commercial property will be discharged via soakaways that have been designed to fit within the curtilage of the property.

Each residential property will incorporate a rainwater harvesting and soakaway system within the rear garden. Rainfall would be retained within the rainwater harvesting tank, ready for future reuse within the property. Excess rainwater would discharge to a soakaway structure within the garden should the tank capacity be exceeded. Flats will similarly have a shared soakaway and rainwater harvesting tank.

Private shared parking courtyards will incorporate permeable paving to discharge runoff.

Green roofs are proposed for some garages and the runoff from such areas will not be used for rainwater harvesting. Garages and green roofs will discharge to soakaways located beneath the courtyard parking areas.

Rainwater Harvesting

The development is in an area subject to water stress. Rainwater harvesting allows reuse of collected rainwater within the home to supply toilets and washing machines, and for use in gardens and landscaped areas, reducing demand on water supply infrastructure.

Rainwater would run off a roof into guttering, protected by a leaf guard, and discharge via downpipes to a subsurface rainwater harvesting tank. The water would be filtered on entry to remove sediments and stored within the body of the tank. A small submersible pump would supply water to the property as required. When the tank is at capacity, additional rainwater would be discharged via a pipe to a soakaway.

When the rainwater harvesting tank is empty, the water supply would revert to the potable (Water Authority) network. The Water Cycle Study considers the demand for potable water in further detail (document 5003-UA001881, Hyder, March 2011).

Overflow Soakaways

Should a rainwater harvesting tank exceed capacity during periods of consistent heavy rainfall, an overflow pipe would discharge excess water to a soakaway within the property curtilage.

3.2.5 Adoption and Maintenance

Soakaways serving residential properties would become the responsibility of property owners or, in the case of flats, a private maintenance company.

Highway drainage, local and regional controls such as swales, basins and ponds, and any associated pipework and structures will be adopted.

3.2.6 Water Quality and Treatment Trains

The proposed SuDS system has been formed using a broad range of components, each having a variety of attributes and strengths for use in differing situations. The SuDS system proposed comprises chains of linked SuDS components which complement one another and have been combined to form a treatment train.

The SuDS Manual provides advice on the relative merits of different components using ratings of Low, Medium and High. The treatment trains described within Sections 3.2.3 and 3.2.4 have been assessed in terms of water quality using the ratings of the SuDS Manual to ensure that the best water quality is achieved through feasible and practical proposals.

It is important to consider the quality of runoff to be discharged when assessing the treatment required. For example, relatively clean runoff from a roof would be likely to require less rigorous treatment than runoff from a road. Therefore, where it may be acceptable to treat roof runoff with SuDS features having low to moderate water quality treatment characteristics, it would be more desirable for road runoff to be treated by a SuDS feature having medium or high treatment characteristics for the appropriate contaminants.

Runoff from parking areas and roads require a form of pollutant removal to remove hydrocarbons and other similar pollutants associated with motor vehicles. Treatment will be by filtration within the variety of SuDS features proposed as runoff passes through vegetation and percolates through the surface stratum or percolates through layers of filtration material such as grit within permeable paving before infiltration to the ground.

The naturally high quality and unpolluted nature of runoff from roofs and paved areas requires minimal treatment. Filtration and settlement of any solids and pollutants will naturally occur within soakaways, further improving the water quality.

It is important to also consider the treatment trains in the context of their function. Where structure perform vital SuDS functions but have low water treatment characteristics, such as oversized pipes, such features have been combined with complimentary features to provide suitable water treatment. The treatment trains have been assessed and the findings presented within Appendix C.

3.2.7 Overland Flowpaths

The Code for Sustainable Homes requires that the site should be designed to accommodate all runoff for events up to the 100 year rainfall event with an appropriate allowance for climate change (30% allowance for climate change has been used). The ponds, swales and other structures discharging directly to the watercourse have been designed to ensure this criterion is met and to ensure that surface water in excess of this event is discharged safely away from property to a watercourse via overland flowpaths. Such flow paths will include the local road network in some locations and direct overflow to watercourses in others.

To accommodate rainfall events in excess of the design events and normal design consideration, which could result in flooding, the infrastructure has been designed to provide overland flow paths for flood waters, directing water away from properties to local SuDS features such as swales and basins, areas of permeable paving, which would be likely to contain significant surplus storage within its substructure, and discharge to the watercourses. Overland flowpaths have been shown on Drawings 7160 and 7161 in Appendix A.

3.2.8 Drainage Proposal

Site investigation indicates that the site will be able to discharge predominantly via ground infiltration extensively using private soakaways and permeable paving. All residential areas within phase one will drain via soakaways. The spine infrastructure has been designed to discharge to ground via infiltration wherever feasible through roadside features and enhanced swales, though in some areas ground infiltration will not be practical or feasible and therefore SuDS features are proposed to accommodate runoff from such areas. Each SuDS feature therefore has a defined catchment based on topography, comprising an area of adjacent impermeable paving. The catchments are shown on Drawings 7160 and 7161 within Appendix A.

Total discharges to watercourses are restricted to 40l/s during 100 year rainfall events, which is less than the allowable rate of 40.1l/s, as demonstrated in Table 3.3. The additional discharge capacity is likely to be required to allow discharge from a future enhanced swale located in catchment 7 and which is not required as part of the spine infrastructure or phase one residential area.

Catchment	SuDS Type	Discharge	
		To downstream SuDS	To watercourse
1	Dry swale, swale, pond, basin	3.3 l/s to catchment 2	
2	Swale, pond, basin	3.3 l/s to catchment 3	
3	Roadside feature	Emergency only to catchment 6	
4	Swale, pond, basin	3.3 l/s to catchment 3	
5	Site edge swale	3.3 l/s to catchment 6	
6	Pond	15 l/s to catchment 7	
7	Enhanced swale (east) Enhanced swale (west)		20 l/s 5 l/s
8	Enhanced swale, online storage		10 l/s
9	Roadside features, Village Street SuDS, enhanced swale, online storage		5 l/s
		Total	40 l/s

Note: Catchment 3, 6, 7, 8 and 9 are part of the spine infrastructure or phase one residential areas.
Discharges from catchments 1, 2, 4 and 5 should be avoided where feasible.
Discharges from catchments 2, 4 and 5 would discharge to pond 6 at a maximum total combined discharge of 10l/s. Should one catchment not discharge at all due to the feasibility of infiltration SuDS, other catchments could utilise that catchment's share of the discharge allowance to pond 6.

Table 3.3 SuDS Feature Design Summary

4 FOUL WATER DRAINAGE STRATEGY

4.1 Principles

Waste (foul) water at the Exemplar Site will discharge to a manhole on the existing nearby Thames Water network for treatment within Bicester Sewage Treatment Works. A pumping station is to be constructed on site to pump foul flows via a rising main up to the connection point.

Restrictions have been placed on discharges by Thames Water following a sewer impact study (reference X4503 – 354 SMG 1009 Proposed Development at Bicester Eco-town Foul Water System, Thames Water, July 2011). Accordingly, discharges to the offsite connection will be restricted to 10l/s during dry weather flow.

A significant reduction in discharges will be achieved through the implementation of water efficient measures, when compared to regular developments.

During future stages of the wider NW Bicester eco development, it may be possible and desirable to treat foul water on site. Foul water from the Exemplar site could be disconnected from the Thames Water network and redirected via the pumping station to a centrally located treatment plant, if this is found to be the most suitable option.

The foul water drainage strategy is shown on drawing 7041 within Appendix A.

4.2 Foul Loading

A breakdown of the types of property within the Exemplar Site has been used to assess foul water discharges. Accommodation and non-residential building schedules have been provided within Appendix E. These figures were used to calculate the preliminary flow estimate based on the number of occupants for each dwelling, the number of end-users/floor plan area for non-residential property and typical usage rates provided by Thames Water (Thames Water Guidelines for Undertaking Sewerage Modelling (November 2005)). The peak foul water loading has been assessed based on the Thames Water rates as being 49l/s.

The Thames Water rates are conservative and actual discharges from site will be reduced by use of water efficient appliances, which would offset potential increases due to retro-fitting of property with less efficient devices by home owners. The rates have been assessed and reduce the peak discharge to 28l/s.

4.3 Initial Works

Due to the phased nature of the development, key elements of the foul drainage strategy, such as the pumping station and off site connection, would be constructed in the first phase of development as part of the spine infrastructure and phase one residential works.

Additionally, foul sewers would be constructed within the spine road to accommodate connections from future phases of the development. Therefore, discharges from the phase one development will be directed to the pumping station by foul sewers and pumped to the offsite connection on the wider foul water network, as shown on Drawing 7041 within Appendix A.

5 CONCLUSION

A drainage strategy is set out that provides a framework for development of both foul and surface water management systems for the Exemplar Site and ensures that the requirements of level 5 of the Code for Sustainable Homes are achieved.

In summary:

- Ground conditions indicate an existing rainfall discharge mechanism based on ground infiltration, with low surface runoff rates (see Section 2);
- A SuDs network is proposed comprising shallow soakaways and ground infiltration features, mitigating flood risk, protecting the supply to local aquifers and providing valuable habitat and amenity areas (see Section 3);
- The eco development has potential to reduce the volumes of surface water discharged during large rainfall events to below predevelopment levels (see Section 3.2);
- Discharge to onsite watercourses has been allowed to accommodate localised differences in ground conditions and improve the flow regime and water quality of the river;
- Peak discharges to watercourses would be reduced from 127.6 l/s to 40.1 l/s following development of the Exemplar Site during the 100 year rainfall event (including allowance for climate change) as contingency for a potential increase in discharge volumes (see Section 3.2.2);
- The SuDS network proposed utilises permeable paving, infiltration blanket, swales and a pond (see Sections 3.2.3 and 3.2.4);
- Online storage in the form of oversized pipes is proposed where a local area is not feasible for use of infiltration SuDS features or where storage is required to be within an area of tarmac;
- SuDS features have been designed to accommodate 100 year events, including a 30% allowance for climate change;
- Rainwater harvesting is proposed across the site, reducing discharges further (see Section 3.2.4);
- Treatment trains are proposed which provide appropriate treatment of runoff (see Section 3.2.6);
- Overland flow paths for exceedance have been considered as these rainfall events (beyond normal design consideration) are likely to exceed the capacity of the SuDS network. The site will be developed to ensure that such flows are directed away from property onsite to safely discharge to watercourses;
- Foul water is to be discharged offsite through a piped system which connects to the local sewer network (see Section 4);
- A significant reduction in foul water discharge is to be achieved through the implementation of water efficient measures (see Section 4);
- The wider eco development offers the potential to redirect foul water arising from the Exemplar Site to a treatment area within the eco development, further reducing foul water discharges to the local sewer network and Bicester Treatment Works (see Section 4).

The widespread use of Sustainable Drainage Systems and rainwater harvesting will provide sustainable storm water management and create a sustainable resource from rainfall, whilst ensuring that flood risk is reduced for areas downstream and benefitting the local area. Ground infiltration will be used extensively throughout the Exemplar Site to ensure that discharge volumes to watercourses are kept to a minimum and that ground water resources continue to be recharged by the site, whilst attenuation features will ensure that discharge rates to watercourses are reduced during large rainfall events to far below existing rates, offsetting historical development within Bicester which would have increased surface water discharge rates to the local watercourses and consequently increased flood risk.

The use of SuDS will contribute to the Green Infrastructure with new wildlife spaces incorporating wetlands, ponds and a variety of vegetation, creating valuable open amenity areas whilst enhancing the local water environment.

The eco development will promote excellent water quality standards, enhancing the local environmental water quality where possible and improving the flow regime of the watercourses within the eco development. SuDS would be used to remove any polluted runoff from diffuse sources providing at source treatment prior to discharge into watercourses.

Appendix A

DRAWINGS

7006-UA001881 – Site Location & Boundary

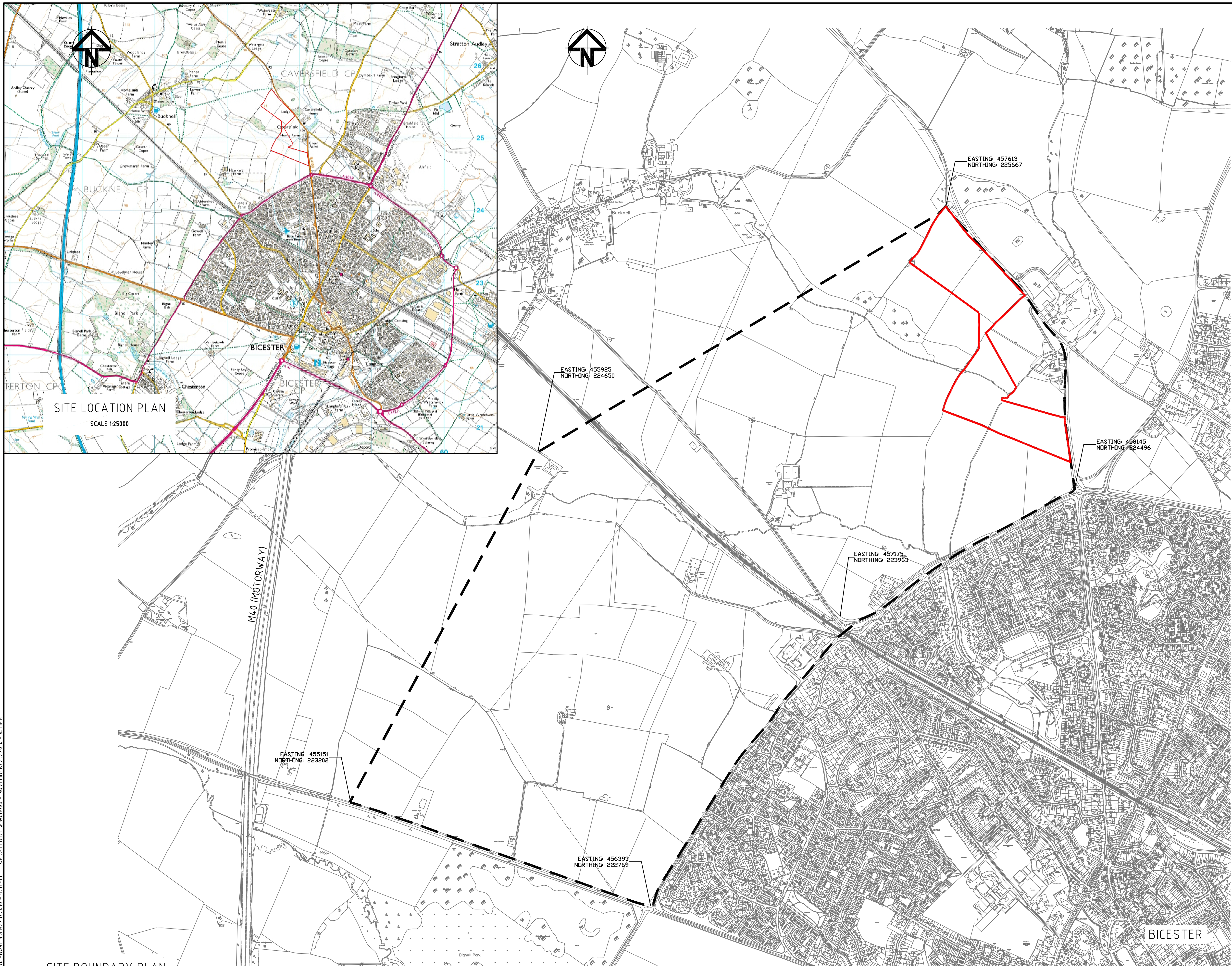
7013-UA001881 – Exemplar Site Area

7019-UA001881 – Existing Water Features

7041–UA001881 – Foul Water Drainage Layout

7160–UA001881 – Surface Water Drainage Layout 1 of 2

7161–UA001881 – Surface Water Drainage Layout 2 of 2



SITE BOUNDARY PLAN

SCALE 1:7500

KEY

ECO DEVELOPMENT BOUNDARY

EXEMPLAR SITE BOUNDARY

Issue	Description	Date
05	MINOR REVISIONS	24/11/10

Status

Scales	AS SHOWN	Author S. JONES
Original Size	A1	Checker D. BRAITHWAITE
Height Datum	-	Approver S.A. DAVIES
Grid	O.S.	© Copyright reserved

Filename 7006-UA001881-UP21D-05-SITE LOCATION PLAN (SERVICES CHECK).DWG

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Project

BICESTER
ECO DEVELOPMENT

Title

SITE LOCATION
AND BOUNDARY PLAN

Drawing No.	Project No.	Issue
7006	UA001881	05

100mm on Original

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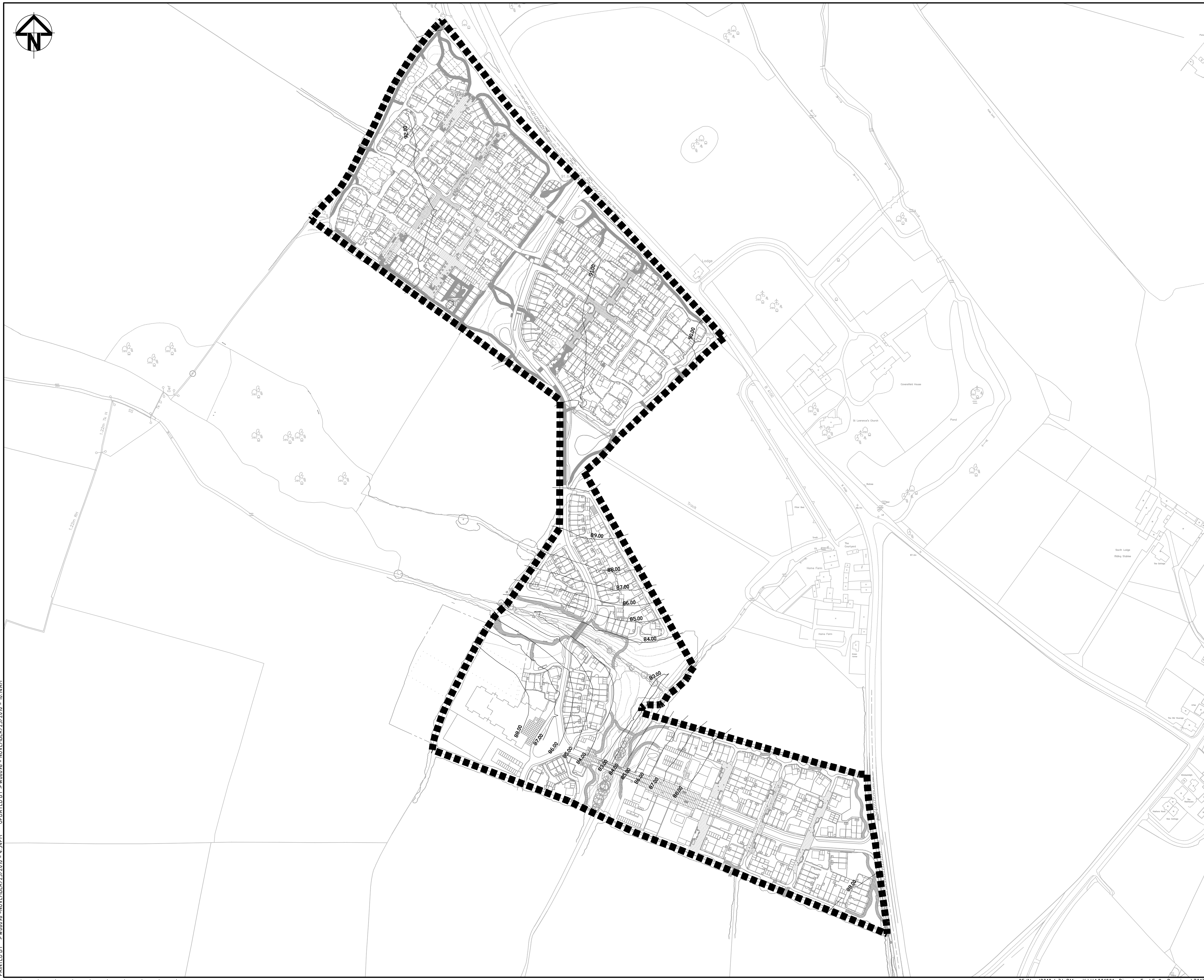

KEY

EXEMPLAR SITE BOUNDARY

NOTE:

HOUSING LAYOUT IS ILLUSTRATIVE ONLY

Issue	Description	Date
06	MINOR REVISIONS	24/11/10

Status

Scales	1:2000	Author M.LLEWELLIN
Original Size	A1	Checker M.PEARSON
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Filename: 7013-UA001881-UP21D-06-EXEMPLAR PLAN AREA.DWG

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BICESTER
ECO DEVELOPMENT

Title

EXEMPLAR AREA

Drawing No.	Project No.	Issue
7013	UA001881	06

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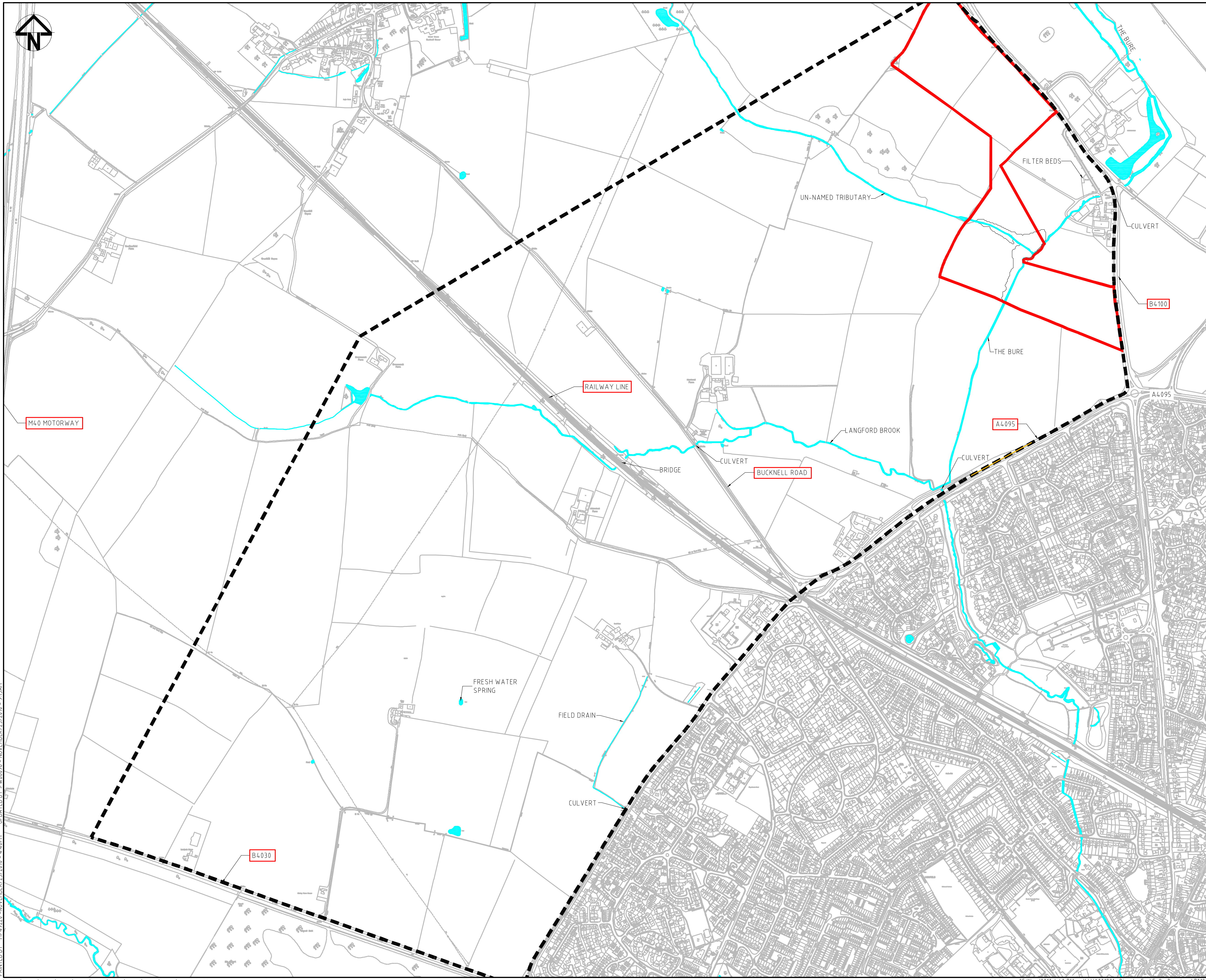

KEY

ECO DEVELOPMENT BOUNDARY

EXEMPLAR SITE BOUNDARY

Issue	Description	Date
02	MINOR REVISIONS	24/11/10

Status

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ECO DEVELOPMENT

Title

EXISTING WATER FEATURES

Drawing No.	Project No.	Issue
7019	UA001881	02

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