

Graven Hill Site D1, Bicester
ABA Pre-App Drainage Note
Prepared for
Graven Hill Purchaser Ltd.
February 2022

Graven Hill Site D1, Bicester**Pre-App Drainage Note****1.0 Introduction**

The former Ministry of Defence-owned site at Graven Hill, to the south of Bicester, was granted outline planning permission for a mixed-use development in August 2014 (ref: 11/01494/OUT). The site is located on the southern side of Graven Hill and were identified for employment use in the consented outline application. More detailed proposals for the site are now to be taken forward.

This note has been written by Alan Baxter Ltd on behalf of Graven Hill Purchaser Ltd to set out the broad drainage considerations and confirm the key principles of the developing Sustainable Drainage Systems (SuDS) strategy and foul drainage scheme for the site following the recent pre-application consultation with Oxfordshire County Council (OCC) the Lead Local Flood Authority (LLFA).

2.0 Summary of Existing Site

The site covers an area of approximately 30.5 hectares on the southern side of Graven Hill. The site is bounded to the southwest by a railway embankment, to the west by woodland, to the north by Pioneer Road/Anniversary Avenue and the southeast by Wretchwick Farm.

The site was historically used by the Ministry of Defence (MOD) to store and distribute military equipment and contains five main warehouses, a number of smaller ancillary buildings, and a fire station. These buildings are linked by a number of private roads and railway lines. The existing buildings on site all date from 1941, apart from the fire station, which dates from the 1970's.

2.1 Topography, Geology and Hydrology

Levels on the site vary from approximately 71m AOD along the northern boundary to 61.5m AOD in the south-eastern corner of the site, giving an average gradient of approximately 1:60 across the site. The site generally slopes gently, with some local variations, which include the banks, cuttings and ditches relating to the existing railway lines. Graven Hill, which rises to approximately 115m AOD, is immediately to the north of the site.

Geological maps and initial site investigations show the site geology consists of made ground over sandy Oxford Clay. From nearby borehole logs, the bottom of the Oxford Clay strata is expected to be approximately 20-30m below site ground level.

The topography and impermeable nature of the underlying soil means that in its natural condition, water falling on the site would likely have permeated through the topsoils and run south, following the contours of the hill, before eventually joining streams and ditches which drain into the River Ray (a tributary of the River Cherwell). The River Ray is approximately 1 mile to the south of the site.

When the site was developed in the 1940's, around 125,000 m² of building and roads were constructed. These are understood to drain to the stream to the south of the site through a system of pipes and ditches. It is not thought that any form of flow control or attenuation was incorporated into the drainage on the site. See drawing 1923/20/SK01 for the existing site surface water drainage arrangement.

Foul water from the site drains via gravity to a Thames Water pumping station in the western part of the site. This pumps foul water to a rising main, which runs under the embankment south of the site and discharges to Bicester sewage treatment works, to the northwest of Graven Hill.

There are a number of sewers crossing the site, including a Thames Water foul sewer running along the site's eastern boundary, which is proposed to be retained following the development of the site. All other live sewers and drains crossing the site are to be intercepted and diverted away from the site boundary by the sellers' team.

3.0 Key Principles Defined in Consented Outline Planning Permission

The site is part of a consented Outline Planning scheme that was submitted by the Graven Hill Village Development Company (GHVDC) for the entire Graven Hill site.

The consented outline surface water drainage strategy for the site is set out in Waterman's 'Sustainable Drainage Design Code' ref. CIV15119 ES 001 Rev A01. The key principles of the consented strategy (see Appendix A) are:

- Infiltration of surface water is not feasible. This has been verified by infiltration testing undertaken as part of the SI, which found the soil to be completely impermeable.
- Surface water discharged from the proposed site should be drained to the same location as existing. Sites D1 and EL1 should continue to drain southwards towards outfall 'SW4' which drains to a tributary of the River Ray.
- The discharge of surface water from the site should be limited to 2 l/s/ha for the 1:1 year event and 11 l/s/ha for the 1:100 + 30% climate change event.
- In order to achieve these discharge rates during periods of heavy rainfall, on-site surface water attenuation will be required.
- Surface water attenuation should, wherever possible, be provided in the following SuDS features:
 - Swales and ditches
 - Filter drains and perforated pipes
 - Filter strips and rills
 - Open attenuation basins
- Where space is restricted such that the measures noted above are not practical, below-ground geocellular tanks or oversize pipes may be used to attenuate surface water runoff.

4.0 Update to Key Principles Following Pre-App Consultation

During a pre-application consultation held with the OCC's Senior LLFA Engineer on 14/02/2022, the following updates to the key principles above were stipulated:

- The discharge of surface water from the site should be limited to Q_{bar} , unless this is shown to be unfeasible. This is the peak rate of flow from a catchment for the mean annual flood
- Given the nature of the proposed development, an urban creep allowance does not need to be considered when determining the required volume of attenuation storage
- A 40% climate change allowance should be made for the proposed events, as opposed to the 30% allowance noted in the previous application

The overall effect of these changes will be to increase the volume of attenuation storage required on site, compared to the principles outlined in the originally consented application.

5.0 Developing Surface Water Drainage Strategy for Site D1 & EL1

As per the principles noted in Section 3.0 and 4.0, surface water runoff will drain southwards, via a combination of open swales and below ground pipes, to outfall SW4, where it will discharge into the tributary of the River Ray.

Discharge from the site will be limited using flow controls, with the required surface water attenuation largely provided in landscaped basins dispersed around the site. These basins will provide amenity benefits as well as attenuation storage, and will be incorporated into the overall landscape design for the scheme. Preliminary analysis indicates that approximately 18,000 m³ of attenuation storage will be required to attenuate flows to the rates specified in Section 4.0. Additional design work will be required to determine the quantity of attenuation storage that can be accommodated on the site, and the consequent feasible discharge rates.

The attenuated surface water drainage flows from the proposed development will continue to drain to the same outfall location as the existing site.

The inclusion of other SuDS features such as rain gardens and rainwater harvesting will be considered in more detail as the scheme design develops. It is considered unlikely that pervious surfaces can be used throughout the scheme, due to the traffic loading associated with the proposed development. However, incorporating pervious surfaces in less heavily trafficked areas of the site will be considered in due course.

For further details of the proposed development, refer to Atelier Gooch's Pre-Planning Application document.

6.0 Developing Foul Drainage Strategy

The site's foul runoff will continue to drain under gravity to the Thames Water pumping station, from which it will be pumped to Bicester sewage treatment works. However, some changes are required to the existing foul drainage infrastructure to accommodate the proposed development.

The intention is for the Thames Water pumping station is to be relocated subject to a review of the viability of this move. The details of the proposed pumping station relocation are currently under review. Additionally, the retained Thames Water sewer in the east of the site will be diverted to fit the layout of the proposed development. All live sewers and drains crossing the site are currently being intercepted and diverted away from the site boundary by GHVDC.

It is understood that no off-site capacity upgrades will be required to accommodate the proposed development.

7.0 Conclusion

A SuDS strategy is being progressed for the proposed re-development of the site at Graven Hill, Bicester. The emerging SuDS strategy is based on the principles agreed at the drainage pre-application consultation on 14/02/2022, namely:

- Site surface water discharged should be limited to as close as feasible to Q_{bar} for the 1:100 + 40% climate change event.
- Open basins should be used to attenuate runoff. Where this is not practical, below ground storage may be used.

- Incorporating SuDS features such as swales, filter strips, rainwater harvesting, and rainwater gardens into the scheme will be considered as the masterplan develops.
- The surface water will discharge from the site to the south-west into the tributary of the River Ray as the existing site does.

The design of the site surface water drainage scheme will be developed in more detail to determine attenuation volumes and discharge rates in due course. This will be informed by the development of the emerging masterplan.

Prepared by Rory McColl
Reviewed by Olivier Fernandez
Issued February 2022

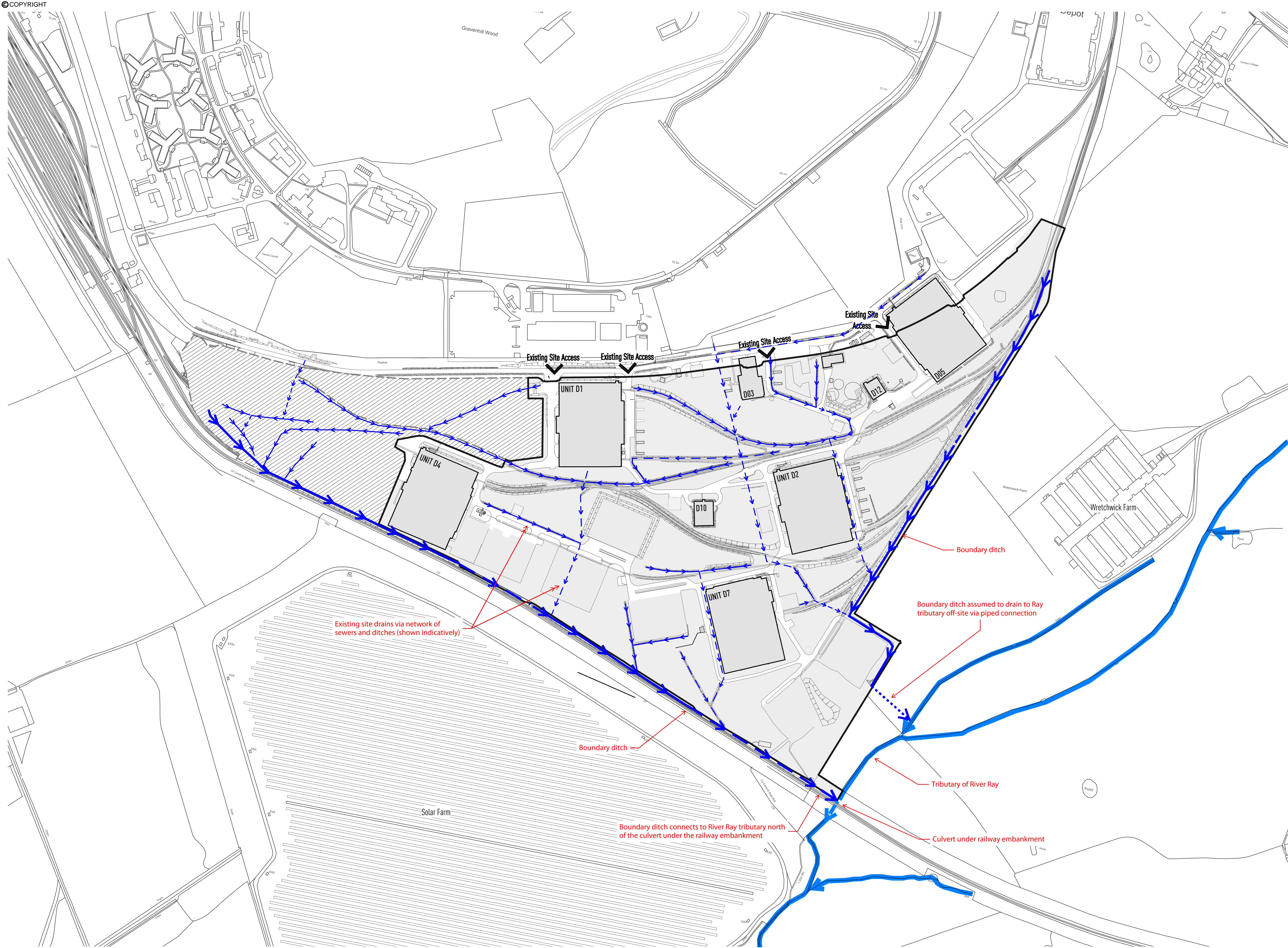
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Sketches



- notes
1. This drawing is to be read in conjunction with all relevant Architect's and Engineer's drawings and the specification.
 2. This drawing is based on Atelier Gooch's drawing 410_S-00-P5 and MK Surveys survey drawings from May 2015.
 3. **Key**
 - Above ground surface water drain
 - - Below ground surface water drain
 - River Ray tributary ditches/streams

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| job GRAVEN HILL SITE D1, BICESTER | | | |
| title EXISTING SITE SURFACE WATER DRAINAGE | | | |
| drawn RM | checked OF | scale (original - A1) 1:2500 | |
| date JAN '22 | | | |
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Appendix A



Graven Hill – Bicester, Oxfordshire

Sustainable Drainage Design Code

February 2015

Waterman Infrastructure & Environment Limited

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Client Name: Cherwell District Council
Document Reference: CIV15119 ES 001 Rev A01
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Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
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| Issue | Date | Prepared by | Checked by | Approved by |
|-------|----------|---------------|-------------|-------------|
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| Comments | DRAFT ISSUE |
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The conclusions resulting from this study and contained in this report are not necessarily indicative of future conditions or operating practices at or adjacent to the Site.

Much of the information presented in this report is based on flood modelling information provided by others. That information has neither been checked nor verified by Waterman Infrastructure & Environment Ltd

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Appendices

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- B. Waterman Technical Note CIV15119 DR 002
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- D. Ground Investigation Info
- E. Waterman Drawings
- F. Amec Flood Risk Assessment
- G. Existing Overland Flood Flow Routes

1. Introduction

- 1.1. Waterman have been commissioned by Cherwell District Council to produce a Sustainable Drainage Design Code for the development of land at Graven Hill, Bicester. In accordance with Schedule 14 of the S106 agreement between Cherwell District Council, Oxfordshire County Council and the Secretary of State for Defence, no applications for reserved matters can be submitted until the Sustainable Drainage Design Code has been submitted to and approved by Oxfordshire County Council.

Site Description

- 1.2. The Site is approximately 186Ha in size and is to be transferred over to Cherwell District Council from the Ministry of Defence in two phases. Land Transfer Area 1 which is approximately 104Ha in size will be transferred to Cherwell District Council in 2015 and Land Transfer Area 2 which is approximately 82Ha in size will be transferred to Cherwell District Council in 2019. Glenn Howells Architects Drawing No: A-L-050 in Appendix A shows the boundaries of Land Transfer Areas 1 and 2.
- 1.3. The central area of Site comprises a large woodland known as Graven Hill. The areas surrounding this woodland generally comprise large storage warehouses and offices with road and rail access. The far north of the Site generally contains agricultural land and woodland. In the north west of the Site is the Bicester International Freight Terminal which provides hard standing storage for shipping containers and is served by rail and heavy good vehicles.
- 1.4. The Site surrounds St David's Barracks which is to remain following the transfer of land to Cherwell District Council. The Site is currently surrounded by greenfield and agricultural land but to the north east of the Site is the A41 beyond which is the town of Bicester and to the north west of the Site is the Bicester to Islip railway beyond which is the Bicester Sewage Treatment Works.
- 1.5. Based on a topographical survey the Site falls from a high point of approximately 114m meters Above Ordnance Datum (m AOD) in the centre of the Site to a low point of approximately 62m AOD on the boundaries of the Site.

Development Proposals

- 1.6. The Site will be developed to contain approximately 1,770 self-build dwellings. Land Transfer Area 1 should include approximately 750 self-build dwellings, commercial and office development, a community centre / nursery and strategic amenity space with associated infrastructure, car parking and landscaping. Land Transfer Area 2 should include approximately 1,020 self-build dwellings, commercial and office development and strategic amenity space with associated infrastructure, car parking and landscaping. It is also proposed that advance of the main construction of 750 dwellings that a demonstrator project of 10no. self-build dwellings is constructed.
- 1.7. Glenn Howells Architects Drawing No: A-L-554-L in Appendix A shows the master plan and phasing for the development.

Scope of Report

- 1.8. This report comprises a Sustainable Drainage Design Code in accordance with the requirements of; Schedule 14 of the S106 agreement between Cherwell District Council, Oxfordshire County and the Secretary of State for Defence, which states:
- 1.9. **'Sustainable Drainage Design Code'** means the Sustainable Drainage Design Code for the Site comprising the following information and drainage design parameters:
 - Technical Note reference CIV15119 DR 002
 - Plan showing the complete Site Drainage Strategy
 - Existing flood routes
 - Flood risk assessment
 - Ground investigation, borehole/trial pit information
 - Soakage/infiltration test information and results
 - Drainage discharge points for the Development to existing watercourses (or main sewer) and drainage discharge rate at each such point and existing green field run off rate to these watercourses
 - Flood routes for each phase of development during construction and after construction with temporary flood storage during construction.

2. Sustainable Drainage Design Code

Current Surface Water Drainage

- 2.1. Surface water is currently collected at the Site by down pipes from buildings and gullies and linear drainage channels in external surface areas which drain to a network of private sewers that discharge to ditches across the Site. Ditches are also used at the Site to collect runoff from highways and railways at the Site and catch land drainage.
- 2.2. Discussions with the Ministry of Defence and Kelda Water (who currently maintain surface water drainage at the Site on behalf of the Ministry of Defence), confirmed that the ditches at the Site are not lined and many ditches do not have identifiable outfalls and rely on a very slow rate of infiltration into the underlying sub soil to drain. Hence, drainage at the Site is currently very poor, with standing water often seen in the ditches around the Site and local flooding occurring at the Site during more extreme storm events.

Drainage Discharge Points and Discharge Rates

- 2.3. Waterman Technical Note reference CIV15119 DR 002 Rev A05 in Appendix B, describes the proposed surface water discharge points and discharge rates for the Site which are summarised in Table 1 below. These surface water discharge points and discharge rates were agreed with the Environment Agency and Oxfordshire County Council at a meeting with them both on 23rd October 2013. Minutes and correspondence following this meeting are presented in Appendix C. As agreed with the Environment Agency and Oxfordshire County Council runoff from the proposed development will be restricted to existing greenfield rates.

Table 1: Discharge Points and Discharge Rates

| Catchment | Outfall | Existing Greenfield Runoff Rate | | Catchment Area | Proposed Runoff Rate | |
|--------------|---------------------------------|------------------------------------|----------|-------------------|----------------------|------------|
| | | 1:1 yr | 1:100yr | | 1:1 yr | 1:100yr+CC |
| Catchment 1A | SW1 – Trib of Langford Brook | 2l/s/ha | 11l/s/ha | 25.8Ha | 52l/s | 284l/s |
| Catchment 1B | SW2 – Trib of Langford Brook | 2l/s/ha | 11l/s/ha | 11.4Ha | 23l/s | 125l/s |
| Catchment 1C | SW3 – Trib of River Ray | 2l/s/ha | 11l/s/ha | 23.9Ha | 48l/s | 263l/s |
| Catchment 2A | SW2 – Trib of Langford Brook | 2l/s/ha | 11l/s/ha | 4.9Ha | 9.8l/s | 54l/s |
| Catchment 2B | SW4 - Trib of River Ray | 2l/s/ha | 11l/s/ha | 35.3Ha | 71l/s | 388l/s |

Sustainable Drainage Systems

- 2.4. The most sustainable way to drain surface water runoff is through the use of Sustainable Drainage Systems (SuDs), which need to be considered in relation to site-specific constraints.
- 2.5. SuDs work by mimicking the natural drainage system and provide a method of surface water drainage which can decrease the peak rate of surface water runoff, and hence reduce the risk of flooding. In addition to reducing flood risk these features can improve water quality and provide biodiversity and amenity benefits.
- 2.6. A variety of SuDs options are available to reduce or temporarily hold back the discharge of surface water runoff. Table 2 below outlines the constraints and opportunities of each of the SuDs devices in accordance with the hierarchical approach outlined in The SuDs Manual (CIRIA C697).

Table 2: Sustainable Drainage Techniques

| Device | Description | Constraints / Comments | ✓/✗ |
|--|--|--|-----|
| Green roofs (source control) | Provide soft landscaping at roof level which reduces surface water runoff. | Up to individual house builder – use to be promoted in developer pack provided to all plot purchasers. | ? |
| Infiltration devices (source control) | Store runoff and allow water to percolate into the ground via natural infiltration. | Infiltration unlikely to be suitable due to the low permeability of the ground. | ✗ |
| Pervious surfaces (source control) | Storm water is allowed to infiltrate through the surface into a storage layer, from which it can either infiltrate and/or slowly release to sewers. | Pervious surfaces could be used depending on road hierarchy. Due to the low permeability of underlying ground, pervious surfaces would need to discharge to a sewer or watercourse. Consideration should also be given to ground slopes. | ✓ |
| Swales and ditches (permeable conveyance) | Broad shallow channels that convey / store runoff, and allow infiltration (ground conditions permitting). | To be incorporated into the drainage scheme with varying slopes and profiles. Check dams required in steeper locations. Due to the low permeability of the underlying ground would need to discharge to a sewer or watercourse. | ✓ |
| Filter drains & perforated pipes (permeable conveyance) | Trenches filled with granular materials (which are designed to take flows from adjacent impermeable areas) that convey runoff while allowing infiltration. | Filter drains & perforated pipes could be used. Due to the low permeability of the underlying ground filter drains & perforated pipes would need to discharge to a sewer or watercourse. | ✓ |

| Device | Description | Constraints / Comments | ✓/✗ |
|---|--|---|-----|
| Filter Strips & rills (permeable conveyance) | Wide gently sloping areas of grass or dense vegetation that remove pollutants from runoff from adjacent areas. | Filter strips & rills could be used. | ✓ |
| Ponds (end of pipe treatment) | Provide water quality treatment & temporary storage. | To be incorporated into the drainage scheme with varying slopes and profiles. Due to the low permeability of the underlying ground would need to discharge to a sewer or watercourse. | ✓ |
| Attenuation Tanks (end of pipe treatment) | Oversized pipes or geo-cellular tanks designed to store water below ground level. | Used only when the SuDs listed above cannot be installed with sufficient volumes to restrict runoff to the required rate. | ✓ |

- 2.7. The most effective way to reduce surface water runoff is through infiltration into the subsoil which reduces the total volume of runoff, rather than simply reducing peak flows. However, based on a ground investigation at the Site by Amec / May Gurney in 2010, the Site is underlain by Oxford Clay which has a low permeability. The ground investigation at the Site by Amec / May Gurney in 2010 included 2No. BRE 365 soakaway / infiltration tests which demonstrated that infiltration drainage at the Site is not feasible.
- 2.8. Borehole / trial pit and soakaway / infiltration test records from the ground investigation at the Site by Amec / May Gurney in 2010 are presented in Appendix D.
- 2.9. A further ground investigation in relation to the proposed development is to be carried out at the Site shortly and will include further soakaway / infiltration tests. It is envisaged that the results of this ground investigation will not change the conclusions of the ground investigation by Amec / May Gurney in 2010, that infiltration drainage at the Site is not feasible and will therefore not change the conclusions and parameters of this Sustainable Drainage Design Code.
- 2.10. It is considered that the most appropriate SuDs to be incorporated within the Development could be green roofs, pervious surfaces, swales & ditches, filter drains & perforated pipes, filter strips & rills, ponds and oversized pipes or geo-cellular tanks.

Proposed Sustainable Drainage Strategy

- 2.11. As infiltration drainage is unlikely to be feasible at the Site, the Site has been divided into five catchments, which drain to a number of unnamed ordinary watercourses which are tributaries of the Langford Brook and River Ray, as shown in Table 1 above and the Waterman Technical Note reference CIV15119 DR 002 Rev A05 in Appendix B.
- 2.12. The drainage of individual dwellings will be the responsibility of the individual house builder. However, the use of SuDs would be advocated and promoted to them in the developer pack provided to all plot purchasers.

- 2.13. Communal infrastructure such as highways and other hard surfaced external areas such as car parks are to be constructed by Cherwell District Council and would be drained by SuDs such as swales & ditches, filter drains & perforated pipes and filter strips & rills. But where space is restricted or road hierarchy doesn't permit the use of the above gullies, linear drainage channels and pipes would be used.
- 2.14. The Environment Agency and Oxfordshire County Council require the peak rate of runoff from the Site to be restricted to existing greenfield rates for up to a 1 in 100 year (+30% for climate change) storm event. The proposed runoff rates from the Site are shown in Table 1 above and the Waterman Technical Note reference CIV15119 DR 002 Rev A05 in Appendix B.
- 2.15. To restrict surface water runoff to existing greenfield rates, attenuation storage will be necessary. The volume of attenuation required for each catchment is summarised in Table 3 below and shown in Waterman Technical Note Ref: CIV15119 DR 002 Rev A05 in Appendix B.

Table 3: Attenuation Volumes

| Catchment | Imp Area | 1in100yr+CC Discharge Rate | 1in100yr+CC Attenuation Volume |
|--------------|----------|-------------------------------|-----------------------------------|
| Catchment 1A | 15.5Ha | 284l/s | 7,600m ³ |
| Catchment 1B | 6.8Ha | 125l/s | 3,350m ³ |
| Catchment 1C | 14.3Ha | 263l/s | 7,000m ³ |
| Catchment 2A | 2.9Ha | 54l/s | 1,450m ³ |
| Catchment 2B | 31.8Ha | 388l/s | 17,250m ³ |

- 2.16. This volume of attenuation could be provided in swales and ponds or where space is restricted oversized pipes or geo-cellular tanks. A plan showing the complete Site Drainage Strategy and the location of attenuation features (Waterman Drawing No: CIV15119-C-SA-92-203 Rev A04) is presented in Appendix E. As previously agreed with Oxfordshire County Council no allowance has been made for attenuation or a reduction in the rate of runoff by pervious surfaces, in the design of attenuation volumes provided in swales, ponds, oversized pipes or geo-cellular tanks. This is because until the construction of the self-build dwellings is complete, any pervious surfaces would be covered which a sacrificial layer to protect them, and therefore runoff would be 100% from these surfaces for a longer than usual construction period.
- 2.17. The proposed sustainable drainage system would be adopted by a number of parties. It is envisaged that any gullies or linear drainage channels collecting highway drainage would be adopted by Oxfordshire County Council under S38 of the Highways Act 1980, any pipes, tanks, manholes or pumping stations would be adopted by Thames Water under S104 of the Water Industry Act 1991 and any features such as swales, ditches and ponds would be adopted and maintained by Cherwell District Council.
- 2.18. Overall this sustainable drainage strategy provides a robust and sustainable drainage system, for the development to follow which would restrict runoff to existing greenfield rates while providing significant water quality, biodiversity and amenity benefits.

Flood Risk Assessment

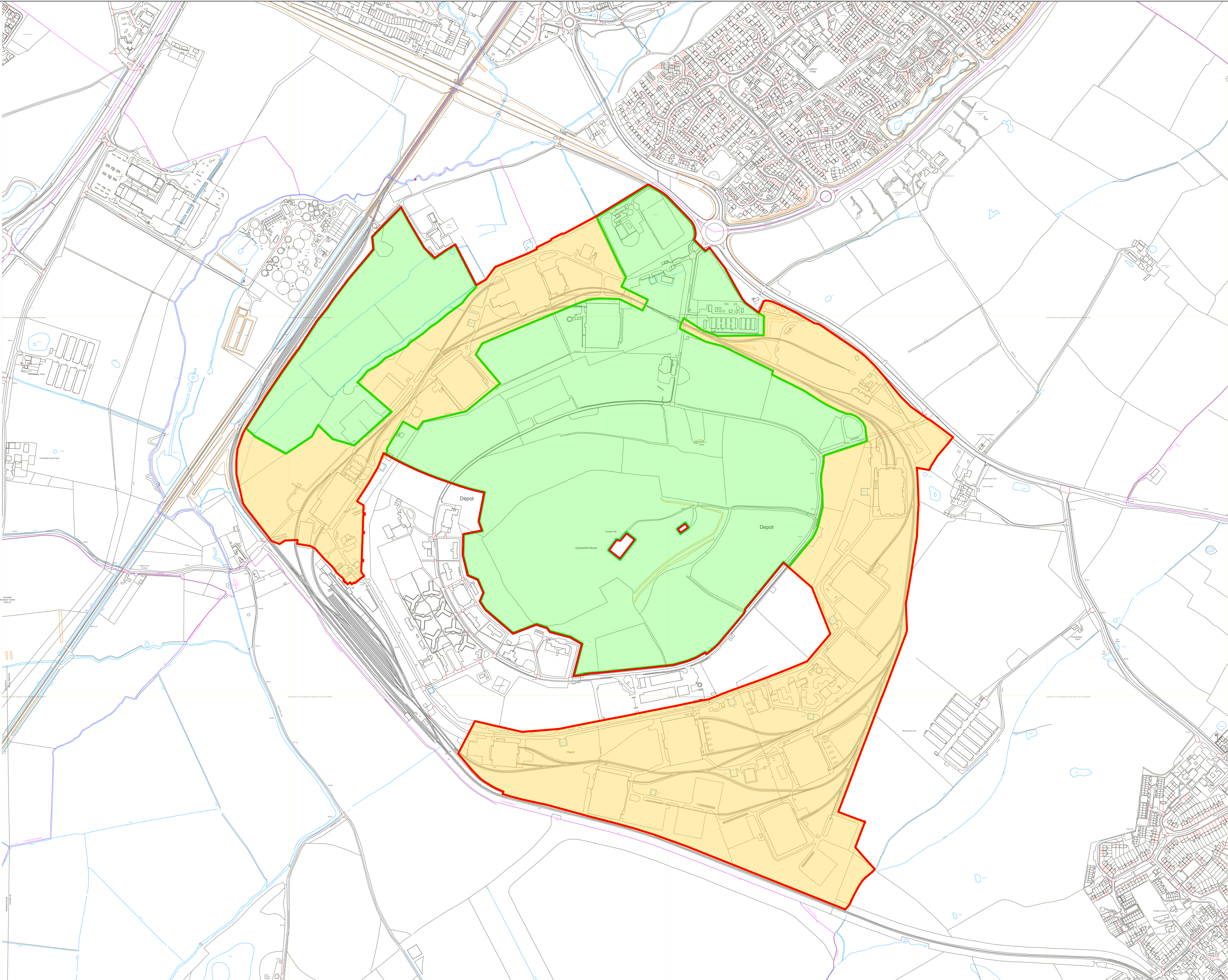
- 2.19. A Flood Risk Assessment was produced for the Site by AMEC and is presented in Appendix F. This report confirms that the Site has a low risk of flooding from rivers, groundwater, overland flow, canal and reservoir sources.
- 2.20. AMEC Drawing No: 23752-CVD-172 in Appendix G shows existing overland flow flood routes at the Site. In general overland flow flood routes radiate out from the higher ground of Graven Hill to low points at the boundary of the Site.
- 2.21. As part of the proposed development, the sustainable drainage system should be designed so that no surface flooding occurs during a 1 in 100 year +30% for climate change storm event. However, for more extreme storm events (with a return period greater than 1 in 100 year +30% for climate change), the levels and layout of the development should be designed such that overland flood flows are routed to green corridors, highways or car parks to ensure overland flood flows are not routed towards proposed buildings or third party land. To reduce the risk of overland flooding affecting buildings it is recommended that building finished floor levels are set 150mm above ground level.
- 2.22. Waterman Drawing No's CIV15119-C-SA-92-211 Rev A01 & CIV15119-C-SA-92-212 Rev A01 in Appendix E, show overland flood flow routes for Land Transfer Areas 1 and 2. It is envisaged that proposed attenuation pond/swales for each phase would be one of the first things constructed. As these proposed attenuation pond/swales are located at the low points of the Site, any overland flood flows during construction would be routed to these features, reducing the risk of flooding offsite.
- 2.23. During construction the contractor would be responsible for the implementation of a temporary sustainable drainage system to ensure that any overland flood flow routes are routed away from buildings and third party land to the proposed attenuation pond/swales located at the low points of the Site, to ensure the risk of flooding is not increased offsite. Appropriate measures such as shut off valves, oil interceptors, bunding of process areas, chemical storage areas and vehicle washing areas etc. would also be provided to prevent any detrition in water quality.

3. Conclusions

- 3.1. Waterman have been commissioned by Cherwell District Council to produce a Sustainable Drainage Design Code for the development of land at Graven Hill, Bicester.
- 3.2. The Site will be developed to contain approximately 1,770 self-build dwellings.
- 3.3. Based on ground investigation information and soakaway / infiltration test, infiltration drainage is unlikely to be feasible at the Site. Hence, the Site has been divided into five catchments, which drain to a number of unnamed ordinary watercourses which are tributaries of the Langford Brook and River Ray.
- 3.4. It is proposed that SuDs such as pervious surfaces, swales & ditches, filter drains & perforated pipes, filter strips & rills and ponds are used to drain the Site. But where space is restricted or road hierarchy doesn't permit the use of the above gullies, linear drainage channels and geocellular tank or oversize pipes would be used.
- 3.5. As agreed with the Environment Agency and Oxfordshire County Council runoff from the proposed development will be restricted to existing greenfield rates.
- 3.6. To restrict surface water runoff to existing greenfield rates, attenuation storage will be necessary. This volume of attenuation could be provided in swales and ponds or where space is restricted oversized pipes or geo-cellular tanks. A plan showing the complete Site Drainage Strategy and the location of attenuation features (Waterman Drawing No: CIV15119-C-SA-92-203 Rev A04) is presented in Appendix E.
- 3.7. A Flood Risk Assessment was produced for the Site by AMEC which confirms that the Site has a low risk of flooding from rivers, groundwater, overland flow, canal and reservoir sources.
- 3.8. AMEC Drawing No: 23752-CVD-172 in Appendix G shows existing overland flow flood routes at the Site. In general overland flow flood routes radiate out from the higher ground of Graven Hill to low points at the boundary of the Site.
- 3.9. As part of the proposed development, the sustainable drainage system should be designed so that no surface flooding occurs during a 1 in 100 year +30% for climate change storm event. However, for more extreme storm events (with a return period greater than 1 in 100 year +30% for climate change), the levels and layout of the development should be designed such that overland flood flows are routed to green corridors, highways or car parks to ensure overland flood flows are not routed towards proposed buildings or third party land as shown on Waterman Drawing No's CIV15119-C-SA-92-211 Rev A01 & CIV15119-C-SA-92-212 Rev A01 in Appendix E.
- 3.10. During construction the contractor would be responsible for the implementation of a temporary sustainable drainage system to ensure that any overland flood flow routes are routed away from buildings and third party land to the proposed attenuation pond/swales which would be one of the first things constructed in each phase and located at the low points of the Site, to ensure the risk of flooding is not increased offsite.
- 3.11. This Sustainable Drainage Design Code therefore demonstrates that surface water from the development can be drained sustainably and that the Site has a low risk of flooding both during and after construction.

APPENDICES

A. Glenn Howells Architects Drawings



PLANNING

NOTES:
DIMENSIONS NOT TO BE SCALED FROM THIS
DRAWING. CONTRACTORS TO NOTIFY
ARCHITECTS OF SITE VARIATIONS
AFFECTING INFORMATION ON THIS
DRAWING. THIS DRAWING IS COPYRIGHT OF
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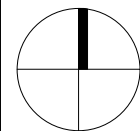
KEY

- Total Site Boundary
- Phase 1 Land Transfer Area
June 2015
- Phase 2 Land Transfer Area
June 2019

| Date | Rev | By | Details |
|----------|-----|----|---|
| 09.10.13 | - | MB | |
| 14.10.13 | A | MB | |
| 29.10.13 | B | MB | Adjusted Land Transfer Areas |
| 04.11.13 | C | JS | Adjusted Land Transfer Areas |
| 06.01.14 | D | MB | Combined Land Transfer Areas 2 & 3 |
| 10.01.14 | E | MB | Updated Site Boundary and Land Transfer Areas |
| 10.01.14 | F | MB | Added Access Information |

| Date | Rev | By | Details |
|----------|-----|----|--|
| 24.10.14 | G | RS | Adjusted site boundary and land transfer areas |

LOCATION KEY



GLENN HOWELLS ARCHITECTS

321 Bradford St, Digbeth, Birmingham, B5 6ET
Tel. 0121 666 7640 F. 0121 666 7641
mail@glennhowells.co.uk

Drawing Title
Land Transfer Areas

| | | | | | |
|--------------|--|-------------|-------------------------|----------|----|
| Date | 09.10.13 | Scale | 1:5000@A1 1:10000@A3 | Checked | JS |
| Project Ref. | 1982 | Drawing No. | A-L-050 | Revision | G |
| Project | Graven Hill Redevelopment of MOD Bicester | Client | EC Harris | | |

B. Waterman Technical Note CIV15119 DR 002

TECHNICAL NOTE

Ref: CIV15119 DR 002 Rev A05
Project: CIV15119

Status: External Issue to ECH
Date: 30th January 2015

Prepared: PJ
Checked: MN

Project Name: Graven Hill

Subject Title: Revised Drainage Strategy

INTRODUCTION

The previous drainage strategy defined on AMEC Drawing No: 23752-CVD-172 is not consistent with the boundaries of the current 'Land Transfer Areas' and development phasing shown on Glenn Howells Architects Drawing No's: 1982 A-L-551 Rev K and 1982 AL-554 Rev L.

Therefore, Waterman has prepared this revised drainage strategy, that reflects the phased availability / handover of land and the phased development. This revised drainage strategy has, wherever possible and practical, tried to avoid conflicts and constraints to the proposed phased development.

Land Transfer Area 1 (Waterman Drawing No: CIV15119-C-SA-92-201 Rev A03)

The proposed development of Land Transfer Area 1 has been divided into two catchments, 1A and the demonstrator project.

In Catchment 1A:

- **Surface water** is proposed to drain to an unnamed existing ordinary watercourse (SW1) in the north of the Site which is a tributary of the Langford Brook.
- **Foul water** is proposed to drain to an existing public sewer (FW1), in the north of the Site.

It is recommended that the new attenuation pond shown in Catchment 1A is sized to accommodate future expansion of Catchment 1A as part of the proposed development of Land Transfer Area 2.

In the demonstrator project:

- **Surface water** is proposed to drain to an unnamed existing ordinary watercourse (SW2) in the west of the Site which is a tributary of the Langford Brook.
- As a temporary measure it is proposed to drain **foul water** from the demonstrator project to a septic tank for preliminary treatment and then reed beds for secondary treatment. Treated water would then be discharged to an unnamed ordinary watercourse (SW2) in the west of the Site which is a tributary of the Langford Brook. This solution is however subject to approval from the Environment Agency.

Land Transfer Area 2 (Waterman Drawing No: CIV15119-C-SA-92-203 Rev A04)

In Land Transfer Area 2 Catchment 1A has been extended, the remainder of the proposed development of Land Transfer Area 2 has been divided into four catchments 1B, 1C, 2A and 2B and the demonstrator project has become part of Catchment 1B.

The extended **Catchment 1A** is shown to be drained as described above.

In Catchment 1B:

- **Surface water** is proposed to drain to an unnamed existing ordinary watercourse (SW2) in the west of the Site which is a tributary of the Langford Brook. Due to the shallow depth of the watercourse at this location, a small new pumping station or rising of ground levels may be required in the west of this catchment.
- The temporary septic tank and reed bed which the demonstrator project drains to would be removed and **foul water** is proposed to drain to a new pumping station located in the west of catchment. Foul

water will then be pumped via a new rising main, to the foul water sewers in Catchment 1A and drain to an existing public sewer (FW1), in the north of the Site.

In Catchment 1C:

- **Surface water** is proposed to drain to an unnamed existing ordinary watercourse (SW4) in the east of the Site, which is a tributary of the River Ray.
- **Foul water** is proposed to drain to a public sewer (FW2) in the east of the Site. The gravity sewer for FW2 currently drains to the existing foul pumping station (FW4) in the south of the Site.

In Catchment 2A:

- **Surface water** is proposed to drain to an unnamed existing ordinary watercourse (SW2) in the west of the Site which is a tributary of the Langford Brook.
- However, this will require a drain beneath the railway tracks, which are outside the boundary of Land Transfer Area 2, to reach outfall SW1.
- **Foul water** is proposed to drain to a public sewer (FW3) in the west of the Site. The gravity sewer for FW3 currently drains to the existing foul pumping station (FW4) in the south of the Site.

In Catchment 2B:

- **Surface water** is proposed to drain to an unnamed existing ordinary watercourse (SW4) in the south-east of the Site which is a tributary of the River Ray.
- However, this will require a drain beneath the railway tracks, which are outside the boundary of Land Transfer Area 2, to reach outfall SW4.
- **Foul water** is proposed to drain to an existing public pumping station (FW4) in the south of the Site.
- To accommodate the increase in foul flows following the proposed development this existing pumping station will need to be upgraded or replaced.

C. Environment Agency & Oxfordshire County Council Information

**Minutes of Meeting Held
Graven Hill Surface Water Drainage Meeting
10am - Wednesday 23rd October 2013
Environment Agency, Wallingford**

Attendees: Peter Johnson (PJ) – Waterman (WM)
Jack Moeran (JM) – Environment Agency (EA)
Nick Read (NR) – Environment Agency (EA)
Gordon Hunt (GH) - Oxfordshire County Council (OCC)

Apologies: David Neale (DN) – Waterman (WM)

| | | Action |
|-----|--|--------|
| | Background to the scheme | |
| 1.0 | PJ presented AMEC Drawings Figure 45 'Graven Hill Strategic Masterplan' & Figure 46 'Graven Hill Detailed Masterplan' showing the previous masterplan for Site. This masterplan currently has draft planning conditions. JM asked for masterplan drawings to be provided electronically to the EA. | PJ |
| 1.1 | It is Cherwell District Councils (CDC) intention to develop the Site. It is CDC intention for residential areas to be self-build. A revised masterplan is being worked up which will be similar to the current masterplan but needs to be updated to account for the phasing of handover of land from the MOD. | |
| 1.2 | CDC intention is to develop the Site in phases, with phase 1 likely to be circa 350 dwellings. All required infrastructure (Drainage, SuDs, Highways, Service's etc.) will be installed in advance of each phase. | |
| | Outfalls & Allowable Discharge Rates | |
| 2.0 | PJ presented AMEC Drawing Figure 'Graven Hill Site and Surroundings Hydrological Features'. PJ confirmed it was WM intention to re-use outfalls SW1-SW5 identified on this drawing. | |
| 2.1 | PJ presented WM Drawing No: CIV15119-C-SA-92-001, which showed proposed catchments. Catchments have been altered from the AMEC Drainage Strategy to account for phasing of the development. PJ proposed that discharges from the Site would be limited to 2l/s/ha during a 1 in 1 year storm event and 11l/s/ha during a 1 in 100 year plus climate change storm event. NR confirmed that these discharge rates would be acceptable on a pro-rata basis for the new catchment areas. | |
| | SuDs & Attenuation | |
| 3.0 | PJ proposed that attenuation would be provided for up to the 1 in 100 year (+30% for climate change) event and provided using swales and ponds. | |
| 3.1 | GH commented that OCC would like to see over the edge road drainage and porous paving were slopes/road hierarchy allow it. PJ suggested that due to underlying clay soil, porous paving could not be relied on for infiltration and would require an outfall to a swale / sewer. | |
| 3.2 | GH suggested that the school wouldn't like open water features but swales would be acceptable along the boundary of the school. | |

3.3 NR & GH would like to see exceedance routes during more extreme storms (up to a 1 in 500 year event) identified at the site. The site should be designed such that flooding is routed away from buildings to green space and road corridors.

3.4 EA & OCC have concerns about who will maintain proposed SuDs on self- build plots. If SuDs are to be adopted by the OCC under the Floods & Water Management Act (to be implemented 6th April 2014), then CDC should be made aware of potential maintenance costs on themselves or home owners. WM to make CDC aware of this. EA & OCC to arrange a meeting with CDC to discuss this and other infrastructure adoption / maintenance.

**WM
EA & OCC**

3.5 EA & OCC have concerns on how pollution of watercourses would be prevented during construction of self-build plots. JM confirmed that this couldn't be policed by planning conditions. PJ suggested that this could be incorporated into a design code for developers. NR commented that this is likely to be too high level for the control of pollution during construction. PJ suggested that CDC may need to produce a detailed developer pack which contains info on how to prevent pollution of watercourses.

Flood modelling, finished floor levels & watercourse diversions

4.0 NR was aware of recent flood modelling of Langford Brook to the west of by Network Rail as part of the Bicester Core scheme. NR to check availability of this model. NR suggested that if this model wasn't available existing flood levels for the Langford Brook could be used and there was no need for WM to re-model for a 3rd time.

NR

4.1 For ordinary watercourses NR suggested that for outline planning, a simple assessment to determine buffer zones around ordinary watercourses to protect the development from flooding would be sufficient.

4.2 NR confirmed that the previous allowance in the AMEC FRA of setting finished floor levels of buildings 300mm above the 1 in 100 year (+20% for climate change) flood level would be sufficient.

4.3 PJ commented that a watercourse in the west of the Site would need to be diverted as part of the development. NR & GH would prefer this watercourse to remain in open channel and access for future maintenance allowed for in the design.

Planning

5.0 JM confirmed that the EA would accept a to change the draft planning conditions so that relevant information is submitted to the LPA prior to each phase rather than the development as a whole. It was agreed though that an addendum report to the AMEC FRA and Drainage Strategy would be worthwhile as it could be referenced in the planning conditions and would give CDC comfort that planning has been gained for a feasible development.

5.1 PJ asked whether water quality and flood level data in the AMEC reports is still current. PJ to provide to the EA who will confirm whether it is still relevant

**PJ
EA**

Approvals & consents post planning

6.0 GH confirmed that for diversions / culverting of ordinary watercourses on the site a land drainage consent would be required from OCC as the Lead Local Flood Authority (LLFA)

- 6.1** Post 6th April 2014, any SuDs will need to be approved by OCC as the SuDs Approving Body (SAB). GH confirmed arrangements for this still need to be confirmed.

Distribution: All attendees + DN

DRAFT

Scott, Paul J

From: Hunt, Gordon - Environment & Economy - Highways & Transport
<Gordon.Hunt@Oxfordshire.gov.uk>
Sent: 26 November 2013 13:41
To: Johnson, J Peter; Moeran, Jack (jack.moeran@environment-agency.gov.uk)
Cc: Read, Nick (nick.read@environment-agency.gov.uk); Deadman, Michael - Environment & Economy - Highways & Transport; Hill, Peter - Freeland Primary School
Subject: RE: 15119 131126 PJGH Graven Hill Drainage Strategy

That's fine
Gordon

From: Johnson, J Peter [mailto:peter.johnson@watermangroup.com]
Sent: 26 November 2013 12:58
To: Hunt, Gordon - Environment & Economy - Highways & Transport; Moeran, Jack (jack.moeran@environment-agency.gov.uk)
Cc: Read, Nick (nick.read@environment-agency.gov.uk); Deadman, Michael - Environment & Economy - Highways & Transport; Hill, Peter - Freeland Primary School
Subject: 15119 131126 PJGH Graven Hill Drainage Strategy

Hi Gordon

We can confirm that swales / ponds and other surface water drainage has currently been sized and will be designed in future on the assumption that roads will initially not be surfaced with porous paving.

Kind regards

Peter

Peter Johnson
Senior Engineer
Waterman Transport & Development Ltd

4th Floor, Civic House
156 Great Charles Street
Birmingham
B3 3HN
t +44 (0)121 212 7700
e peter.johnson@watermangroup.com
www.watermangroup.com



From: Hunt, Gordon - Environment & Economy - Highways & Transport [<mailto:Gordon.Hunt@Oxfordshire.gov.uk>]
Sent: 26 November 2013 09:01
To: Johnson, J Peter; Moeran, Jack (jack.moeran@environment-agency.gov.uk)
Cc: Read, Nick (nick.read@environment-agency.gov.uk); Deadman, Michael - Environment & Economy - Highways & Transport; Hill, Peter - Freeland Primary School
Subject: RE: 15119 131120 PJ EAOCC Graven Hill Drainage Strategy

Hi Peter

The strategy reads fine, but I have one concern.

The first part of the development is planned to be self – build, therefore if the non - bus routes, which I expect, will be of porous construction, are constructed with a sacrificial layer (to protect the stone underneath), the run off will be 100%. This means that the swales and ponds will have to be sized to accommodate the initial flows, pollution and sediment during a longer than usual construction period.

Have you planned for this within your surface water drainage design?

Regards

Gordon

From: Johnson, J Peter [<mailto:peter.johnson@watermangroup.com>]

Sent: 20 November 2013 16:47

To: Moeran, Jack (jack.moeran@environment-agency.gov.uk); Hunt, Gordon - Environment & Economy - Highways & Transport

Cc: Read, Nick (nick.read@environment-agency.gov.uk)

Subject: 15119 131120 PJ EAOCC Graven Hill Drainage Strategy

Jack / Gordon

Please find attached Waterman Technical Note 'Graven Hill - Revised Drainage Strategy' ref: CIV15119 DR 002 Rev A03

We would be grateful for your comments on this drainage strategy.

As discussed at the meeting on 23rd October 2013, we have revised the drainage strategy to ensure it reflects the phased availability of land and development is not constrained by non-availability of land or access to discharge points. The drainage principals previously agreed by AMEC and documented in their drainage strategy report have been retained though, as discussed in our meeting:

- Same outfalls to be used.
- Discharge rates limited to 2l/s/ha during a 1 in 1 year storm event and 11l/s/ha during a 1 in 100 year plus climate change storm event.
- Attenuation is provided for up to the 1 in 100 year (+30% for climate change) event using swales and ponds.
- No open water features are to be provided within the school grounds.

Further details such as, the type of SuDs to be used for roads, driveways, houses etc (Oxfordshire County Council preference for over the edge drainage and permeable paving is noted), exceedance routes during extreme storm events and watercourse diversions will be provided at the detailed application stage once the proposed development layout is finalised.

If you have any queries or require any further information please do not hesitate to contact us.

Kind regards

Peter

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Senior Engineer
Waterman Transport & Development Ltd

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Mr Peter Johnson
Waterman Environmental
156, Civic House Great Charles Street
Queensway
Birmingham
West Midlands
B3 3HN

Our ref: WA/2013/116199/02-L01
Your ref: 15119 131024
Date: 10 December 2013

Dear Mr Johnson

**GRAVEN HILL SW DRAINAGE STRATEGY
GRAVEN HILL, BICESTER**

Thank you for consulting us on this matter. We received your email on 20 November 2013 and we are now in a position to respond.

We have reviewed the Waterman technical note ref CIV15119 DR 002 Rev A03 dated 20th November 2013.

We note that this appears to build on the previously consented scheme but provides further information on how the phasing of the site will be implemented. From previous discussions and a review of the minutes of our meeting with Waterman and Gordon Hunt of OCC on 23.10.13 there appears to be a consistent approach to the previously agreed strategy in terms of catchments, rates and points of discharge.



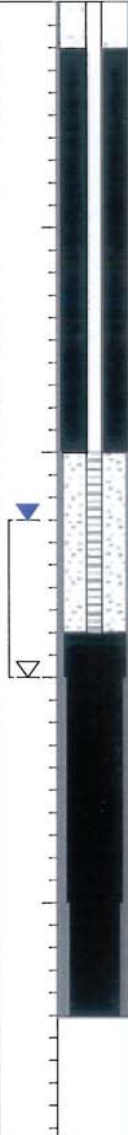





We welcome continued discussion in relation to the development as the scheme progresses.

Yours sincerely

**Mr Jack Moeran
Planning Advisor**

Direct dial 01491 828367
Direct e-mail planning-wallington@environment-agency.gov.uk

D. Ground Investigation Info

|  <p>May Gurney Limited Geotechnical - Site Investigation Ayton Road, Wymondham, NR18 0RH Tel: 01953 609656 Fax: 01953 609619 Web: www.maygurney.co.uk</p> | | | <h2 style="text-align: center;">Window Sample Record</h2> | | | <h2 style="text-align: center;">WSD03</h2> <p style="text-align: center;">Sheet 1 of 1</p> | | |
|--|---|--------------|--|------------------|----------------------|--|------------------|--|
| Project: Bicester | | | | | | | | |
| Project ID: SI1622 | | | Client: Entec UK Limited | | | Ground Level: 71.347mAOD | | |
| Contractors ID: | | | Engineer: Ed Gilligan | | | Coordinates: 459477.67E 220352.97N | | |
| Description | Legend | Depth (m) | O.D. Level (m) | Sample Test | | Remarks and Test Results | PID (ppm) | Installations |
| | | | | Type | Depth (m) | | | |
| MADE GROUND: Grass over brown slightly sandy clayey gravel with whole brick and occasional concrete. Possible asbestos. |  | | | CS01 | 0.10-0.20 | | 0.00 |  |
| Soft to firm grey-green slightly gravelly CLAY. Gravel is angular to subangular medium to coarse flint. Possible reworked natural. |  | 0.40 | 70.95 | CS02 | 0.50-0.60 | | 0.00 | |
| Firm dark brown slightly silty CLAY - Fissile and laminated. |  | 0.60 | 70.75 | | | | | |
| | | | | CS03 | 1.00-1.10 | | 0.00 | |
| | | | | C1 | 1.20-2.00 | | | |
| Firm dark brown CLAY with shell fragments. |  | 1.50 | 69.85 | | | | | |
| ...At 2.00mbgl abundant mica crystals. | | | | C2 | 2.00-3.00 | | | |
| Yellow-brown clayey coarse SAND. Significant water ingress. |  | 2.50 | 68.85 | | | | | |
| Firm dark brown CLAY with shell fragments. |  | 2.70 | 68.65 | | | | | |
| | | | | C3 | 3.00-4.00 | | | |
| | | | | C4 | 4.00-4.50 | | | |
| | | 5.00 | 66.35 | | | | | |
| Window Sample Complete at 5.00 m | | | Water Level Observations | | | | | |
| Drive Records | | | Date | Water Strike (m) | Standing Time (Mins) | Standing Level (m) | Casing Depth (m) | Depth Sealed (m) |
| Diameter (mm) | To (m) | Recovery (%) | | | | | | |
| 102 | 2.00 | | 14/07/10 | 3.00 | 20 | 2.30 | - | |
| 86 | 3.00 | | | | | | | |
| 76 | 4.00 | | | | | | | |
| 66 | 4.50 | | | | | | | |
| Client: Entec UK Limited Engineer: Ed Gilligan Date: 14/07/2010 Plant: Terrier Drilled By: M. Earl Logged By: EG Checked By: P. Lewin | | | Remarks: 1. Starter pit dug from GL to 1.20mbgl. 2. Water level standing at 2.30mbgl upon completion. 3. Installation details: 32mm HDPE Standpipe installed from GL to 2.80mbgl. Plain pipe from GL to 2.00mbgl and a slotted pipe from 2.00m to 2.80mbgl. Hole backfilled with concrete from GL to 0.20mbgl, bentonite from 0.20m to 2.00mbgl, gravel from 2.00m to 2.80mbgl and bentonite from 2.80m to 5.00mbgl. Hole finished with a flush cover and gas tap. | | | | | |