GHBullard & Associates LLP
Civil and Traffic Engineering Consultants

Proposed Residential Development

Wellwick Site, St Osyth, Essex

FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY

GHB Reference:

217/2023/FRADS

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This report has been limited to the level of detail required in order to achieve the scope objectives and cannot be relied upon for matters outside of this.

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1. PROJECT DETAILS

1.1. Table 1 Project Details

Report Title:	Proposed Residential Development Wellwick Site, St Osyth, Essex – Flood Risk Assessment and Drainage Strategy
Date:	19 December 2023
Document Reference and Revision:	217/2023/FRADS 01
Prepared by:	GH Bullard & Associates LLP
On behalf of Client:	City and Country Residential Ltd

1.2. Table 2 Authorisation Sheet

Project:	Proposed Residential Development
Report Title:	Proposed Residential Development Wellwick Site, St Osyth, Essex – Flood Risk Assessment and Drainage Strategy
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2. INTRODUCTION

2.1. This flood risk assessment and drainage strategy is being submitted to accompany an Outline planning application for a residential development comprising 37 units at the Wellwick Site, St Osyth, Essex. A site location plan is attached in **Appendix A.**

2.2. This Outline planning application area forms part of the development included for within Planning Applications 11/00333/OUT and 19/01171/OUT.

2.3. The report includes a thorough review of commercially available flood risk and Environment Agency (EA) data indicating potential sources of flood risk to the site.

2.4. The information provided within this report is based on the best available data currently recorded or provided by a third party. The accuracy of this report is therefore not guaranteed and does not obviate the need to make additional appropriate searches, inspections and enquiries.

2.5. The National Planning Policy Framework (NPPF, December 2023), Section 14 (Meeting the challenge of climate change, flooding and coastal change), Paragraph 165 states that:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere."

2.6. The NPPF recommends the Environment Agency (EA) Flood Maps as a starting point for Flood Risk Assessment. An extract from the EA Flood maps is reproduced in Figure 2.1 below.

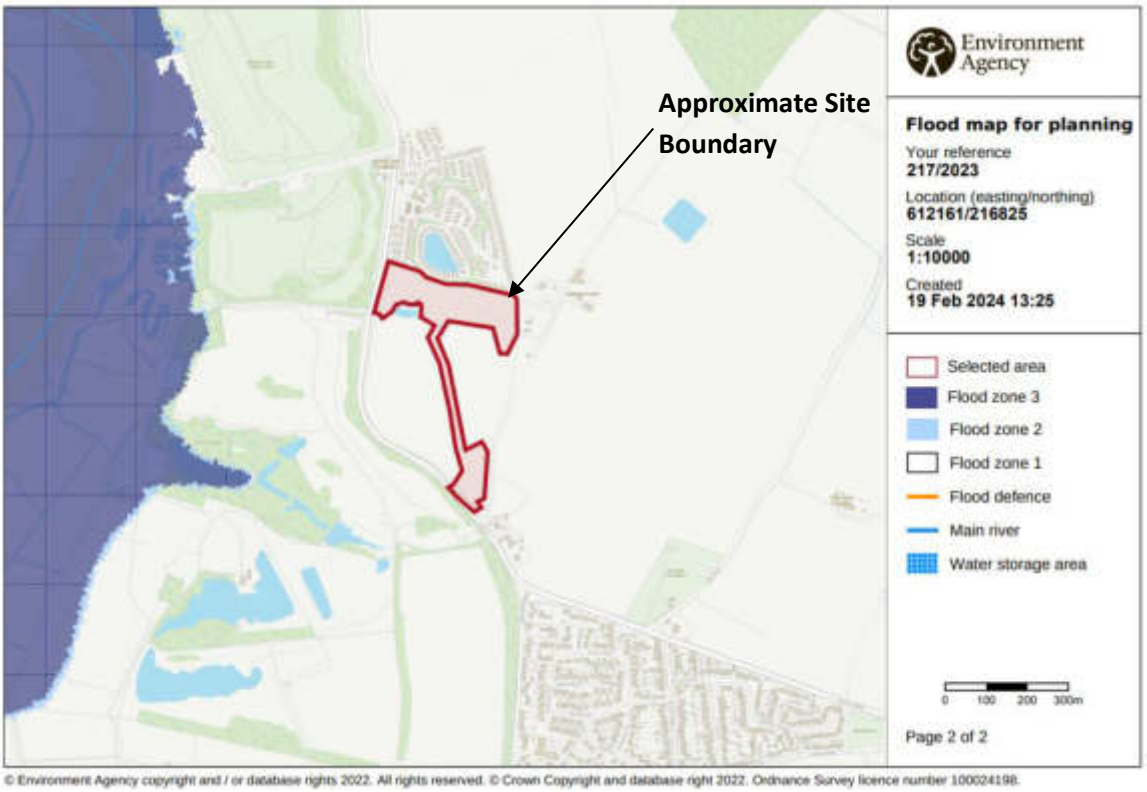


Figure 2.1: Environment Agency Flood Map (Rivers and Seas)

2.7. The Environment Agency has produced standing guidance for developments dependent on their size and location. As can be seen from Figure 2.1, the site is located within Flood Zone 1 with a Low probability of flooding.

2.8. Industry best practice requires assessment of all flooding sources to be carried out. Despite this document having now been superseded by the NPPF, Figure 3.2 of the "PPS25: Development and Flood Risk" (PPS25) Practice Guide lists five key sources of flooding:

i. Fluvial (refer to Section 6);

ii. Tidal (refer to Section 7);

iii. Pluvial (refer to Section 8);

iv. Groundwater (refer to Section 9); and

v. Infrastructure Failure (refer to Section 10).

3. POLICY CONTEXT

3.1. The purpose of the planning system is to contribute to the achievement of sustainable development – *NPPF, Paragraph 7.*

3.2. At the heart of the National Planning Policy Framework is a presumption in favour of sustainable development which does not change the statutory status of the development plan as the starting point for decision making – *NPPF, Paragraph 12.*

3.3. Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere – *NPPF, Paragraph 165.*

3.4. The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding from any source– *NPPF, Paragraph 168.*

3.5. Following the Sequential Test, both elements of the Exception Test will have to be passed for development to be allocated or permitted – *NPPF, Paragraph 171.*

3.6. Tendring District Local Plan 2013-2033 and Beyond: North Essex Authorities' Shared Strategic Section 1, 26 January 2021.

3.7. Tendring District Local Plan 2013-2033 and Beyond: Section 2, 25 January 2022.; Policy SPL 3: Sustainable Design, Policy PPL 1: Development and Flood Risk, Policy PPL5: Water Conservation, Drainage and Sewerage.

3.8. Tendring District Council Strategic Flood Risk Assessment Final Report, March 2009 prepared by JBA Consulting.

3.9. Tendring District Council Strategic Flood Risk Assessment Addendum, August 2017 prepared by Essex County Council Flood Services.

3.10. Essex County Council as Lead Local Flood Authority design guidance; The Sustainable Drainage Systems Design Guide for Essex.

3.11. Environment Agency Flood Risk Assessment guidance.

3.12. The SuDS Manual (C753) – Ciria Industry Best Practice Guidance.

4. EXISTING SITE INFORMATION

4.1. The site is located approximately 1.4km the north of St Osyth, Essex and is bound by the B1027 at the west and south, a lodge holiday park site (Oaklands Holiday Park) at the north, a smaller lodge site, Pumping Station and fields at the east and a pond and former gravel quarry along the boundaries of the access road linking the north and south of the site. Refer to the site location plan in **Appendix A**.

4.2. The site is brownfield with an area of approximately 4.85ha and comprises grassland with some trees and shrubs and a few small outbuildings. The site is part of a former gravel quarry, with the north area sloping down to the level of the quarry base at the south. Refer to the existing site layout drawing in **Appendix B**.

4.3. The site can be located from the following information:

i. Postcode: CO16 8HR

ii. NG Reference: TM121169

iii. The site levels range from 19.80m AOD at the north-west boundary to 12.44m AOD. The north site area is located at a level between 19.8m AOD to 18.0m AOD where the ground slopes steeply down to approximately 13.50 to 12.44m AOD. The south site area is at a level between 13.7m AOD to 13.4m AOD, with the site entrance at a level of approximately 17m AOD. Refer to the drawing in **Appendix B** for the topographical levels.

4.4. The BGS records describe the geology as:

i. Superficial: None recorded (main site area) and Kesgrave Catchment Subgroup – Sand and Gravel (at the west, north and south boundaries).

ii. Bedrock: Thames Group – Clay, Silt and Sand.

4.5. The BGS 1:50,000 scale drift maps (Figure 4.1) show the form of the Superficial deposits.

4.6. The British Geological Survey has a borehole record located approximately 55m to the south-east of the site at the Pumping Station site, Ref: TM 11NW/3 (at ground level of approximately 19.8m AOD), which shows Sand and Gravel to 7.9m depth (to 11.9m AOD) over London Clay to 11.35m bgl. Refer to **Appendix C** for the borehole log.

4.7. It is assumed that all gravel has been excavated from the area. There is no information relating to any quarry backfill material, which is considered to be of poor consistency.

4.8. It is assumed that the pond at the south boundary has been created as a feature, although it may be draining part of the adjacent highway as there is a pipe discharging to it, with a water level of approximately 11.00m AOD measured in 2018, which was understood to be the groundwater level at that time.

4.9. Infiltration testing was undertaken within the site area during 2018; a test undertaken within the north-east part of the site (TP4), showed 1.1m depth of 'Subsoil' over Sand to 1.5m bgl, with an infiltration rate of 1.37×10^{-6} m/s. The investigation also revealed groundwater at 1.5m bgl at the south-east area of the site (TP3). Refer to **Appendix B** for the approximate test locations.

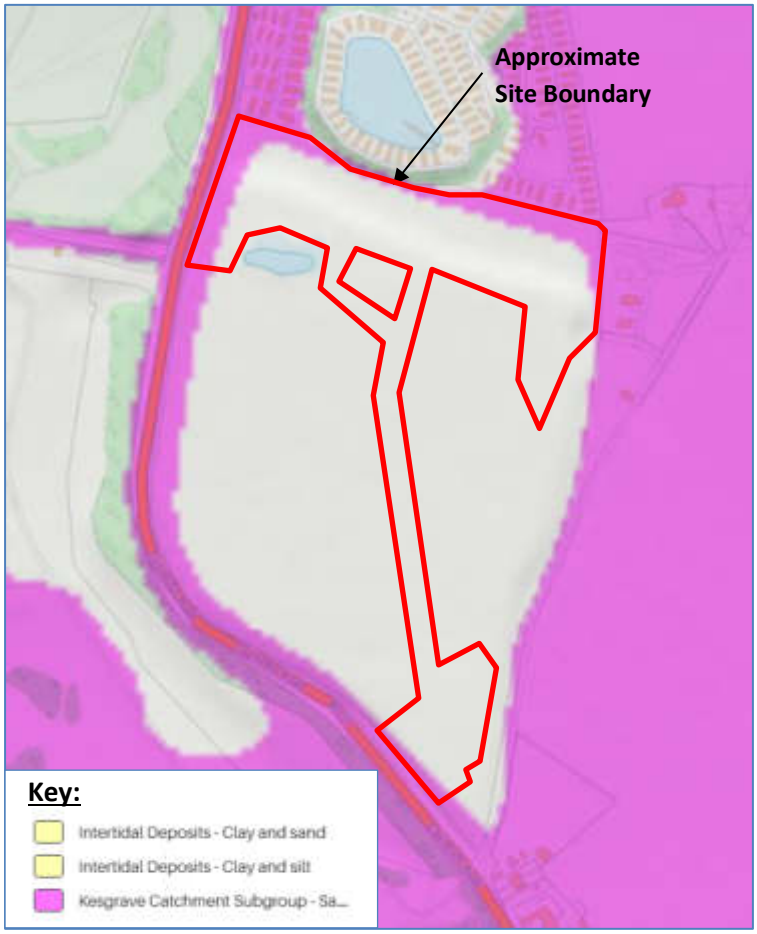


Figure 4.1 - BGS 1:50,000 Superficial Drift Map

4.10. Further infiltration testing in accordance with BRE 365 was undertaken across the site area during November 2023, with the trial pits located at the toe of the north site area embankment and one within the site access. This testing revealed brown, clayey, gravelly sand in all the trial pits down to 1.1m bgl, with infiltration rates ranging from $4.42x10^{-6}$m/s to $1.94x10^{-5}$m/s within the north site area and no infiltration within the location of the access road. Groundwater water was encountered at 1.2m bgl within the centre of the main site, which rose to 0.6m bgl, equating to an approximate level of 12.15m AOD. Groundwater was also encountered within the access road location at 0.6m bgl. Refer to the infiltration testing results in **Appendix D** and Appendix B for the approximate test locations.

4.11. The site area currently drains via infiltration and overland flow towards the existing basin within the north site area. The existing site flow paths are shown on the drawing in **Appendix B**.

4.12. The Environment Agency has mapped Source Protection Zones which shows the site is not located over a protection zone.

4.13. Environment Agency Aquifer (Bedrock Geology) mapping shows that the site is located over an Unproductive Aquifer.

4.14. Environment Agency Aquifer (Superficial Drift) mapping shows that the site is located over a Secondary A aquifer; these aquifers comprise permeable layers that can support local water supplies and may form an important source of base flow to rivers.

4.15. The Environment Agency has mapped groundwater vulnerability and Figure 4.2 shows the site is located over a Low and Medium to Low vulnerability Aquifer.

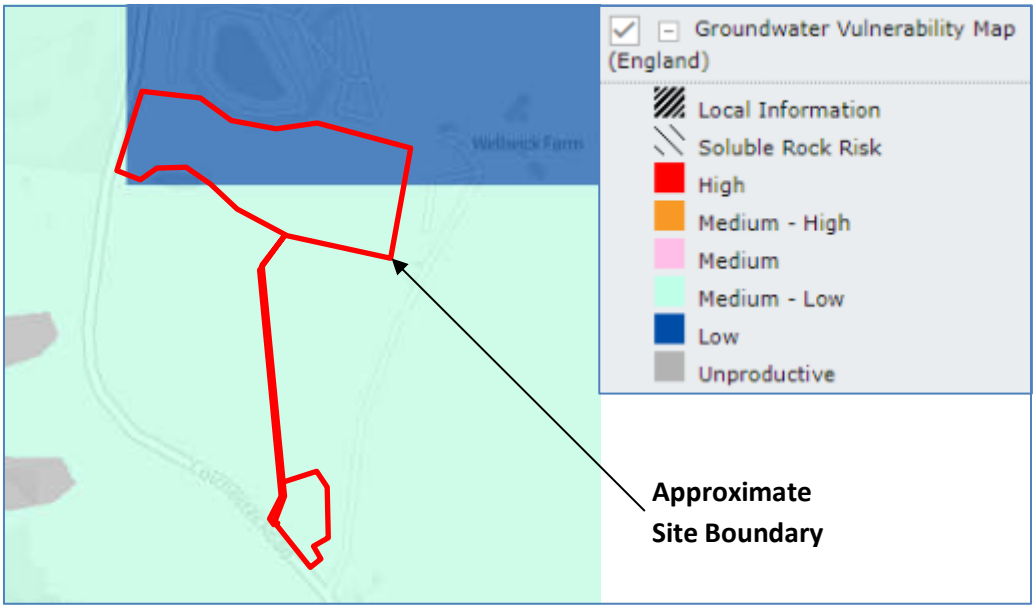


Figure 4.2- Environment Agency Groundwater Vulnerability Zones

4.16. The nearest Main River is Flag Creek located approximately 740m west of the site, which flows south-west to Brightlingsea Reach (tidal estuary).

4.17. The nearest mapped water features are a pond at the south boundary as discussed in paragraph 4.8, and a larger pond at the north boundary within the Lodge Park. This larger pond is understood from the BGS borehole log in **Appendix C**, to be a waterfilled former gravel pit.

4.18. An asset plan was obtained from Anglian Water which shows there is no surface water sewer adjacent to the site, with a foul drainage network located 320m south-west of the site entrance. Refer to **Appendix E** for the asset record.

5. PROPOSED DEVELOPMENT

5.1. The proposed residential development comprises 37 units with associated garages, driveways access roads and landscaped areas, split between a north site area (24 dwellings) and a south site area (13 dwellings), linked by an access road. An indicative layout drawing showing how the quantum of development can be accommodated within the site is attached in **Appendix F**.

5.2. The residential development is classified as **More Vulnerable**; Buildings used for **dwelling houses**, student halls of residence, drinking establishments, nightclubs and hotels.

5.3. The Environment Agency table (Table 5.1) shows that the development located within Flood Zone 1 does not require the application of the Exception Test.

5.4. The design life of the development is 100 years.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✔	✔	✔	✔	✔
Zone 2	✔	Exception Test required	✔	✔	✔
Zone 3a †	Exception Test required †	X	Exception Test required	✔	✔
Zone 3b *	Exception Test required *	X	X	X	✔ *

Key:

✔ Exception test is not required

X Development should not be permitted

Table 5.1: Environment Agency Flood Zone/ Classification Table

Climate Change

5.5. The National Planning Policy Framework (NPPF) sets out how the planning system should help to minimise vulnerability and provide resilience to the impacts of climate change.

5.6. The climate change allowances are predictions of anticipated change for:

i. Peak river flow by river basin district

ii. Peak rainfall intensity

iii. Sea level rise

iv. Offshore wind speed and extreme wave height

5.7. The climate change allowances are predictions of anticipated change. The Environment Agency has provided peak rainfall climate change allowances by Management Catchment, which for this site are summarised in figure 5.1.

5.8. In accordance with current Environment Agency guidance, an allowance of 35% and 45% will be used in the design of the drainage strategy for the 3.3% AEP and 1% AEP rainfall events respectfully.

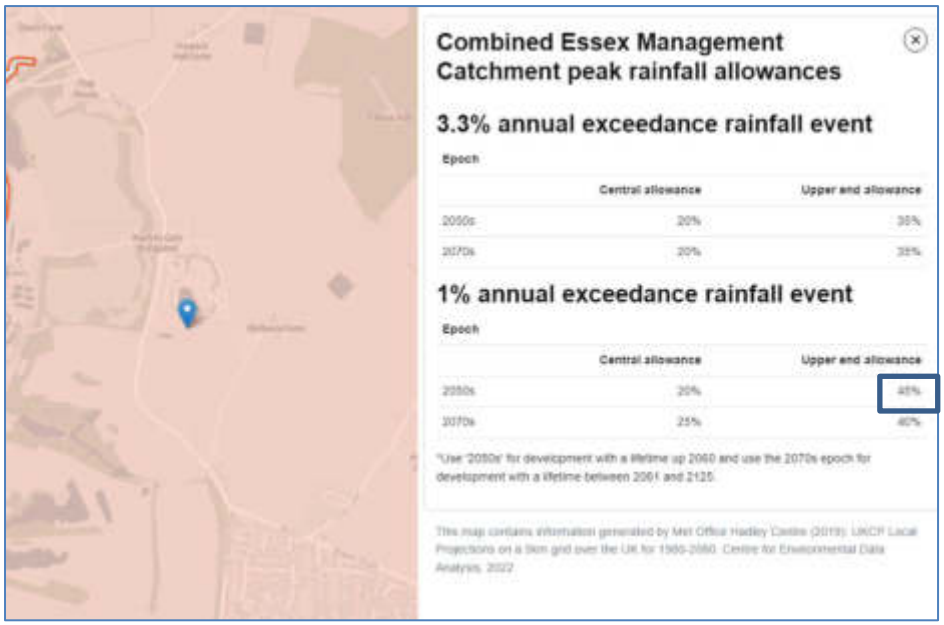


Figure 5.1: Environment Agency Peak Rainfall Allowances

FLOOD RISK ASSESSMENT

6. FLUVIAL FLOODING

6.1. Fluvial flooding is the flooding associated with rivers. This can take the form of:

i. Inundation of floodplains from rivers and watercourses

ii. Inundation of areas outside the floodplain due to influence of bridges, embankments and other features that artificially raise water levels

iii. Overtopping of defences

iv. Breaching of defences

v. Blockages of culverts

vi. Blockages of flood channels or corridors

6.2. Figure 2.1 shows that the site is located within Flood Zone 1 where the risk of flooding is less than 1 in 1000 (0.1% AEP), with a low probability of flooding.

7. TIDAL FLOODING

7.1. Tidal flooding is a risk of water levels from the sea or an estuary exceeding the normal tidal range. This can take the form of:

i. Overtopping of defences

ii. Breaching of defences

iii. Other flows (fluvial surface water) that could pond due to tide locking

iv. Wave action

7.2. As outlined in 6.2, the Environment Agency Flood Map for Rivers and Seas shows the site is located within Flood Zone 1, where the likelihood of tidal flooding is less than 0.1% AEP.

8. PLUVIAL FLOODING

8.1. Pluvial flooding is a risk of overland flows and ponding associated with extreme rainfall events. This can take the form of:

i. Sheet runoff from adjacent land (urban or rural)

ii. Surcharged sewers

8.2. As rain falls everywhere within the United Kingdom, there will always be a residual risk of flooding from extreme rainfall events.

8.3. The Environment Agency has produced maps with risk classifications that show the risk of flooding from surface water runoff (Figure 8.1). The maps show that the site is at a Very Low risk of flooding with exception for the lowest areas of the site (at the toe of the slopes) where there is a Low risk of flooding indicated and an isolated area at Medium risk. There is a High risk of flooding indicated in the location of the pond to the south of the north site area boundary.

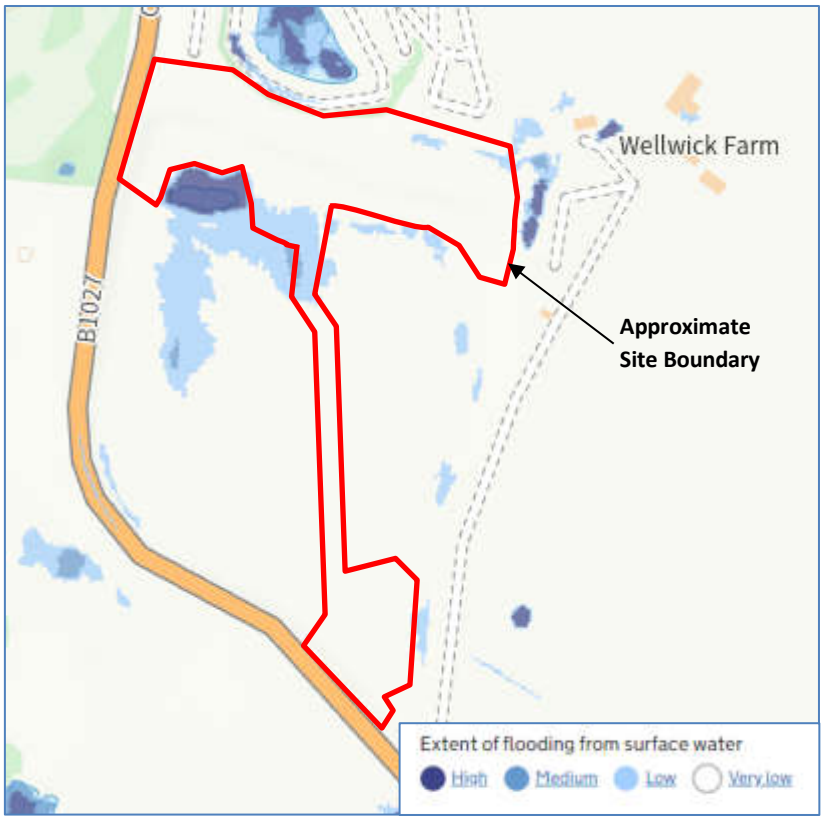


Figure 8.1 – Surface water flooding extents

8.4. The Environment Agency has produced maps that show the depth of surface water flooding during a Low risk scenario (1% to 0.1% AEP), which can be taken to represent the flood risk including for climate change (Figure 8.2). The maps show that the site is at risk of flooding below 300mm in the lowest parts of the site at the toe of the slopes, and between 300 to 900mm in an isolated location which extends south of the 'north site area'. The flood risk extent is also shown on the drawing in **Appendix B**.

8.1. It is proposed, as part of the 'north site area' development, that the site levels are altered by lowering them in the north and raising them in the south area. This will reduce the pluvial flood risk to the development in the south part of the site as the levels will be raised higher than the maximum flood depth (in the Low risk scenario) of 900mm. It is not considered necessary to provide flood volume mitigation for the ground level alteration in this location as the runoff contributing to this area of flooding will be intercepted and captured as part of the proposed site drainage strategy. It is also proposed that a filter drain will be located at the toe of the revised north embankment to intercept and convey any runoff from the site area at the north,

8.2. The risk of overland flow from adjacent sites is considered to be Low based on the surface water mapping, the surrounding site use, the topography, proposed interception drain at the north boundary and the location of the pond at the south boundary. Any overland flow would follow the contours towards the existing pond as currently occurs.

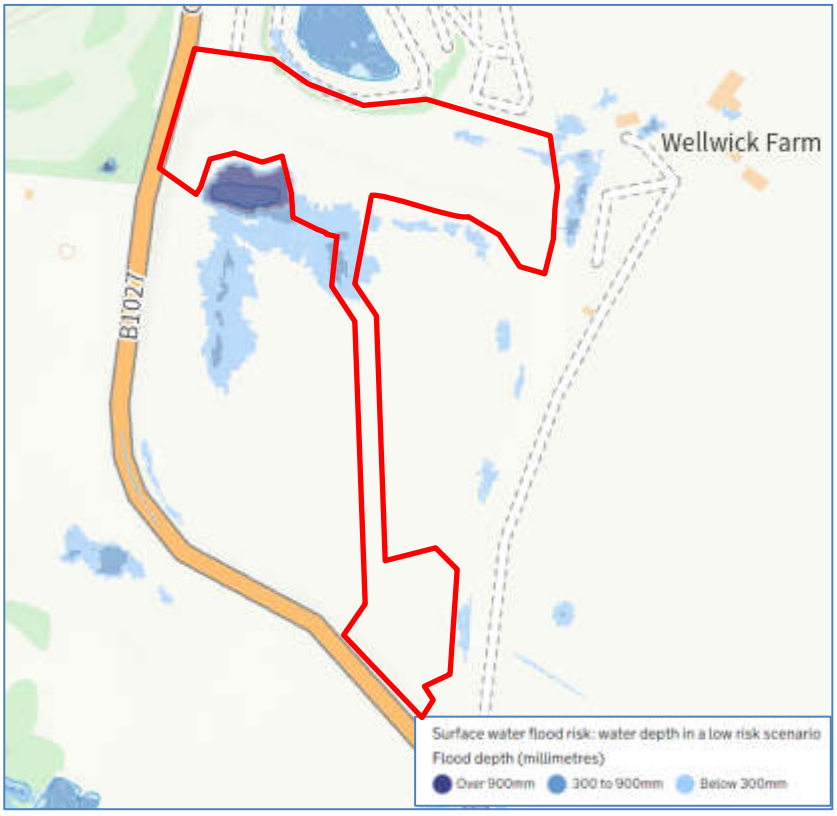


Figure 8.2 – Surface Water Flood Extents - Low Risk

9. GROUNDWATER FLOODING

9.1. Groundwater flooding is a risk of the water table rising after prolonged rainfall to emerge above ground level remote from a watercourse. It is most likely to occur in low lying areas underlain by aquifers of high vulnerability.

9.2. The Environment Agency has mapped groundwater vulnerability and Figure 4.2 shows the site is located over an Aquifer of Low and Medium to Low vulnerability.

9.3. The Tendring District Council Strategic Flood Risk Assessment Addendum, August 2017 prepared by Essex County Council Flood Services includes mapping of the Areas Susceptible to Groundwater Flooding (AStGWF). The report advises that the mapping should be used to

highlight where surface water flood risk may be relevant to a potential development, with mapping related to Tendring 2017 SHLAA sites. The mapping is attached in **Appendix G**, and shows the site is located within an area of <25% with an area of >=25% to <50% at the south. The mapping summarises that the site area is at a Low flood risk.

9.4. Given the site geology, groundwater vulnerability, topography and AStGWF mapping, the site is considered to be at Low risk of groundwater flooding at the higher levels and a Low to Medium risk within the lower levels of the site where the groundwater is shallow.

10. INFRASTRUCTURE FAILURE FLOODING

10.1. Infrastructure failure flooding is a risk of collapse, failure or surcharging of man-made structures and drainage systems. This could take the form of:

i. Reservoirs

ii. Canals

iii. Burst water mains

iv. Blocked sewers

v. Failed pumping stations

10.2. The Environment Agency have mapped failure of reservoirs, which shows the site is not located within the maximum extent of flooding from reservoirs.

10.3. The risk of flooding from blocked sewers is considered to be Low as any flood water would follow the site contours and enter the network downstream or flow towards the existing pond.

DRAINAGE STRATEGY

11. PROPOSED DEVELOPMENT

11.1. The proposed residential development comprises 37 units with associated garages, driveways access roads and landscaped areas, split between a north site area (24 dwellings) and a south site area (13 dwellings), linked by an access road. An indicative layout drawing showing how the quantum of development can be accommodated within the site is attached in **Appendix F**.

11.2. Development site characteristics:

- Total Development area is 4.1ha
- Total proposed impermeable development area is 0.96ha

11.3. The development forms part of granted planning applications 11/00333/OUT and 19/01171/OUT.

11.4. The technical quantums have been referenced in the Essex County Council drainage pro-forma shown in **Appendix J**.

11.5. Options for draining the development have been assessed;

(i) Geological information indicates that the ground conditions in the north site area are likely suitable for infiltration methods, however there is insufficient space to accommodate soakaways and infiltration features the minimum required distance away from building foundations within this north area. If future proposed foundation design permits the location of infiltration features closer than 5m within the north site area, then this can be reviewed in line with additional infiltration testing and specialist geotechnical advice at detail design stage. The runoff from this north area will therefore need to be directed south.

(ii) The infiltration rate achieved at the north-west of the site during November 2023, indicates infiltration is feasible in this location, however based on the shallow depth to groundwater at the site (approximately 0.6m bgl), it is necessary to raise the ground levels to provide a sufficient depth of unsaturated fill material above the groundwater level, beneath an infiltration feature.

It is proposed that the existing ground levels within the wider site area are raised as part of the development associated with Planning Application 11/00333/OUT and 19/01171/OUT and so it is proposed that the runoff from this development (north and south site area and access road) will discharge to an infiltration swale located at the perimeter of the wider site ownership boundary, located at a higher backfilled ground level. It is proposed that the wider site will be backfilled to an approximate depth of 2.0 to 3.25m to achieve a proposed ground level of approximately 15.25m AOD. The proposed backfill will be engineered to achieve a minimum infiltration rate of **$1x10^{-5}$ m/s**.

The perimeter swale will be designed to accept the runoff from the development and from the drainage catchments associated with Planning Application 11/00333/OUT and 19/01171/OUT. This infiltration proposal will be subject to further testing to BRE 365 in the location of the proposed swale and of the proposed site fill material. If the required infiltration rates or depth of fill are not achievable then a positive overflow to the existing

piped network to the west of the development could be installed, with a maximum previously agreed discharge rate of 4.87l/s.

11.6. It is proposed that the site will be backfilled to achieve a proposed ground level of approximately 15.25m AOD, which would provide a minimum 1.2m unsaturated depth of infiltration fill above a groundwater level of 12.15m AOD, beneath a 1.9m deep infiltration feature, in accordance with Environment Agency groundwater protection requirements. The proposed backfill should be engineered to achieve a minimum infiltration rate of $1x10^{-5}$ m/s, with the infiltration rate of the underlying strata currently assessed as **$5.4x10^{-6}$m/s** during the recent site investigation works (**Appendix D**). As outlined above, the existing ground infiltration rates in the location of the proposed swale and of the proposed site fill material will be subject to further testing to BRE 365. The depth to the groundwater will also need to be monitored and confirmed in the infiltration feature locations.

Surface Water Disposal

11.7. In accordance with Government and Local Plan Policies and the requirements of the Building Regulations, surface water runoff from the development will be drained at source in a sustainable way by making full use of Sustainable Drainage Systems (SuDS) where possible.

11.8. The SuDS hierarchy dictates that infiltration at source is considered first. After infiltrating at source has been considered, the next stage is to deal with runoff in individual catchments, followed finally by site wide drainage solutions. Runoff from the development should not adversely impact upon drainage systems outside of the site boundary.

11.9. Detailed surface water drainage design should take into account all three key SuDS principles in equal measure:

i. Reducing peak quantity;

ii. Improving quality; and

iii. Providing amenity and biodiversity value.

11.10. It is proposed that the development runoff will be discharged via a piped network to an infiltration swale system at the wider site boundary (within the site ownership), which will provide attenuation storage, cleansing and infiltration of the runoff. The swale will also have an overflow to the existing basin at the north site area. The runoff associated with the site access and south site shared access catchments will discharge to the swale via a bioretention basin. Refer to the drawings in **Appendix H** for the drainage strategy layout, typical details and catchment areas.

11.11. It will be necessary to inform the future homeowners at the site of the purpose and location of the swale system and how this will need to be maintained to provide effective site drainage. This could be communicated via a homeowner information pack.

11.12. Table 11.1 summarises how the use of SuDS components has been considered and utilised in this drainage strategy.

SUDS Type	Component Type	Suitable	Explanation/Comments
Source Control	Rainwater Harvesting systems	Yes	Rainwater harvesting systems not proposed as part of the development. Water Butts are recommended within each plot.
	Green Roofs	No	Not proposed as part of the development.
	Rain gardens	No	No scope to accommodate within the layout.
	Permeable Paving	No	No scope to accommodate within the layout.
Infiltration	Soakaway	No	No scope to accommodate within the layout based on current criteria.
	Filter Drain/Strips	No	No scope to accommodate within the layout.
	Infiltration Basin	No	No scope to accommodate within the layout.
	Swale	Yes	To be provided to the south-west of the site within the wider site ownership to cleanse, attenuate and infiltrate the runoff.
	Tree Pits	No	No scope to accommodate within the layout.
Conveyance	Swale	No	No scope to accommodate within the layout.
	Filter Drain	No	Storage provided by a swale network in this strategy.
Detention	Sub-surface Storage	No	No requirement for additional storage.
	Detention Basin	Yes	Bioretention provided at south of site.
	Pond	No	As above
	Wetland	No	As above

Table 11.1: Table summarising the use of SuDS components.

Quantity

11.13. InfoDrainage has been used to design the swale storage associated with up to the 1% AEP event plus an allowance for 45% climate change using FEH data, a design infiltration rate of **5.4x10^{-6}m/s** and a Factor of Safety of 10 (see Figure 11.2). An allowance of 10% urban creep has also been included for in the calculations.

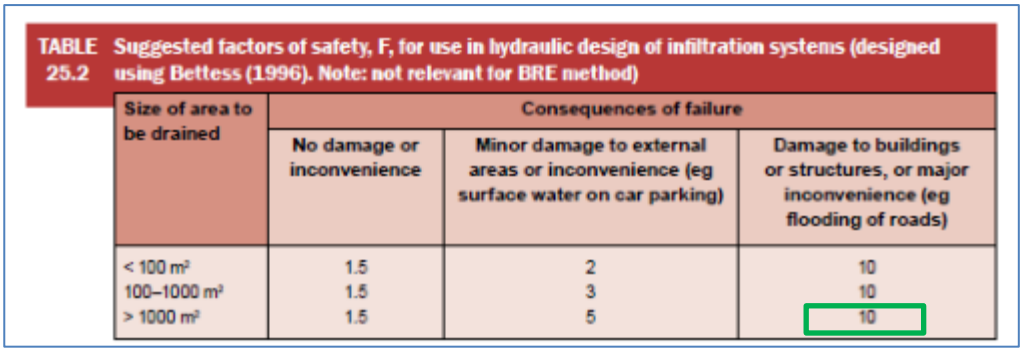


TABLE 25.2 Suggested factors of safety, F, for use in hydraulic design of infiltration systems (designed using Bettess (1996). Note: not relevant for BRE method)

Size of area to be drained	Consequences of failure		
	No damage or inconvenience	Minor damage to external areas or inconvenience (eg surface water on car parking)	Damage to buildings or structures, or major inconvenience (eg flooding of roads)
< 100 m²	1.5	2	10
100–1000 m²	1.5	3	10
> 1000 m²	1.5	5	10

Figure 11.2: Extract from CIRIA SuDS Manual C753

11.14. The calculations for the 1 in 2 year, 1 in 30 year and 1 in 100 year rainfall event plus climate change are attached in **Appendix I,** with the drainage layout shown on the drawing in **Appendix H**. The calculations show that the there is no flooding on or off-site during rainfall events up to the 1% AEP plus climate change scenario.

Quality

11.15. The water discharging to the ground must be cleansed and therefore treatment processes are introduced through the drainage network. These should be in accordance with Chapter 26 of the Ciria SuDS Manual C753, where the hazard of low to medium is mitigated with the various SuDS components to equal or exceed the hazard indices. Refer to the following Tables 26.2 and 26.4 which show the hazard and mitigation indices associated with the proposed drainage scheme.

11.16. It is proposed that the development runoff will discharge via a swale system prior to discharge to the ground.

11.17. The tables show that the mitigation indices associated with the swale exceed the hazard indices associated with the roofs, driveways and associated access roads.

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

Swale surface

TABLE 26.4 Indicative SuDS mitigation indices for discharges to groundwater			
Characteristics of the material overlying the proposed infiltration surface, through which the runoff percolates[1]	**TSS**	**Metals**	**Hydrocarbons**
A layer of dense vegetation underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.6[4]	0.5	0.6
A soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.4[4]	0.3	0.3
Infiltration trench (where a suitable depth of filtration material is included that provides treatment, ie graded gravel with sufficient smaller particles but not single size coarse aggregate such as 20 mm gravel) underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.4[4]	0.4	0.4
Constructed permeable pavement (where a suitable filtration layer is included that provides treatment, and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.7	0.6	0.7
Bioretention underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.8[4]	0.8	0.8
Proprietary treatment systems[5, 6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for inflow concentrations relevant to the contributing drainage area.		

Biodiversity & Amenity

11.18. Amenity and biodiversity are often considered together as they overlap and linkages are made.

11.19. Amenity is the multi-functional use that should be highlighted for any part of the SUDS landscape, which is available for use by people when not being used for drainage. This is an underlying principle of place making urban design, to make a location desirable to live and work.

11.20. Biodiversity encompasses the number and abundance of all species of life on earth. Locally, biodiversity reflects the character of the plants and wildlife that share the space in which humans live, work and play.

11.21. The development has recognised the existing drainage features and has enhanced them where possible.

11.22. The existing pond to the north-west of the site has been retained and will become part of the development amenity area to be enjoyed by the residents. The existing pond has been enhanced by providing access, open space and property frontages for inclusion and maintenance purposes. The existing native ecology will be maintained.

11.23. The development has incorporated the swale at the wider site boundary, adjacent to the existing vegetation. When the swale is not at full capacity, the side slopes allow for the area to be enjoyed by the public.

11.24. The proposed development landscape and SuDS components provide amenity and biodiversity encouraging growth for native species and interaction with people.

Exceedance

11.25. In an exceedance event in which rainfall surpasses the design capacity, there should be no vulnerable buildings or infrastructure at risk of flooding.

11.26. Site ground levels will be locally contoured to deflect water away from the buildings. The exceedance flow path will be directed away from the building thresholds and to the north-west site boundary and to the existing pond, replicating the current flow path.

11.27. The exceedance paths have been shown on the layout plan in **Appendix H**.

Foul Water Disposal

11.28. Part H of The Building Regulations (2010) 2015 Edition states that "Foul drainage should be connected to a public foul or combined sewer wherever this is reasonably practicable".

11.29. There are no existing public foul sewers located within the immediate site vicinity. Refer to the Anglian Water Asset Plan information attached in **Appendix E**. Anglian Water assessed the capacity of their network to accept the foul flows from the development as part of an enquiry during November 2011 and a copy of their report is attached in **Appendix E**.

11.30. Based on the Anglian Water Assessment Report, it is proposed that the foul discharge from the development will discharge to a proposed Pumping Station located in the south-west of the site from where it will be pumped to the existing Anglian Water network further south of the site in Colchester Road (node TM12163201). A foul drainage layout for the development is attached in **Appendix H**.

11.31. The connection to the Anglian Water network will be subject to their Infrastructure Charges and consents.

12. ADOPTION & MAINTENANCE

12.1. It is important to establish the adopting authorities at an early stage to define the requirement and how these meet the standards.

12.2. It is not proposed that the drainage will be adopted; it will be maintained by a Management Company associated with the development.

12.3. The local council could designate flood features if they so wish in accordance with 'Flood & Water Management Act 2010 Section 30 and Schedule 1, designation of features', to protect from future change.

12.4. It is important to prevent silt from entering the drainage system during the construction phase and a Construction Surface Water Management Plan should be developed prior to commencement of works.

12.5. Maintenance of the system will include for frequent inspections of the network and swale with debris removal to ensure designed levels of performance are achieved.

13. SUMMARY

13.1. It has been demonstrated that the site is located within Flood Zone 1.

13.2. Table 13.1 summarises the probability of the site flooding from the five key sources as listed in PPS25.

Source	Description	Risk	
Fluvial	Rivers	Flood Zone 1	**(<0.1% AEP)**
Tidal	Seas		
Pluvial	Surface Water	Very Low to Medium	**(<0.1% to 3.3% AEP)**
Groundwater	Aquifers	Low-Medium	-
Infrastructure failure	Reservoirs Blocked Sewers	Outside extent of flooding Very Low	-

Table 13.1 – Flood Risk Summary

13.3. The pluvial (surface water) flood risk will be reduced within the lower parts of the site as it is proposed to raise the ground levels in this area as part of the drainage strategy, with levels raised higher than the maximum flood depth (in the Low risk scenario) of 900mm. It is also proposed that a filter drain will be located at the toe of the revised north embankment and to the east of the south development area, to intercept and convey any runoff from the site area.

13.4. Surface Water runoff from the development will discharge to an infiltration swale located at the wider site perimeter, within the Site Ownership boundary. The ground levels will be raised to provide a minimum of 1.2m unsaturated depth of suitable fill material between the infiltration base of the swale and the highest groundwater level. Further testing is required at detailed design stage to confirm infiltration rate of the existing strata within the swale location and of the proposed fill material and confirm the groundwater level across the site. If

13.5. The drainage strategy is designed to store and discharge the runoff associated with up to the 1 in 100 year rainfall event plus an allowance of 45% climate change and 10% urban creep, without flooding within the site.

13.6. The runoff will discharge via a piped network, bioretention area and swale system, with the bioretention basin and swale suitably cleansing the runoff prior to discharge to the ground.

13.7. Exceedance flow will be directed away from vulnerable buildings and infrastructure and directed north-west towards the existing pond as currently occurs.

13.8. In accordance with government policy, SuDS will be used on site where possible, and surface water drainage of the site will be carried out in a sustainable way.

13.9. As long as maintenance of the new drainage systems are correctly carried out, the risk of flooding and the subsequent risks from infrastructure failure or pluvial means, is very Low.

13.10. It is considered that the risk of flooding to the site has been adequately considered and therefore development of the site does not pose an unacceptable flood risk either to occupants of the site or to others off site.

13.11. The Environment Agency accepts that extreme floods will occur and it will never be possible to eliminate flood risk altogether.

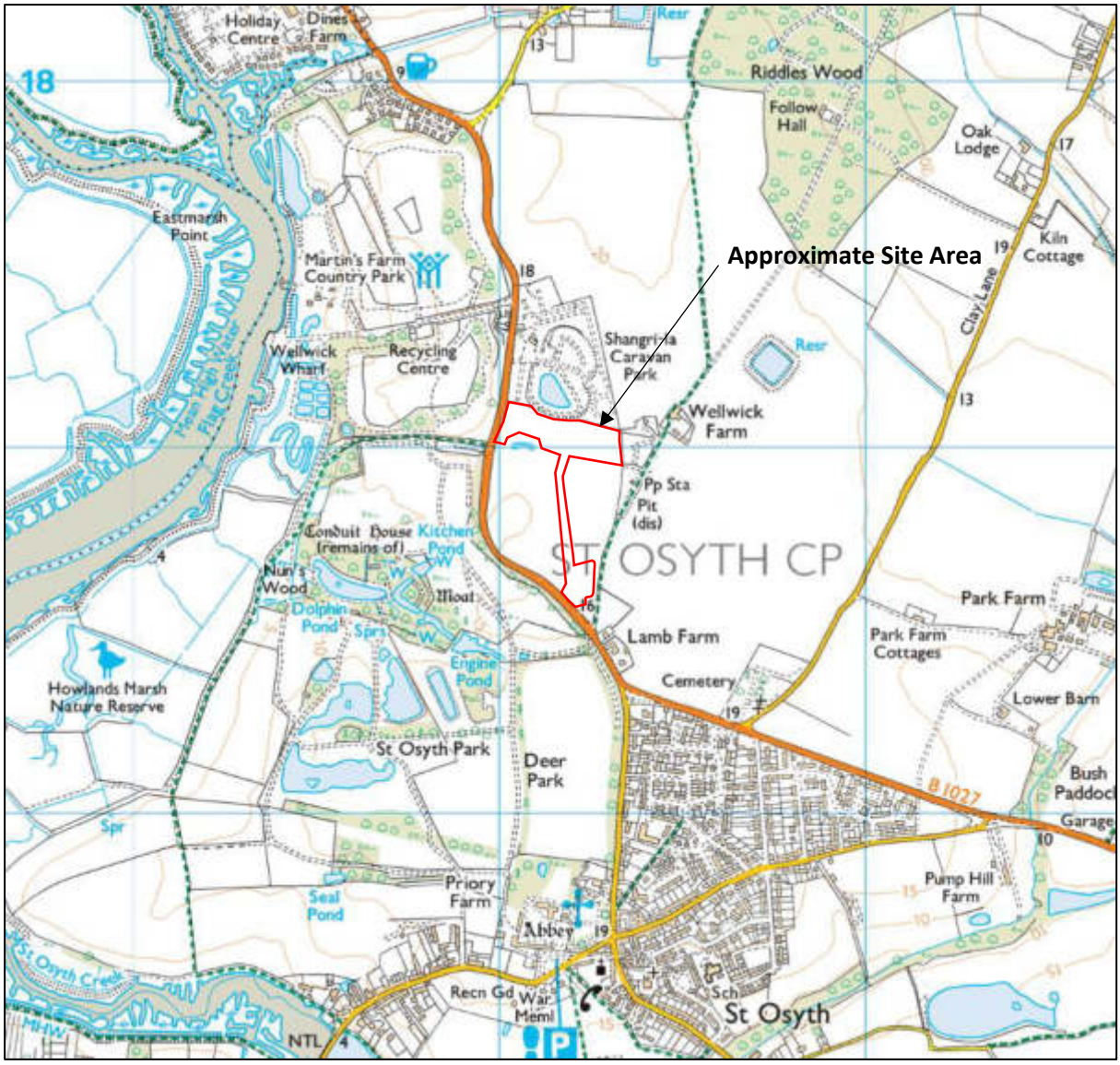
APPENDICES

Appendix A

Site Location Plan

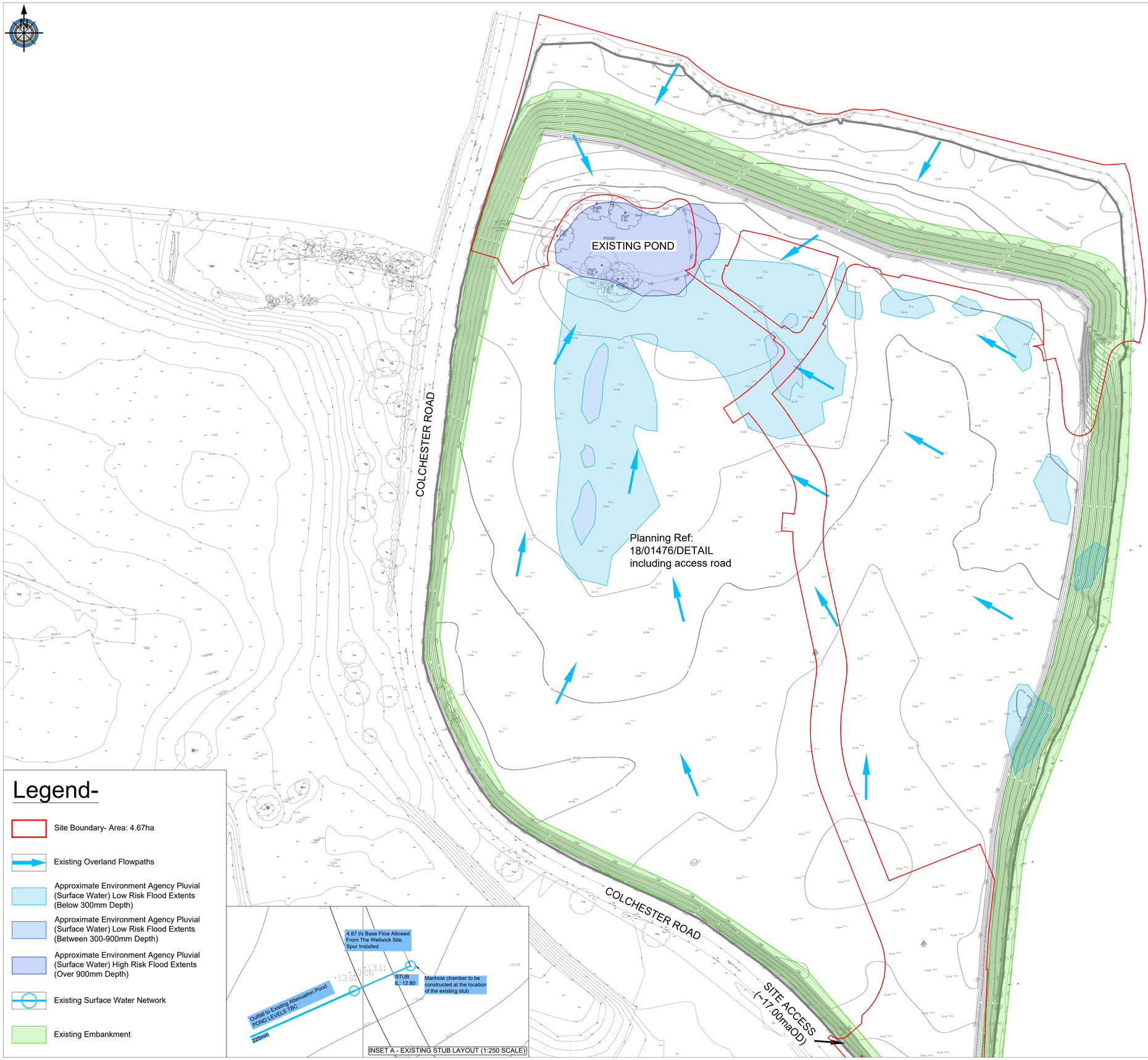
217/2023: Residential Development Site, Wellwick, St Osyth, Essex, CO16 8HR

Site Location Plan



Appendix B

Existing Site Layout



NOTES:

1. This drawing is to be read in conjunction with GHB series 217/2023 drawings and documents and any other relevant project team documents.
2. Preliminary Issue - This drawing is not to be used for construction or detailed pricing purposes. Any work undertaken before approvals are received (in writing) are at risk of abortive works.
3. This drawing has been produced based upon the following information:
   Topographical Survey by City & Country (Ref. N/A dated N/A) subject to transformation of :
   Scale N/A and translation (N/A, N/A, N/A) about point (N/A, N/A, N/A).
   Architectural Layout by City & Country (Ref. CC009-PL-02-1 (pdf) dated 24/05/2023) subject to transformation of :
   Scale 593.908 and translation (N/A, N/A, N/A) about point (N/A, N/A, N/A).
4. This drawing has been prepared solely for the purpose of obtaining a Planning Consent based on information available and planning requirements at the date of issue only.

Rev	Rev Date	Description	Drawn	Chck'd
P3	08/03/24	Layout and Site Boundary Alterations	JWT	JAH
P2	21/12/23	Layout and Site Boundary Alterations	ARC	JAH
P1	12/12/23	Initial Issue	ARC	JAH

GHBullard & Associates LLP
Civil and Traffic Engineering Consultants
[redacted]
27 Barton Road,
Thurston,
Suffolk,
IP31 3PA

Client: CITY & COUNTRY

Project: RESIDENTIAL DEVELOPMENT
WELLWICK SITE
ST OSYTH, ESSEX

Drawing Title: FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY EXISTING SITE LAYOUT

Status: FOR PLANNING

Scale: 1:1000 @ A1

Created: DEC 2023 | Drawn: ARC

DWG Reference: 217-2023.DWG | Checked: JAH

Drawing Number: 217/2023/010 | Revision: P3

P# = Preliminary, C# = Construction, AB# = As Built

Appendix C

BGS Borehole Log

TM 11 NW/3
1236 · 1690

1 in 242.

242/13 Tendring Hundred Waterworks Co., St. Osyth Pumping Station, St. Osyth

(a) Surface +65. Shaft x 8. Lined. *1914.*
Suction +42. Yield 10,000 g.p.h., 10 h.p.d. (summer); 6 h.p.d. (winter). *1935.*
Suction +29. *Nov. 1963.*
(b) and (c) Surface +c.65. 2 bores c.36 x 8 in. Water siphoned into (a). *1923.*
(a) (b) and (c) P.W.L. +32. Yield 9,250 g.p.h. *Oct. 1955.* P.W.L. +31. Yield 4,830 g.p.h. *Oct. 1960.* P.W.L. +32½. Yield 4,790 g.p.h. *Oct. 1962.* P.W.L. +31. Yield 5,600 g.p.h., 8 h.p.d. *Oct. 1963.*

(a) Sand and Gravel) ? LC)	... ...	37½	37½

(a) [redacted] 26

30.8.64 37 ¼ deep.

TM11/1A-C

242/13 **Tendring Hundred Waterworks Co., St. Osyth Pumping Station, St. Osyth**

a. TM1235 1690
b. TM1233 1685
c. TM1231 1681

(a) Surface 165. Shaft x 8. Lined. *1914.*
Suction -42. Yield 10,000 g.p.h., 10 h.p.d. (summer); 6 h.p.d. (winter). *1935.*
Suction +29. *Nov. 1963.*
(b) and (c) Surface +c.65. 2 bores c.36 x 8 in. Water siphoned into (a). *1923.* *
(a) (b) and (c) P.W.L. +32. Yield 9,250 g.p.h. *Oct. 1955.* P.W.L. +31. Yield 4,830 g.p.h. *Oct. 1960.* P.W.L. +32¾. Yield 4,700 g.p.h. *Oct. 1962.* P.W.L. +31. Yield 5,600 g.p.h., 8 h.p.d. *Oct. 1963.*

(a) Sand and Gravel) > L.C)	...	37¾	37¾

(a)

[redacted]

26

37 ½ deep.

30.8.64

* D - TH 124 196
E - TH 122 195

LJB/D/294

TABLE 1 TM 123 169 LJB1/46

ST. OSYTH PUMPING TEST PWS. TM11/1A-C
Essex.

Calculated values of Storage Coefficient (S) and Transmissivity (T)

	S	T g.p.d./ft.
Well Point No. 1		
Water table type curve analysis	6.8×10^{-3}	0.5×10^{5}
	$S_y = 4.0 \times 10^{-2}$	1.8×10^{4}
Non-leaky artesian type curve analysis	5.0×10^{-3}	1.1×10^{4}
Well Point No. 2		
Water table type curve analysis	1.6×10^{-2}	1.2×10^{4}
Non-leaky artesian type curve analysis	1.6×10^{-2}	1.2×10^{4}
Syphon No. 1		
Non-leaky artesian type curve analysis	3.6×10^{-3}	2.9×10^{4}
Syphon No. 2		
Non-leaky artesian type curve analysis	2.5×10^{-2}	1.3×10^{3}
Distance drawdown type curve analysis	5.3×10^{-2}	6.1×10^{3}
Pumping well recovery analysis		7.9×10^{3}
		6.5×10^{3}
Well point No. 2 recovery analysis	3.2×10^{-3}	9.8×10^{3}
Well point No. 1 recovery analysis	2.8×10^{-3}	1.0×10^{4}
		9.7×10^{3}

VALUES AVERAGED

Q = 4000 gph.
date of test = 21-24/3/72
length of test = 30 days
No map in the file.

Confidence excellent ☐ ☑ ☐ ☐ ☐ poor

14.11 Fq.

GEORGE STOW CO. LTD.,

224/257 ABC

Waterworks Engineers TM11 DE

READING ROAD ——— HENLEY-on-THAMES, OXON.

RECORD OF WELL (SHAFT OR BOREHOLE)

DATE COMPLETED 8. 12. 64.

TRIAL BORES TM11DE

please see TM12/29 for S.E. 'F'

All depths to be measured below Ground Level.

Work carried out for TENDRING HUNDRED WATER COMPANY (8) 48 NE/6

Locality (Exact Site) ST. OSYTH County ESSEX N 38SE/6 D

Level of Ground Surface above Sea Level (O.D.) ..... ft.

Depth of Shaft ..... ft. ..... ins. Diameter ..... ft. ..... ins.

Depth of Bore ..... ft. ..... ins. Diameter: At Top ..... ins. At Bottom ..... ins.

Details of Permanent Lining Tubes.

..... ft. ..... ins. Size diam. ..... ft. Plain ..... ft. Slotted. Top At ..... ft. ..... ins. above / below Ground Level

SEE OVER

Water Struck at depth of (in ft.) .....

Rest Level of Water below / above Ground Level ..... ft. ..... ins. ..... ft. ..... ins. ..... ft. ..... ins.

Yield on ..... Hours / Days test. Pumping ..... Gallons per ..... Date .....

Pump Water level ..... ft. ..... ins. below Ground Level.

Time of Recovery ..... hours.

Headings. Depth below Ground Level .....

Directions and Lengths .....

Remarks Telephone Call from Mr. Carlton I.G.S. (11-2-69). New Records Details 'ABC' ons in feet 'DEF'

See back for Strata Record.

1

RECORD of WELL or BORING

242/13 ABC

Survey No. 242
1" N.S. 242
Six-inch 37 N/W

at (name of farm) Tendring Hundred Waterworks Co.

Town, Village, &c. St. Osyth County Essex

Exact site: Field No. 335, Essex XXXVII 13

Surface level of ground 65 ft. above Ordnance Datum. Well commenced at 10 ft. below surface level of ground.

Sunk 26 ft., diameter ..... ft. Bored ..... ft.; diameter of boring: at top ..... in., at bottom ..... in.

Details of lining tubes

TM11/1A-C

Water struck at depths of (feet)

Rest-level of water below/above top of well or bore ..... ft. Pumping level ..... ft. Time of recovery ..... hours.

Suction at 23 ft. depth. Yield: (i) on test ..... galls. per ....., (ii) normal 10,000 galls. per hr.

Quality

Made by ..... for W. Clacton U.D.C. Date of boring 1904

Information from Clacton U.D.C. See M.O.H. report att. to 224/52

(For Survey use only) GEOLOGICAL CLASSIFICATION.	NATURE OF STRATA. (and any additional remarks)	THICKNESS. Feet.	Inches.	DEPTH. Feet.	Inches.
Sand and Gravel ?LC PEL 30.F.64 37¼ dep.	Superficial gravel.			~~26~~ 37¼	

* Pumping 10 hours per day in summer, " " " " " winter.
Maximum daily yield estimated at 150,000 gallons.

Total quantity pumped in year ending 31st. March, 1935 : 19,984,000 galls. av. a/f 55,000 g/d.

} Information from Water Survey, 1935 attached to 224/52.

Site on 6" N 48NE. HGWD 23.6.64

1600 yds. N by E. of Church

~~For further information see 242/13 ... 224/52.~~

Visited 6-5-53.
Shallow well. diameter about 9ft.
At present disused. originally steam pumps now to be replaced by electric. Pumped to Clacton.
Not affected by flooding.
Inf from foreman.
P.M.C.

Surface of ground at Pumping Station is 64·92 OD.
— information from engineer in letter dated 13/6/60 BW.

Information from Mr Neal, Engineer, given from memory at Gt. Bentley P.S. 10/6/60:
Shaft 36ft x 8ft — lined throughout with gratings at bottom.
and 2 bores less than 36ft deep x 6 in. from which water is syphoned into main well. BH.

Geological Survey and Museum, South Kensington, London, S.W.7

For Survey use only.

Date received.	G.S.M.	M. of H. notified.	Site marked on 1" map.

(24733) Wt 24080/216 3,000 11/36 S.I. & L. Ltd. Gp 614

2

Information in letter from Tendring Hundred Waterworks
WOR/262 11-11-63.

Surface level of (a) +65 Liverpool;

well top + 3" above G.L. + levelled as +63.19 Newlyn.

Suction in (a) at +29 L. (Nov. 1963).

(b) + (c) lining tubes 8 in. I.D., siphons in use since 1923.

(a) (b) + (c) P.W.L. +31 L., yield 5,600 g.p.h., 8 L. p.d. Oct. 1963.

ADDITIONAL INFORMATION SHEET

Licence No. TM 11/1 A-C 242/13 A-C

Date of completion of well catalogue .....

Date of publication Sept 1965

Additional Sheet No. 1

DATE	*	ADDITIONAL INFORMATION			INIT.
			ft	ft	
5.4.78	a,b,c.	Drift	37.25	17.25	
per		London Clay	—	—	
R.D.Lake					

FILMED

* Insert Well Reference Letter, If More Than One Well At Site

P.T.O.

Section 6	Pumping test	Observ. well	Recorder	E.R. log

Geological Survey, Water Department, South Kensington, London, S.W.7.

TM11SAS

3-A

DATE		ADDITIONAL INFORMATION	INIT.

FILMED

Insert Well Reference Letter, If More Than One Well At Site

Additional Information Sheet No..... Commenced.....

ADDITIONAL INFORMATION SHEET

Licence No. ....

TM11/1A-C
242/13

Date of completion of well catalogue ....

Date of publication ....

Additional Sheet No. ....

DATE	*	ADDITIONAL INFORMATION	INIT.
7/70	B	Sand and gravel — No details c. 36	
	C	? LC	
		DATA Bank	

FILMED ....

* Insert Well Reference Letter, If More Than One Well At Site

P.T.O.

Section 6	Pumping test	Observ. well	Recorder	E.R. log	Geological Survey, Water Department South Kensington, London, S.W.7.

(4132) Wt.34084/P.S.119 5m 9/68 C.W.R.Ltd. Gp.861

DATE	*	ADDITIONAL INFORMATION	INIT.

FILMED

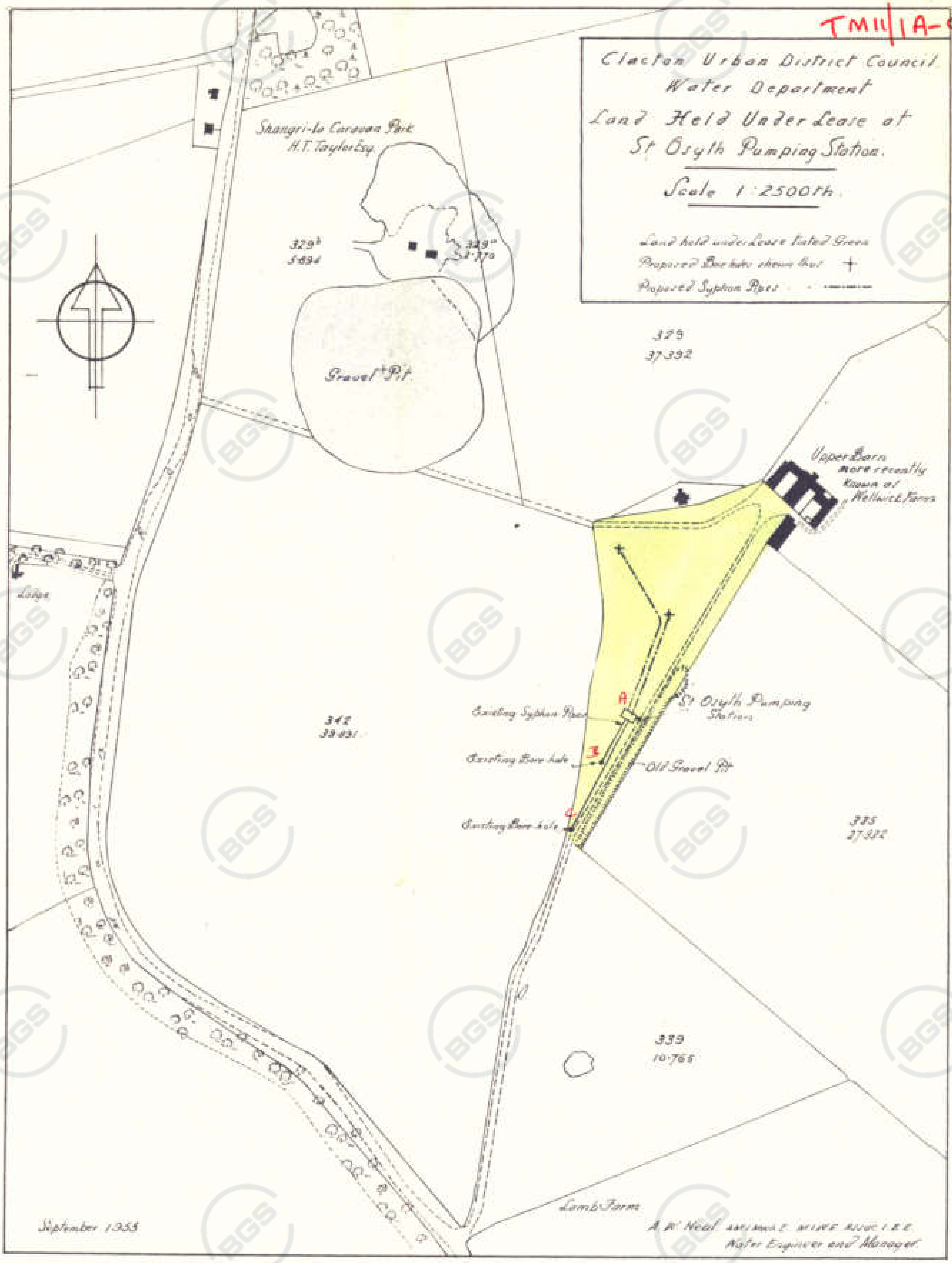
INSERT WELL REFERENCE LETTER, IF MORE THAN ONE WELL AT SITE

Additional Information Sheet No..... Commenced.....

6

242/13

TM11/1A-C



St. Osyth Pumping Station.

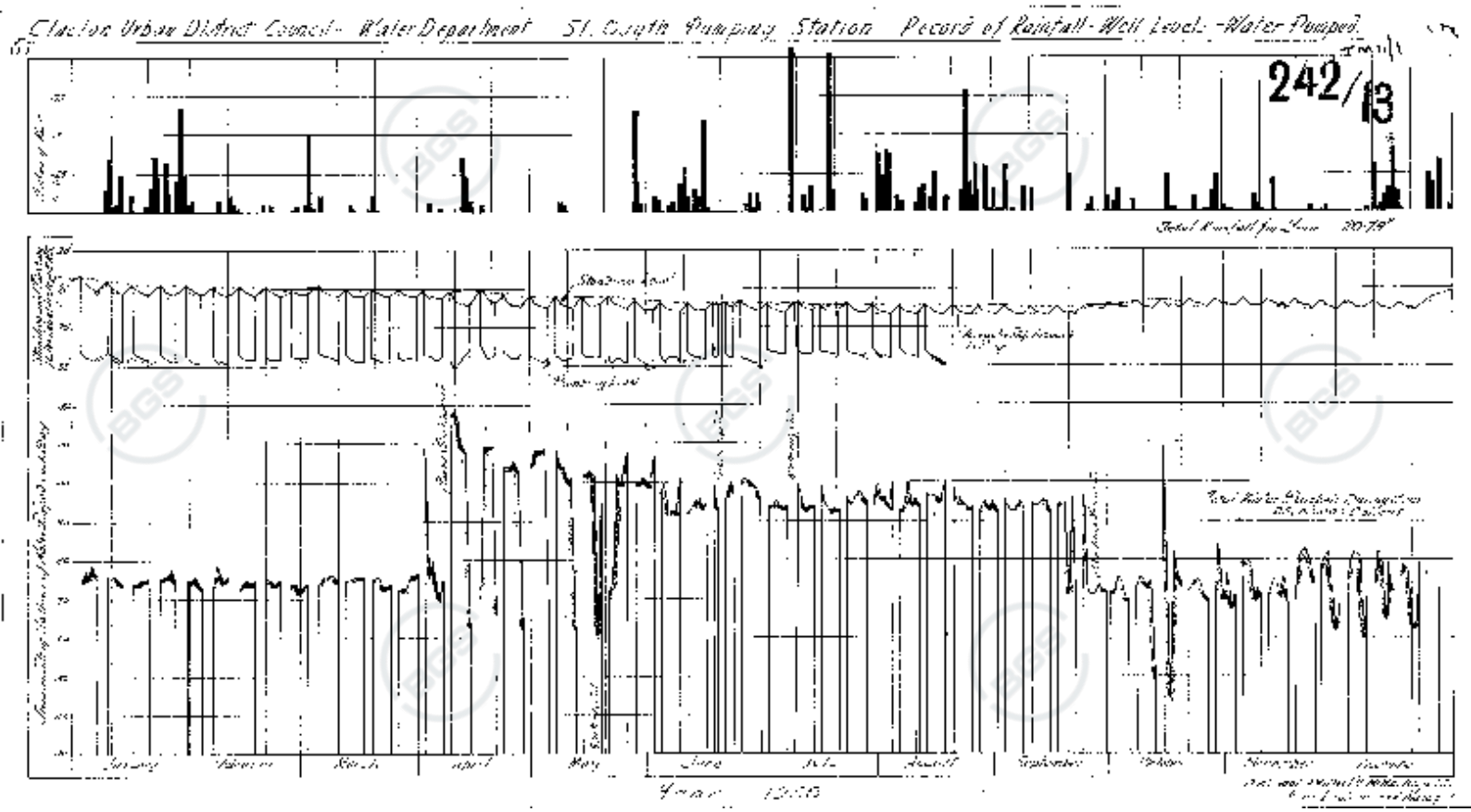
1954

1954.

LEVELS OF WATER IN WELL

Jan. Feb. March. April. May June. July. Aug. Sept. Oct. Nov. Dec.

BGS ID: 560310 : BGS Reference: TM11NW3
British National Grid (27700) : 612360,216900



Appendix D

Infiltration Testing Report

N

205 0.6mdp 202

206

201 + Groundwater level check. 0.6mdp

203 + 0.6mdp

204 0.6mdp

0.6mdp

+ Infiltration testing to BRE 365.

AS DUG LOCATIONS 13.11.23

Test 3m off embankment toe.

3m

6m

0.6

Grd water chks.

Section A-A.

INFILTRATION TEST LOCATION
WELLWICK 217-2023-SK1

Wellwick
Indicative Site Plan
CC009-PL-02-1
1:1000
BAH
May 2023
24.05.2023
Amendment

CITY & COUNTRY

0 50 100 metre

BRE365 Output Spreadsheet Test SA201

Site	23-33 Welwick	Soil description	brown clayey gravelly sand	Install	top of gravel 0.0
Client	City & Country				base of gravel 0.6
Dates	13/11/2023				Drain Zone 0.6m (d100)

Vp75-25 the effective storage volume of water between 75 and 25% modified by voids ratio
as50 internal area of soakage pit up to 50% eff storage depth inc base area
tp75-25 time for water to fall 75% to 25% effective storage depth
Effective storage depth is assumed to be 100% or dry or nearly (95%) dry.
Use 3rd Fill for calculation

inf rate f = Vp75-25 divided by as50 x tp75-25

Vp75-25	is	width	x	length	x	50% full	x	voids		
as50	is	w x l	+	length	x	100% ful	+	width	x	100% full
tp75-25	is	time to drain 75 to 25% full								

*input in red cells only

construction	width	w	0.45	metres	
construction	length	l	1.5	metres	
construction	voids ratio	v	0.35		
test	time at 75%	t75	25	minutes	
test	time at 25%	t25	170	minutes	
test	depth 100%	d100	0.6	metres	between time full and time empty

*select

voids ratio	
0.3	sand and gravel
0.35	typical
0.4	round single size

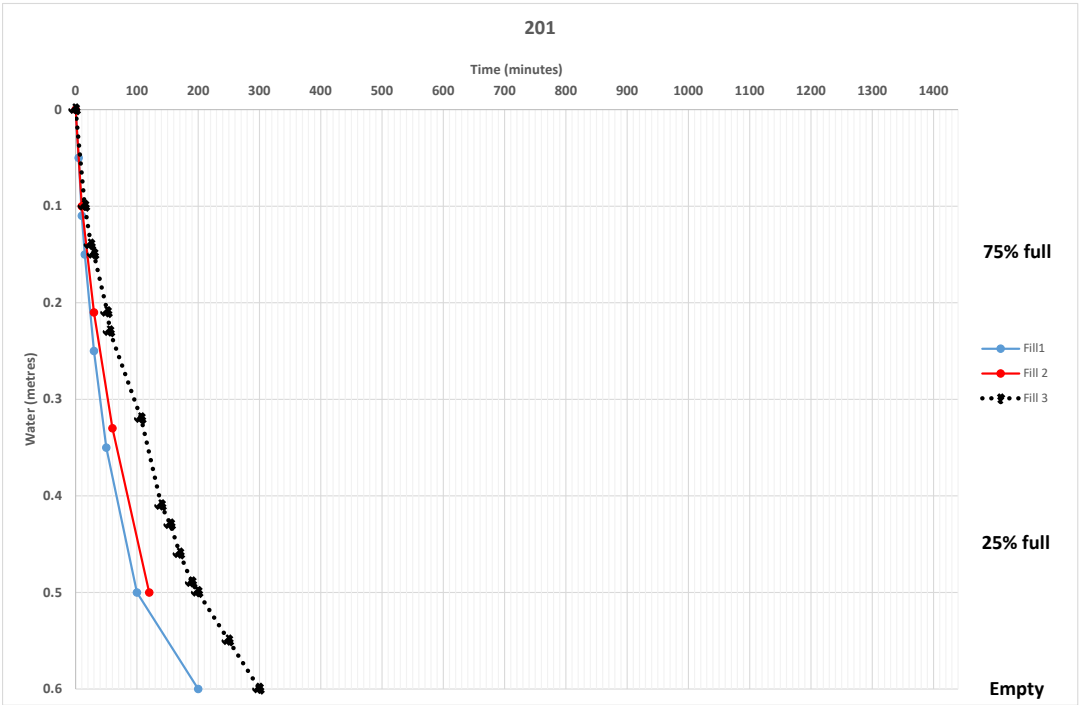
*outputs in yellow cells

Vp75-25	=	0.070875	calculated from the dimensions in red
as50	=	1.845	calculated from the dimensions in red
tp75-25	=	145	calculated from the time in red

Result of test in red

inf = **4.42E-06** m/s **Use Fill 3**

Spreadsheet calibrated using results in BRE365



BRE365 Output Spreadsheet Test SA202

Site	23-33 Welwick	Soil description	brown clayey gravelly sand	Install	top of gravel 0.4
Client	City & Country				base of gravel 0.8
Dates	13/11/2023				Drain Zone 0.4m (d100)

Vp75-25 the effective storage volume of water between 75 and 25% modified by voids ratio
as50 internal area of soakage pit up to 50% eff storage depth inc base area
tp75-25 time for water to fall 75% to 25% effective storage depth
Effective storage depth is assumed to be 100% or dry or nearly (95%) dry.
Use 3rd Fill for calculation

inf rate f = Vp75-25 divided by as50 x tp75-25

Vp75-25	is	width	x	length	x	50% full	x	voids		
as50	is	w x l	+	length	x	100% ful	+	width	x	100% full
tp75-25	is	time to drain 75 to 25% full								

*input in red cells only

construction	width	w	0.45	metres	
construction	length	l	1.5	metres	
construction	voids ratio	v	0.35		
test	time at 75%	t75	65	minutes	
test	time at 25%	t25	200	minutes	
test	depth 100%	d100	0.6	metres	between time full and time empty

*select

voids ratio	
0.3	sand and gravel
0.35	typical
0.4	round single size

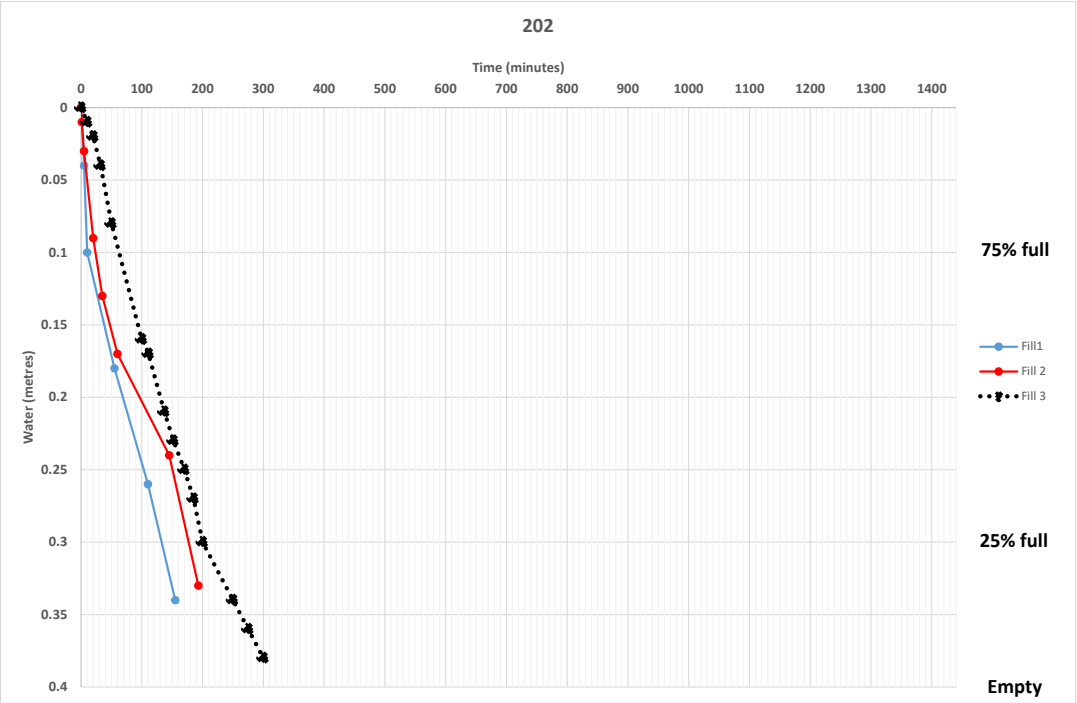
*outputs in yellow cells

Vp75-25	=	0.070875	calculated from the dimensions in red
as50	=	1.845	calculated from the dimensions in red
tp75-25	=	135	calculated from the time in red

Result of test in red

inf = **4.74E-06** m/s **Use Fill 3**

Spreadsheet calibrated using results in BRE365



BRE365 Output Spreadsheet Test SA203

Site	23-33 Welwick	Soil description	brown clayey gravelly sand	Install	top of gravel 0.4
Client	City & Country				base of gravel 1.1
Dates	13/11/2023				Drain Zone 0.6m (d100)

Vp75-25 the effective storage volume of water between 75 and 25% modified by voids ratio
as50 internal area of soakage pit up to 50% eff storage depth inc base area
tp75-25 time for water to fall 75% to 25% effective storage depth
Effective storage depth is assumed to be 100% or dry or nearly (95%) dry.
Use 3rd Fill for calculation

inf rate f = Vp75-25 divided by as50 x tp75-25

Vp75-25 is width x length x 50% full x voids
as50 is w x l + length x 100% ful + width x 100% full
tp75-25 is time to drain 75 to 25% full

*input in red cells only

construction	width	w	0.45	metres	
construction	length	l	1.5	metres	
construction	voids ratio	v	0.35		
test	time at 75%	t75	30	minutes	
test	time at 25%	t25	140	minutes	
test	depth 100%	d100	0.6	metres	between time full and time empty

*select voids ratio
0.3 sand and gravel
0.35 typical
0.4 round single size

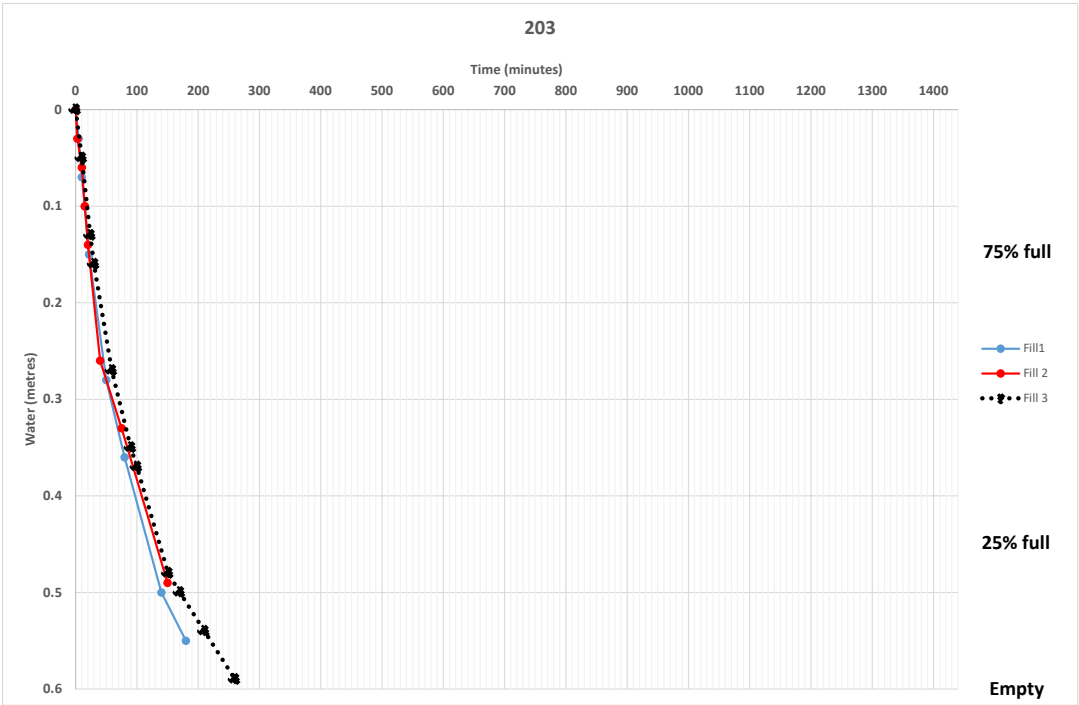
*outputs in yellow cells

Vp75-25	=	0.070875	calculated from the dimensions in red
as50	=	1.845	calculated from the dimensions in red
tp75-25	=	110	calculated from the time in red

Result of test in red

inf = 5.82E-06 m/s **Use Fill 3**

Spreadsheet calibrated using results in BRE365



BRE365 Output Spreadsheet Test SA204

Site	23-33 Welwick	Soil description	brown clayey gravelly sand	Install	top of gravel 0.0
Client	City & Country				base of gravel 0.6
Dates	13/11/2023				Drain Zone 0.6m (d100)

Vp75-25 the effective storage volume of water between 75 and 25% modified by voids ratio
as50 internal area of soakage pit up to 50% eff storage depth inc base area
tp75-25 time for water to fall 75% to 25% effective storage depth
Effective storage depth is assumed to be 100% or dry or nearly (95%) dry.
Use 3rd Fill for calculation

inf rate f = Vp75-25 divided by as50 x tp75-25

Vp75-25	is	width	x	length	x	50% full	x	voids		
as50	is	w x l	+	length	x	100% ful	+	width	x	100% full
tp75-25	is	time to drain 75 to 25% full								

*input in red cells only

construction	width	w	0.45	metres	
construction	length	l	1.5	metres	
construction	voids ratio	v	0.35		
test	time at 75%	t75	150	minutes	
test	time at 25%	t25	0	minutes	
test	depth 100%	d100	0.6	metres	between time full and time empty

*select voids ratio

0.3	sand and gravel
0.35	typical
0.4	round single size

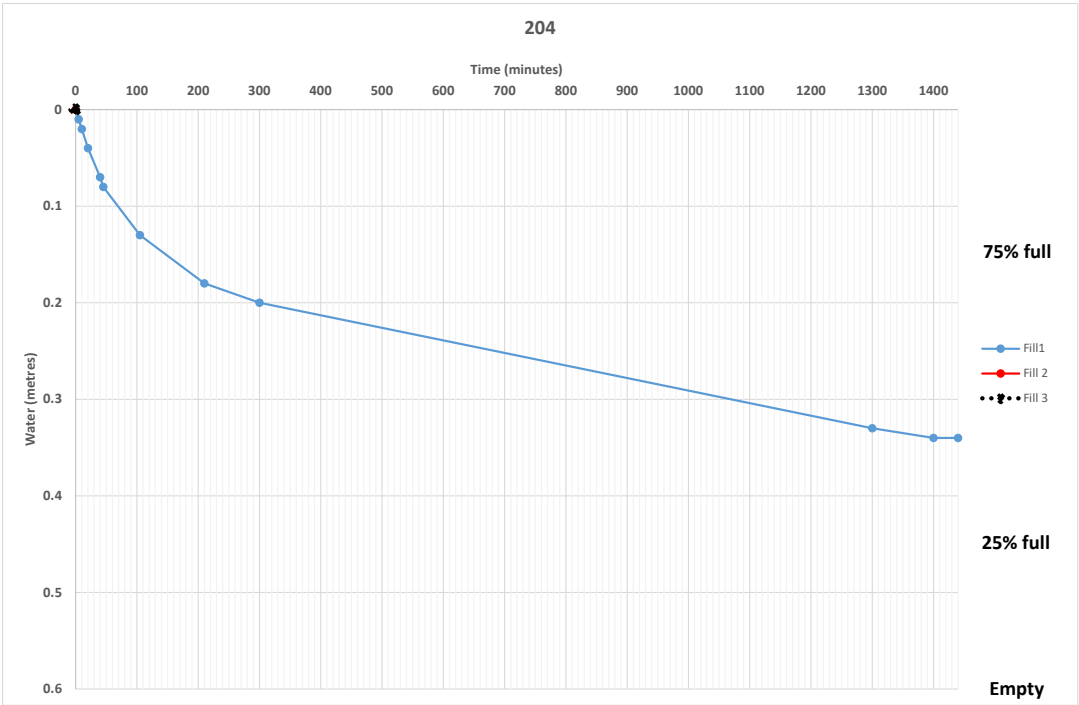
*outputs in yellow cells

Vp75-25	=	0.070875 calculated from the dimensions in red
as50	=	1.845 calculated from the dimensions in red
tp75-25	=	-150 calculated from the time in red

Result of test in red

inf = ######## m/s **Did not drain to 25% - no inf rate**

Spreadsheet calibrated using results in BRE365



BRE365 Output Spreadsheet Test SA205

Site	23-33 Welwick	Soil description	brown clayey gravelly sand	Install	top of gravel 0.4
Client	City & Country				base of gravel 1.1
Dates	13/11/2023				Drain Zone 0.6m (d100)

Vp75-25 the effective storage volume of water between 75 and 25% modified by voids ratio
as50 internal area of soakage pit up to 50% eff storage depth inc base area
tp75-25 time for water to fall 75% to 25% effective storage depth
Effective storage depth is assumed to be 100% or dry or nearly (95%) dry.
Use 3rd Fill for calculation

inf rate f = Vp75-25 divided by as50 x tp75-25

Vp75-25	is	width	x	length	x	50% full	x	voids		
as50	is	w x l	+	length	x	100% ful	+	width	x	100% full
tp75-25	is	time to drain 75 to 25% full								

*input in red cells only

construction	width	w	0.45	metres	
construction	length	l	1.5	metres	
construction	voids ratio	v	0.35		
test	time at 75%	t75	7	minutes	
test	time at 25%	t25	40	minutes	
test	depth 100%	d100	0.6	metres	between time full and time empty

*select

voids ratio	
0.3	sand and gravel
0.35	typical
0.4	round single size

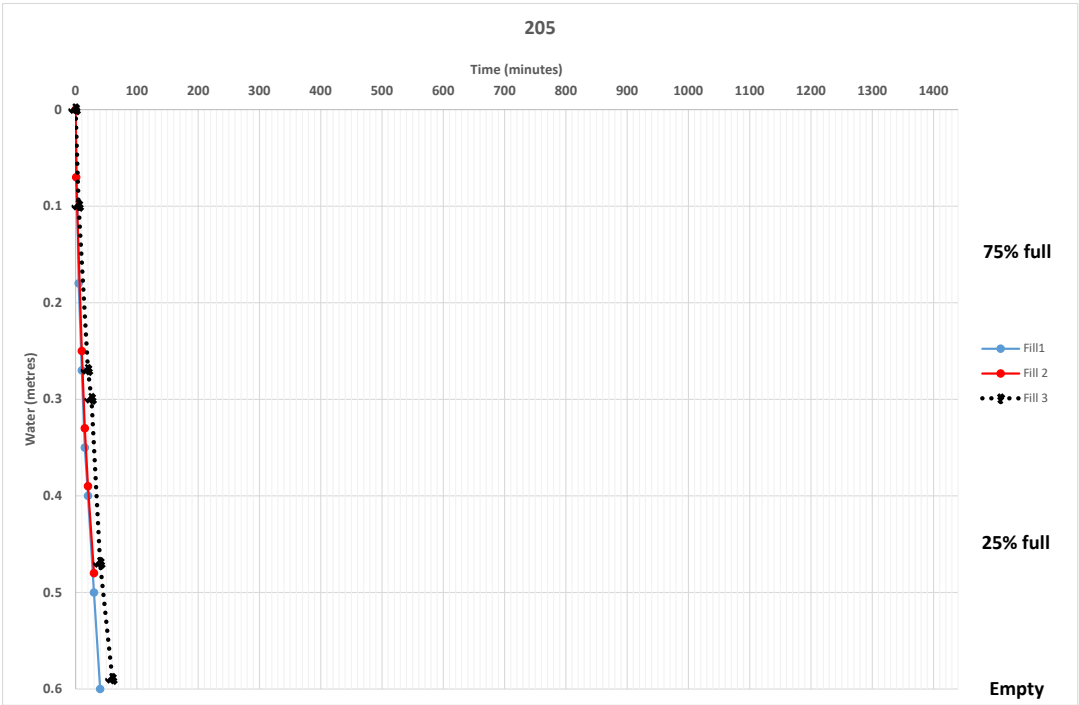
*outputs in yellow cells

Vp75-25	=	0.070875	calculated from the dimensions in red
as50	=	1.845	calculated from the dimensions in red
tp75-25	=	33	calculated from the time in red

Result of test in red

inf = 1.94E-05 m/s **Use Fill 3**

Spreadsheet calibrated using results in BRE365



BRE365 Output Spreadsheet Test SA206

Site	23-33 Welwick	Soil description	brown clayey gravelly sand	Install	top of gravel 0.2
Client	City & Country				base of gravel 0.6
Dates	13/11/2023				Drain Zone 0.4m (d100)

Vp75-25 the effective storage volume of water between 75 and 25% modified by voids ratio
as50 internal area of soakage pit up to 50% eff storage depth inc base area
tp75-25 time for water to fall 75% to 25% effective storage depth
Effective storage depth is assumed to be 100% or dry or nearly (95%) dry.
Use 3rd Fill for calculation

inf rate f = Vp75-25 divided by as50 x tp75-25

Vp75-25 is width x length x 50% full x voids
as50 is w x l + length x 100% ful + width x 100% full
tp75-25 is time to drain 75 to 25% full

*input in red cells only

*select voids ratio
0.3 sand and gravel
0.35 typical
0.4 round single size

construction	width	w	0.45	metres	
construction	length	l	1.5	metres	
construction	voids ratio	v	0.35		
test	time at 75%	t75	10	minutes	
test	time at 25%	t25	110	minutes	
test	depth 100%	d100	0.4	metres	between time full and time empty

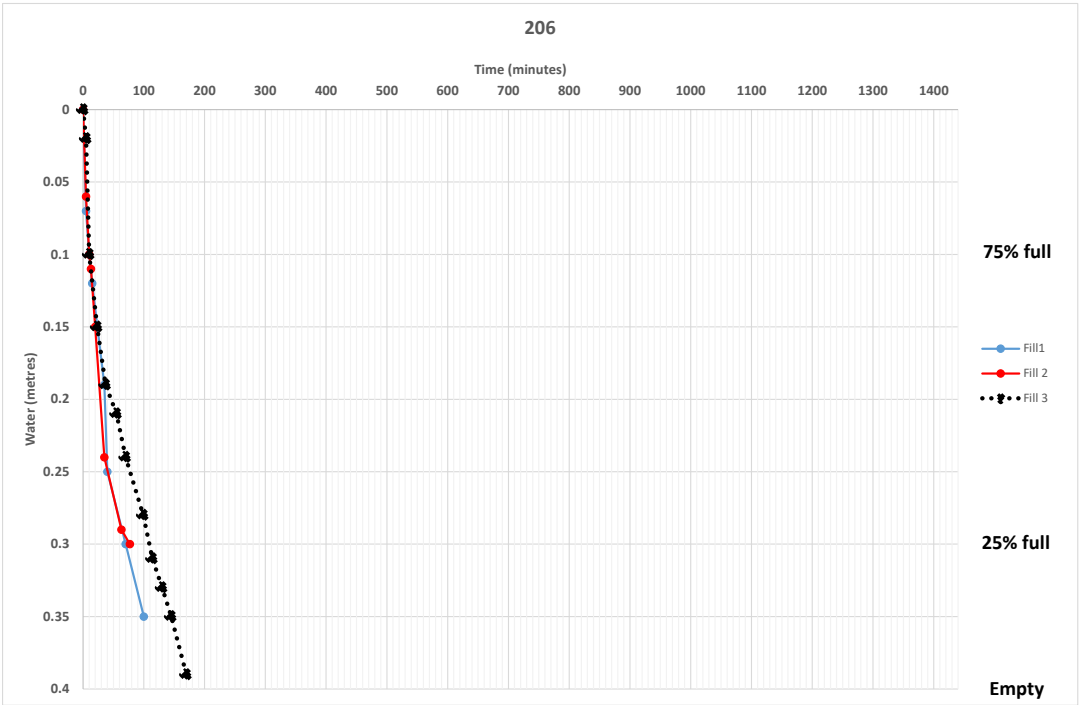
*outputs in yellow cells

Vp75-25	=	0.04725	calculated from the dimensions in red
as50	=	1.455	calculated from the dimensions in red
tp75-25	=	100	calculated from the time in red

Result of test in red

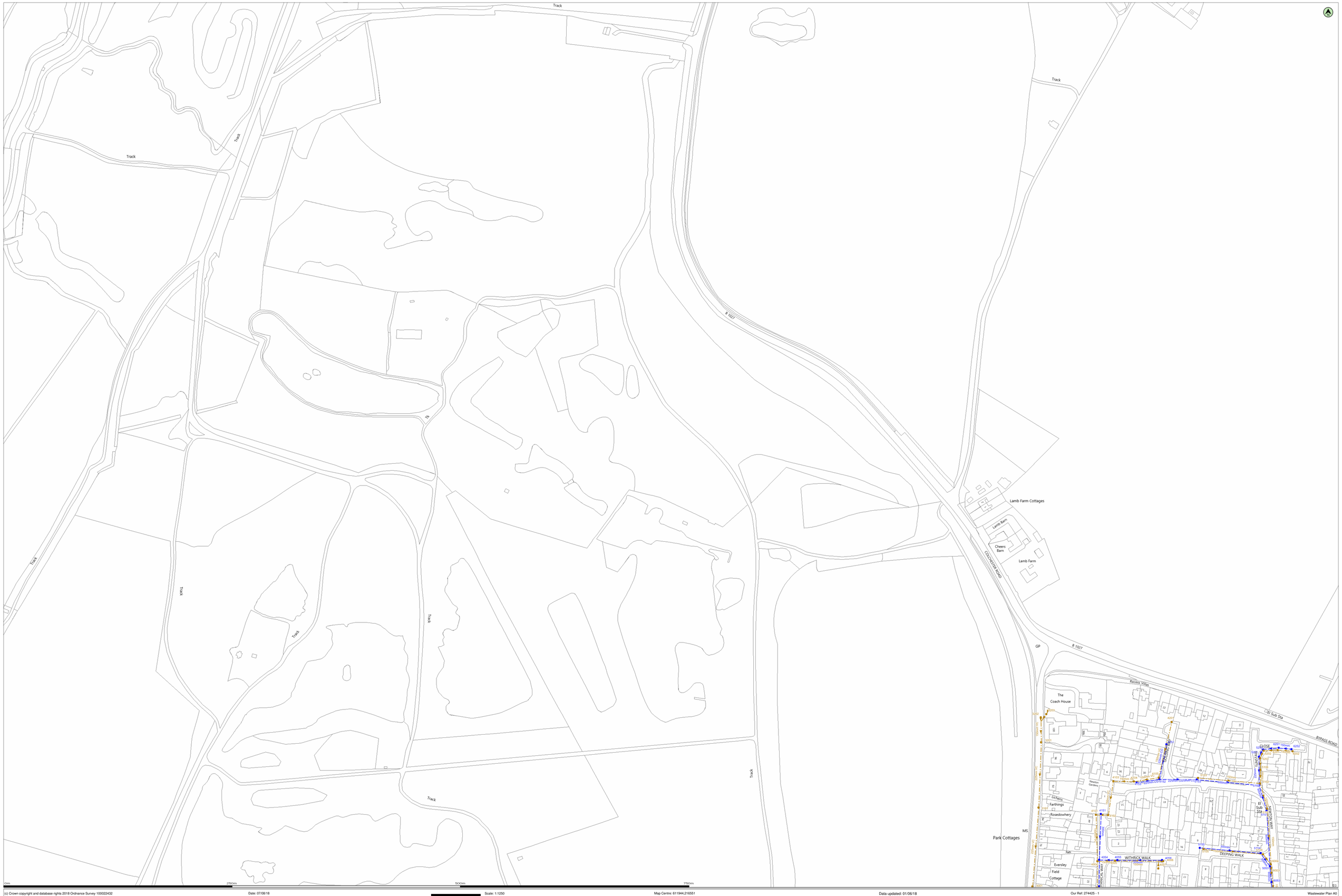
inf = 5.41E-06 m/s **Use Fill 3**

Spreadsheet calibrated using results in BRE365



Appendix E

Anglian Water Asset Information and Development Assessment Report



Date: 07/08/18 | Scale: 1:1250 | Map Centre: 611944,216551 | Data updated: 01/06/18 | Our Ref: 274425 - 1 | Wastewater Plan A0

Foul Sewer		Outfall*		Sewage Treatment Works	
Surface Sewer					
Combined Sewer		Inlet*		Public Pumping Station	
Final Effluent					
Rising Main*		Manhole*		Decommissioned Pumping Station	
Private Sewer*					
Decommissioned Sewer*					

*Colour denotes effluent type)

[redacted]

094-2018 Priory

love every drop anglianwater

Developer Impact Assessment Output Report For The Priory Estate, St Osyth

Document control			
Prepared by	R.Morris	Date	16/11/2011
Reviewed by		Date	

Site details	
GDB Site Reference	0411/SP87(008)
Location	The Priory Estate – St Osyth
Grid Ref	TM11831564
Development type	Residential
Houses	6 sites consisting a total of 332

Contact details	
Developer Account Manager	Keith Ireland
Developer	
Consultant	City & Country
Growth Planning	R.Morris

1. Executive Summary

This study has been undertaken in response to an enquiry by the Priory Estate for a drainage assessment at The Priory Estate, St Osyth. This proposed development is for a total of 321 properties spread out over 6 sites (phases) in the Estate. This analysis has been performed on the foul system only.

The assessment was looked at in stages as requested by the developer.

Phase 1 - Site 5 (8 Properties) will be connected to the nearest available manhole TM12153801. The sewer size at this location is 225mm diameter.

The study concludes that the sewer system does have capacity to accommodate this phase of the development and will not cause any significant detriment to the capacity of the sewer system. Although the model already predicts flooding downstream of the property, the increase in flooding volume from 8 properties would be minimal and therefore no off site reinforcement will be required.

Phase 2 - Site 1(23 Properties) will be connected to the nearest available manhole TM11158502. The sewer size at this location is a 225mm diameter. No flooding is predicted on this length of sewer prior development.

The study concludes that the sewer system does have capacity to accommodate this phase of the development and will not cause any significant detriment to the capacity of the sewer system and therefore no off site reinforcement will be required.

Phase 3 to 5 - Sites 2, 3 and 4 (100 properties) have been addressed together. The sites slope from North East to South West. They will be connected to the nearest available manhole TM11155401. The sewer size at this location is 225mm diameter. No flooding is predicted on this length of sewer prior development.

It is not possible to adequately assess the impact of these phases onto the system. The flows generated by these sites are predicted to spill from the EO at Mill Dam SPS. Upsizing the SPS would resolve the situation but would also create more spills from the downstream CSO at a Point Clear Road and would trigger the need for a UPM based on the total population increase in the upstream catchment (the cost and timescale to undertake this UPM study is not available at this time).

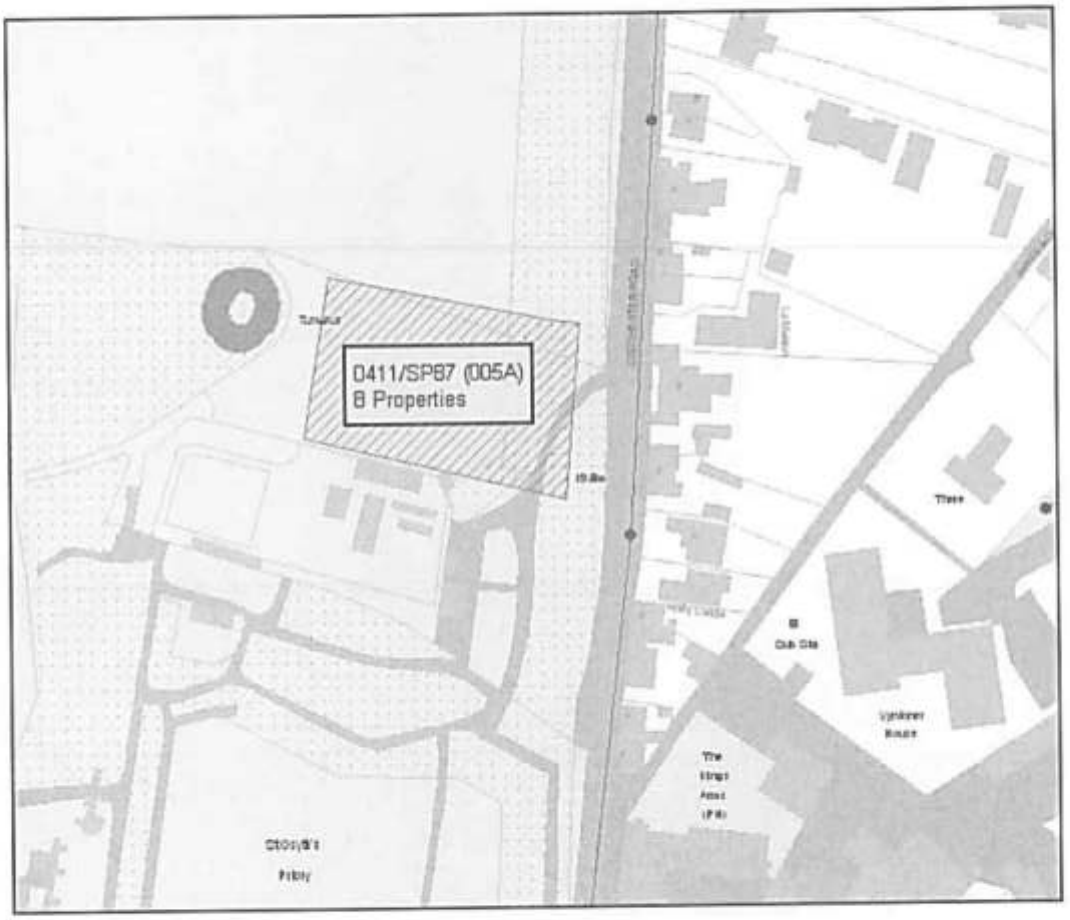
Further investigation/surveys will be necessary in order to fully answer this. A local update of the model will also be required.

Phase 6 - Site 6 (190 Properties) slopes down from North West to South East. The lowest ground level on this site is lower than the invert level of the public sewer on Colchester Road. It will be connected to the nearest node TM12163201 via a pumping main. The sewer size at this location is 225mm diameter. Flooding is predicted from the existing model downstream of this node at the junction of Spring Road and Brook Vale.

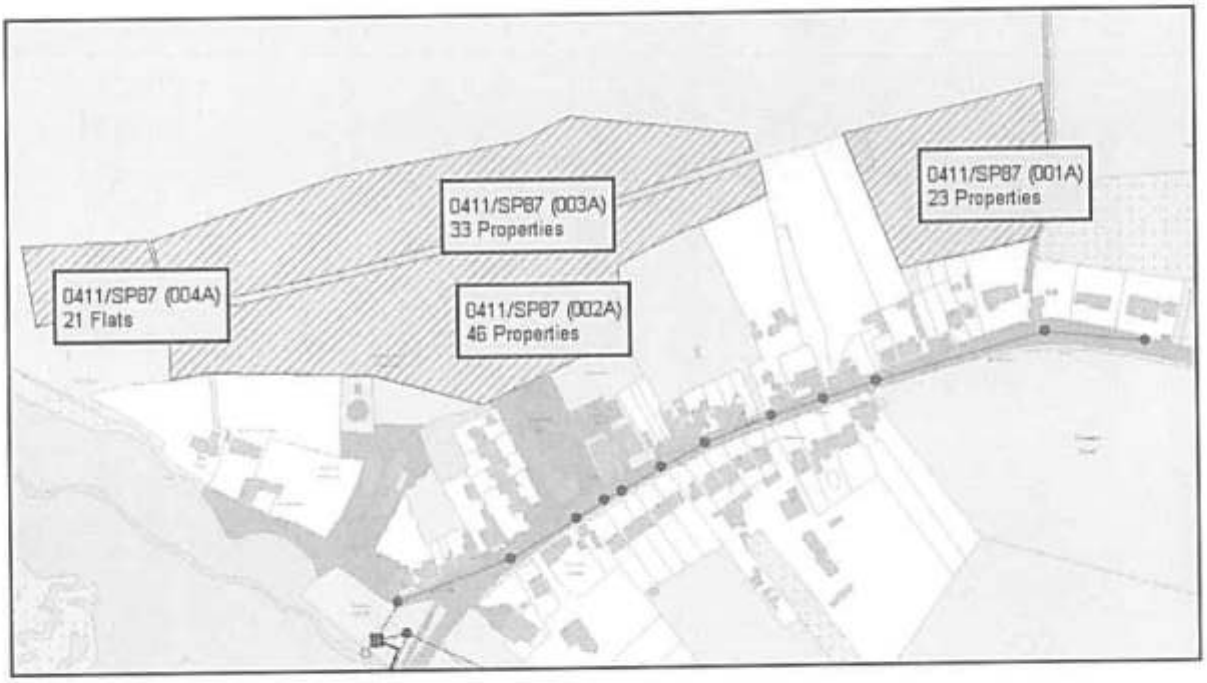
The study concludes that the development will cause detriment to the capacity of the sewer system and will result in increased flood risk. The locations of detriment include TM12155303 and various other nodes on Spring Road. The system downstream of TM12155301 cannot cope with the generated flows. Therefore in order to accommodate this phase of the development off site reinforcement to the existing foul network will be required.

2. Proposed Development

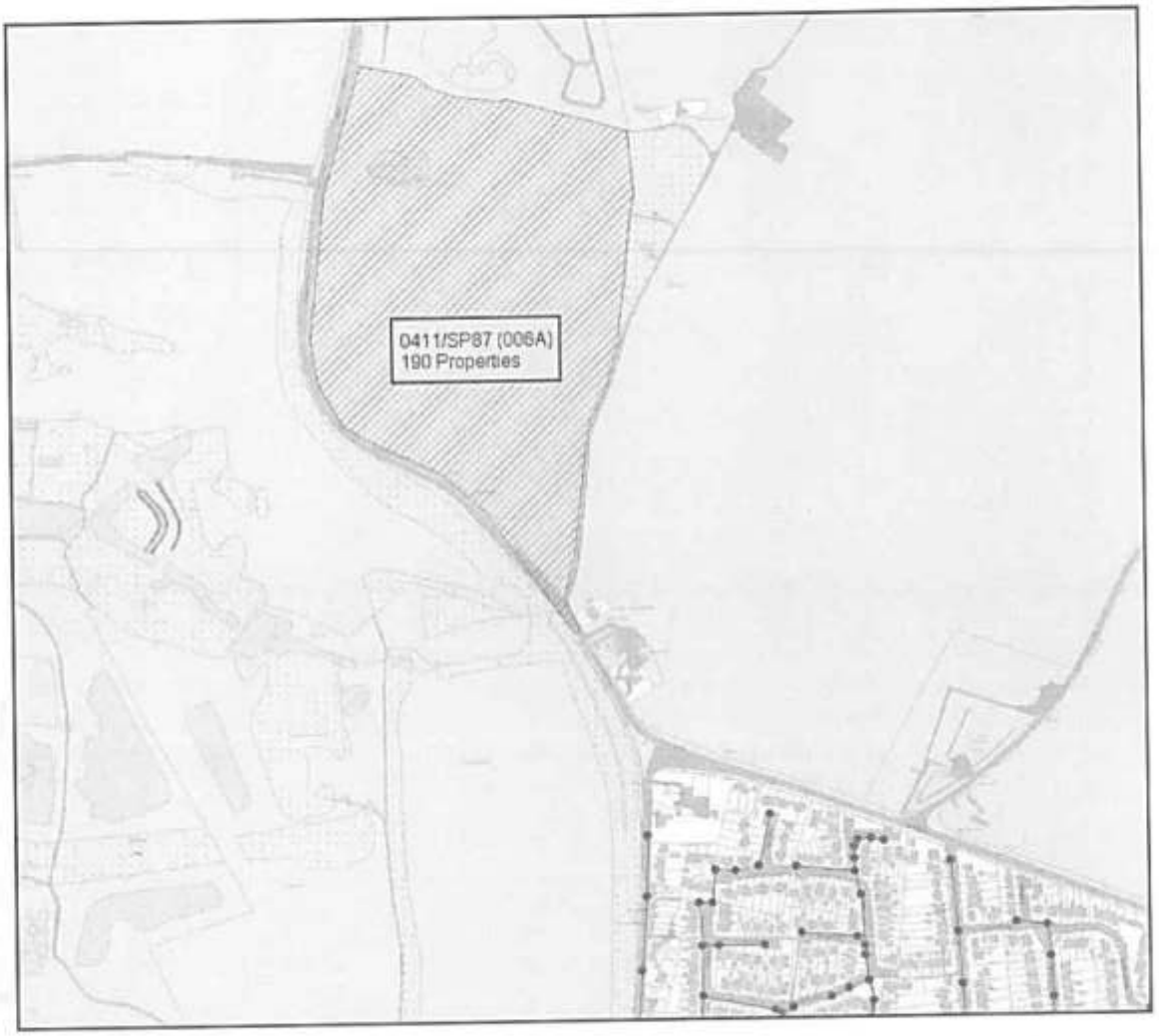
Site Location Plan



Phase 1 – Site 5 Location Plan



Phases 2 to 5 – Sites 1 to 4 Location Plan



Phase 6 – Site 6 Location Plan

DEVELOPMENT DETAILS – modelling assumptions				
	Attribute	**Value**	**Totals**	**Unit / Calculation**
	Development size	17		Ha
	Residential			
A	Residential dwellings	321		No.
B	Residential occupancy	2.2		No.
C	Residential population (P)	706		No. (A x B)
D	Residential PCC (G)	131		l/h/d
E	*Average residential demand*		1.07	l/s (C x D)/86400
	Infiltration			
F	*Infiltration* (0.25 PG)		0.27	l/s 0.25xE
	Care Homes			
G	Care home occupancy			No.
H	Care home PCC			l/h/d
I	*Average care home demand*		0	l/s (E x F)/86400
	Commercial/Trade			
J1	Supermarket discharge			l/s (As Advised)
K	*Average commercial/trade*		0	
	Schools			
L	School PCC			l/h/d
M	School occupancy			No.
N	*Average school demand*		0	l/s (K x L)
	Other			
O1	Health Centre			l/s (As Advised)
	Average other demand		0	l/s
	DWF Total (Average)		1.34	l/s (E+F+I+K+N+O)

Proposed connection location	Various
Connection sewer or node reference	Site 1 - TM11158502 Sites 2,3 and 4 - TM11155401 Site 5 - TM12153801 Site 6 - TM12163201
Connection sewer diameter	150mm (Sites 1,2,3 and 4) ; 225mm (Site 5 and 6)
Connection relative to the development	South East
Discharge regime	Gravity
Pump discharge rate	N/A
CREEP & STORAGE	
Creep per property (m^3)	5
Total creep (m^3)	1605
Total development storage (m^3)	192
Highest Point of development (mAOD)	N/A – 6 sites
Lowest Point of development (mAOD)	N/A – 6 sites
KNOWN CATCHMENT ISSUES	
DG5'S	None in vicinity
CSO's-EO's	No issues at the Point Clear CSO
General comments	The catchment upstream of Brook Vale Is made up of over 1104 properties connected to a single 225mm sewer. This is already under capacity. Mill Street SPS is rated at 36 l/s for 1239 properties.

3. Foul Sewerage system

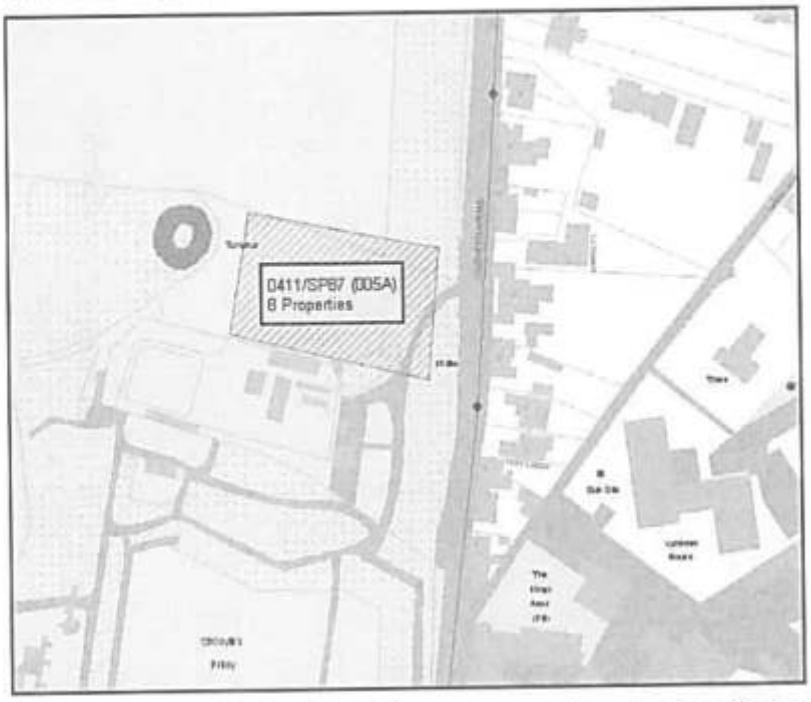
The St Osyth WwTW drainage catchment only serves the St Osyth Parish and which is fully drained. St Osyth represents a connected population of 4,768, equivalent to approximately 1,987 properties.

To enable the analysis to be performed the existing hydraulic model for St Osyth was used. The AWS modeling specification V9 was used to identify the thresholds for infrastructure upgrade. A small update was made to add a previous flooding scheme option along Saxon Way. Also the ground levels along Mill Street were changed to match the Terrain Data.

At the request of the developer each phase of this development was assessed separately where appropriate except for phases 3, 4 and 5 (sites 2, 3 and 4) where these were assessed together because of their proximity and impact on the proposed connection point.

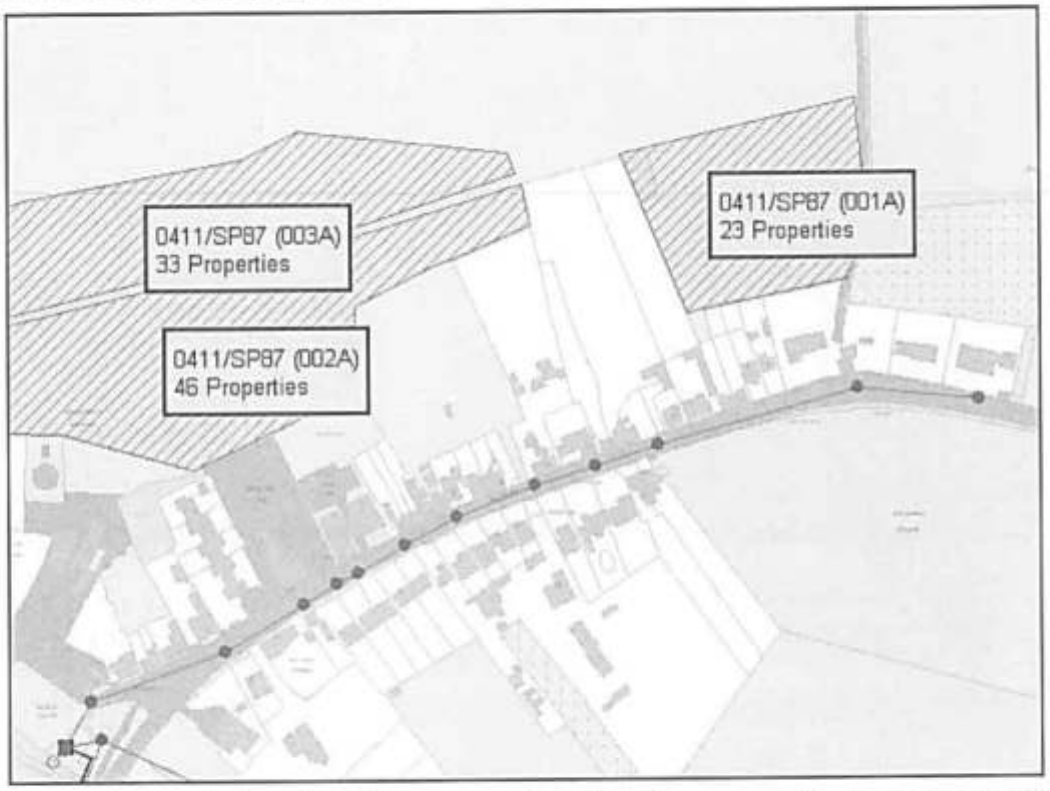
4. Impact of development upon existing and future performance

Phase 1 - Site 5



The study concludes that the sewer system has sufficient capacity to accommodate the development and will not cause any significant detriment to the capacity of the sewer system. Although the model already predicts flooding downstream of the property, the increase in flooding volume from 8 properties would be minimal and therefore no off site reinforcement will be required.

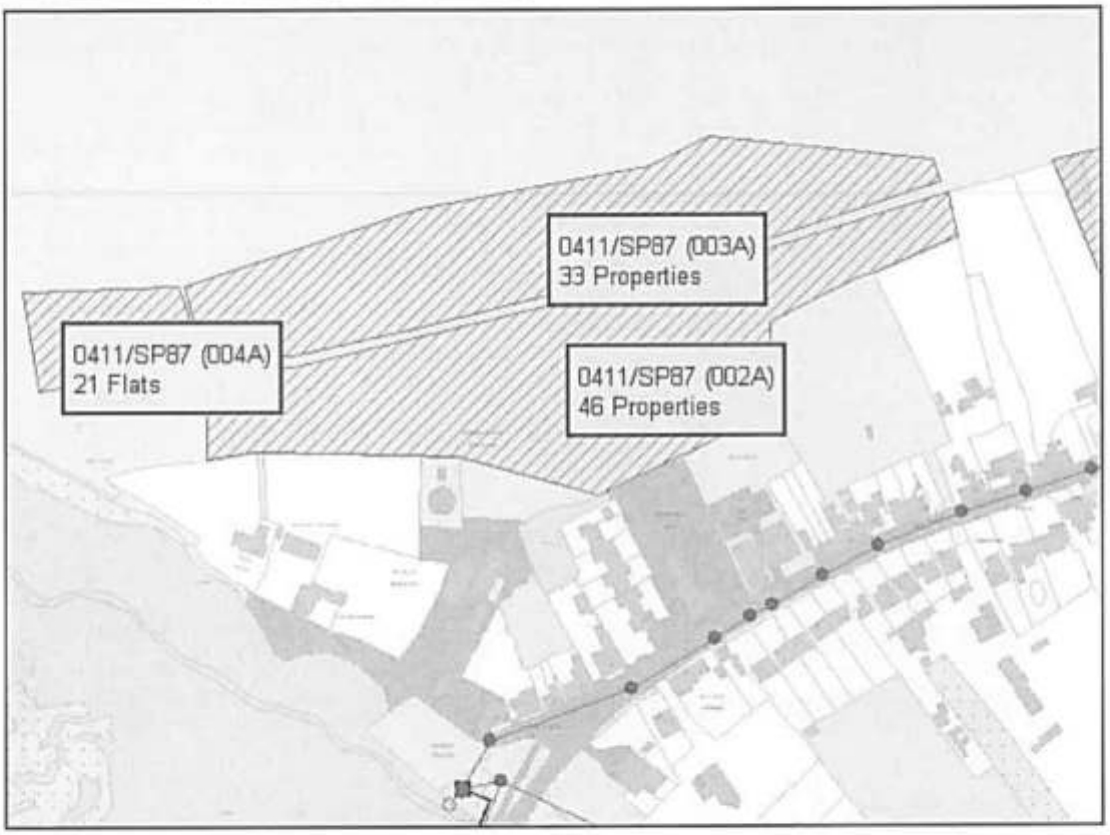
Phase 2 - Site 1(23 Properties)



The study concludes that the sewer system does have capacity to accommodate this phase of the development and will not cause any significant detriment to the capacity of the sewer system and therefore no off site reinforcement will be required.

The point of connection will be to the nearest available manhole TM11158502. The sewer size at this location is a 225mm diameter. No flooding is predicted on this length of sewer prior development.

Phase 3 to 5 - Sites 2, 3 and 4 (100 properties)



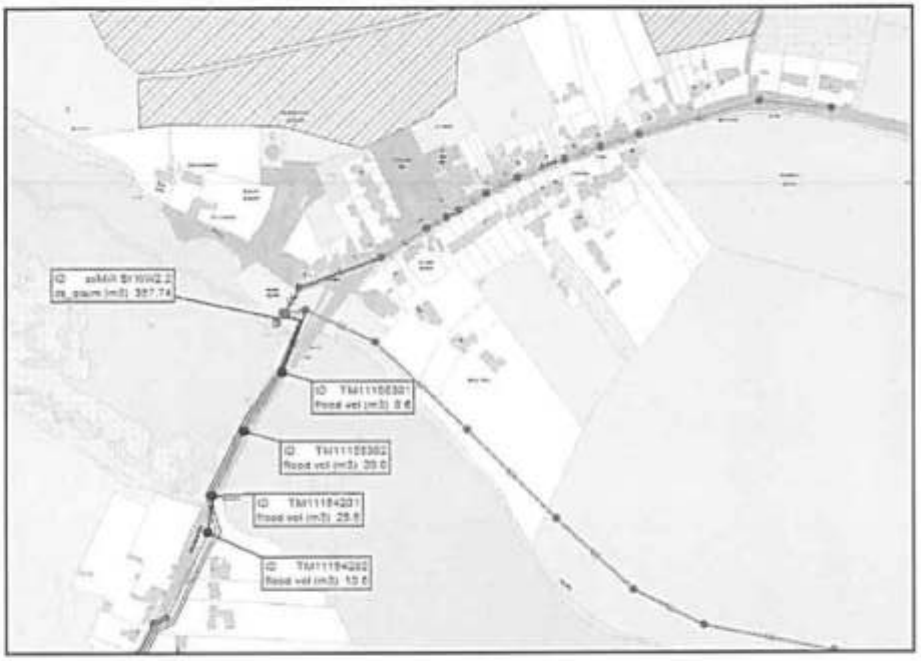
These sites have been addressed together. The sites slope from North East to South West. They will be connected to the nearest available manhole TM11155401. The sewer size at this location is 225mm diameter. No flooding is predicted on this length of sewer prior development.

It is not possible to adequately assess the impact of these phases onto the system. The flows generated by these sites are predicted to spill from the EO at Mill Dam SPS. Upsizing the SPS would resolve the situation but would also create more spills from the downstream CSO at a Point Clear Road and would trigger the need for a UPM based on the total population increase in the upstream catchment (the cost and timescale to undertake this UPM study is not available at this time).

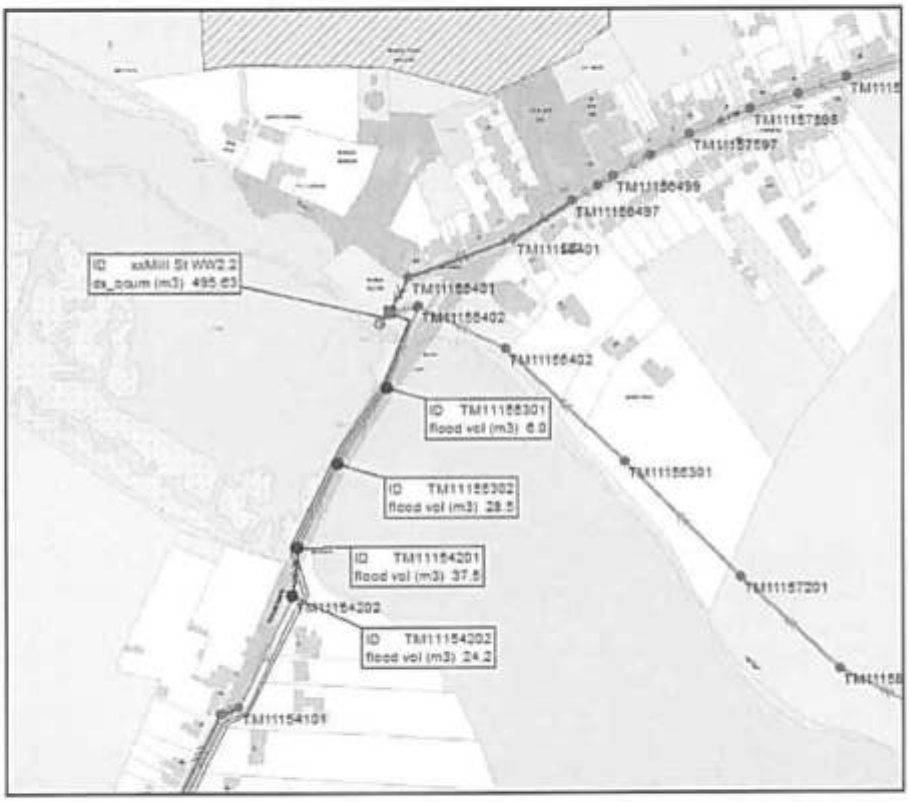
Also the current capacity of the Mill Dam SPS (36 l/s) does not match with its design value (46l/s). It is difficult to promote a pump upsize in this instance.

Further investigation/surveys will be necessary in order to fully answer this. A local update of the model will also be required.

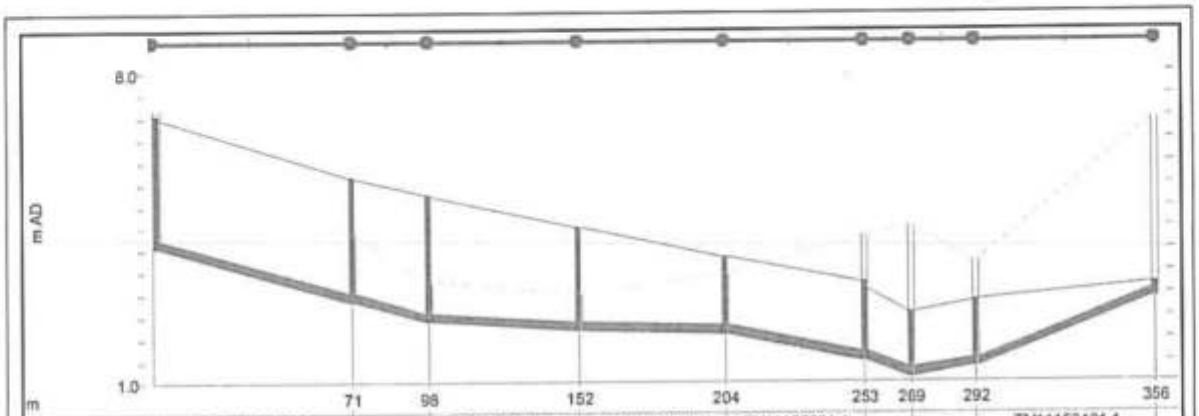
EXISTING & FUTURE PERFORMANCE



Phases 3 to 5 (Sites 2, 3 and 4)
10 year existing maximum flood volumes.
A few nodes predict flooding + 357m3 spill from the EO at Mill Dam SPS.



Phase 3 to 5 (Sites 2, 3 and 4)
30 year existing maximum flood volumes.
A few nodes predict flooding + 495m3 spill from the EO at Mill Dam SPS.



Link	TM11154101.1	-	TM11154201.1	TM11155302.1	TM11155301.1	-	-	TM11156401.1
width (mm)	225	225	225	225	225	225	225	225
height (mm)	225	225	225	225	225	225	225	225
us inv (mAD)	4.070	3.847	2.380	2.180	2.100	1.490	1.340	3.891
ds inv (mAD)	3.847	2.380	2.180	2.100	1.490	1.130	1.130	1.340
DS Flow (m3/s)	0.06983	0.05905	0.05251	0.05087	0.05143	-	0.04535	0.03394

Node	-	TM11154202	TM11154201	TM11155302	TM11155301	-	-	TM11155401	-
ground (mAD)	7.205	5.374	3.293	3.023	3.474	4.312	4.530	3.760	3.244
flood dep (m)	-0.135	1.284	1.952	1.505	0.380	-1.038	-1.934	-0.908	-3.687
flood vol (m3)	-0.1	24.5	37.9	28.9	6.4	-1.0	-7.5	-0.9	-3.7
vol.lost (m3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

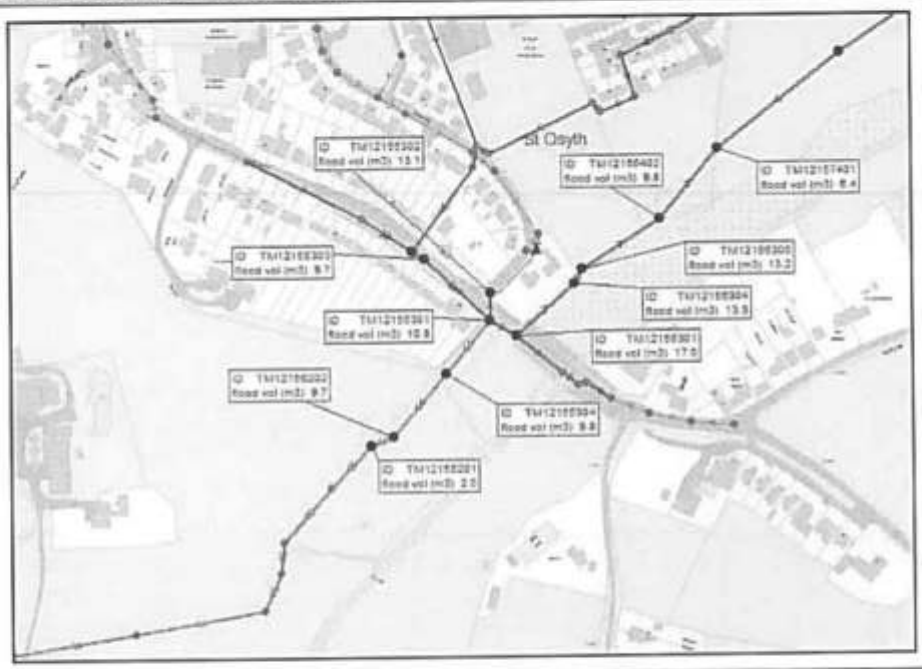
Phase 3 to 5 (Sites 2, 3 and 4)
30 year future performance long section.
As can be seen there are significant predicted surcharge levels and flooding volumes.

Phase 6 - Site 6 (190 Properties)

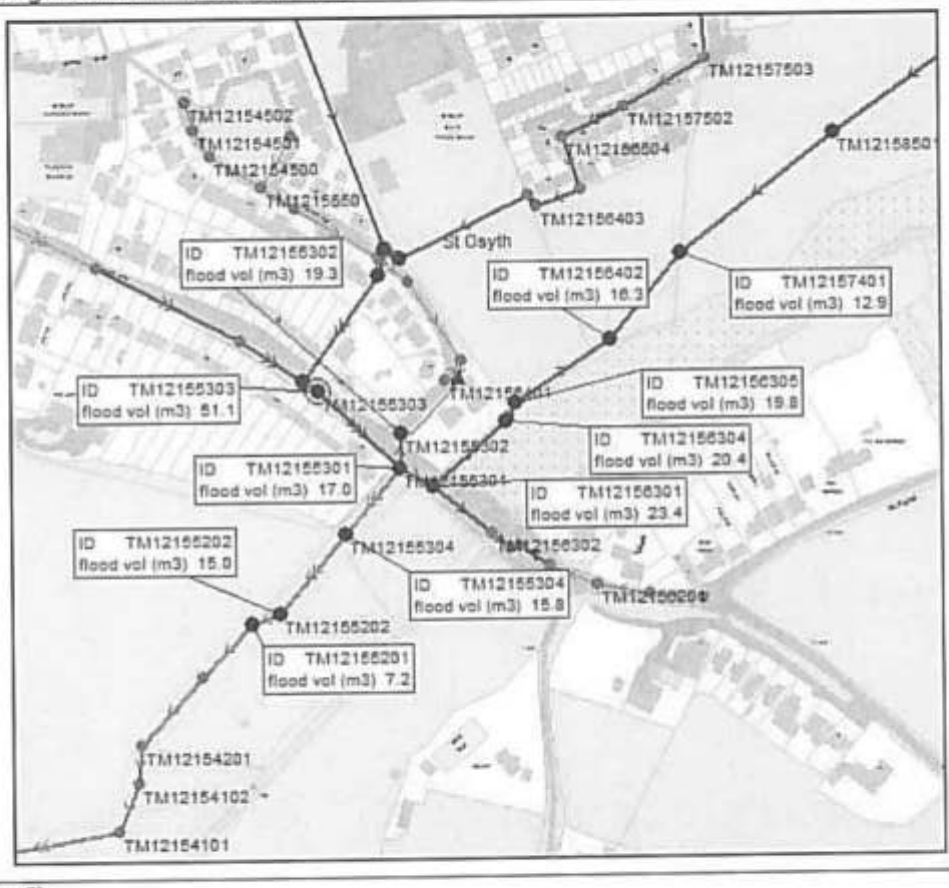
This site slopes down from North West to South East. The lowest ground level on this site is lower than the invert level of the public sewer on Colchester Road. It will be connected to the nearest node TM12163201 via a pumping main. The sewer size at this location is 225mm diameter. Flooding is predicted from the existing model downstream of this node at the junction of Spring Road and Brook Vale.

The study concludes that the development will cause detriment to the capacity of the sewer system and will result in increased flood risk. The locations of detriment include TM12155303 and various other nodes on Spring Road. The system downstream of TM12155301 cannot cope with the generated flows.

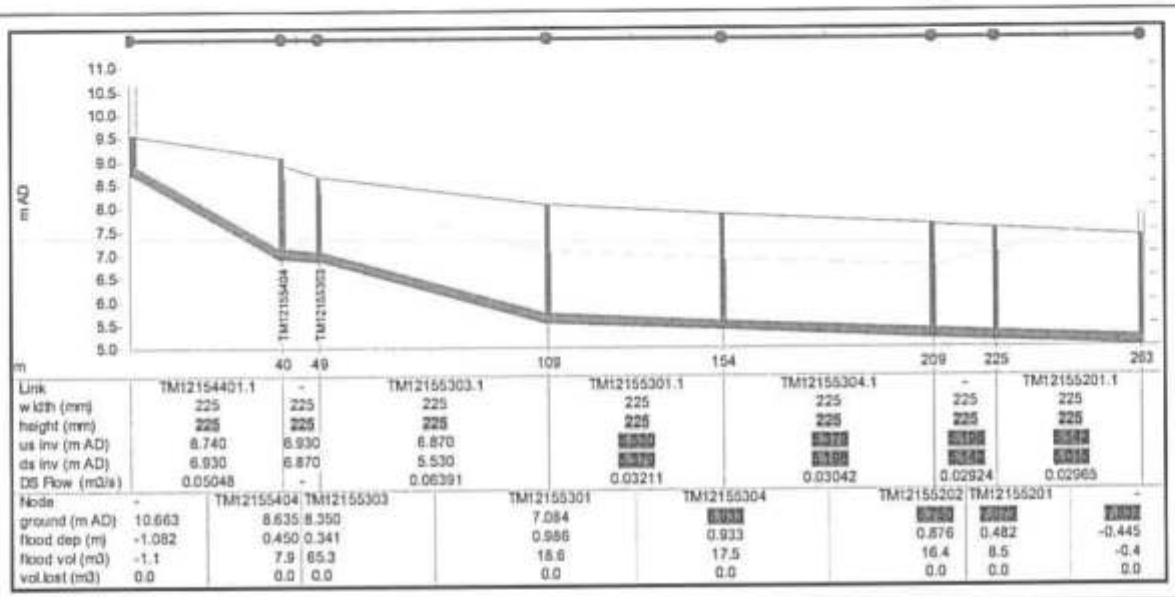
EXISTING & FUTURE PERFORMANCE



Phase 6 (Site 6)
10 year existing maximum flood volumes.

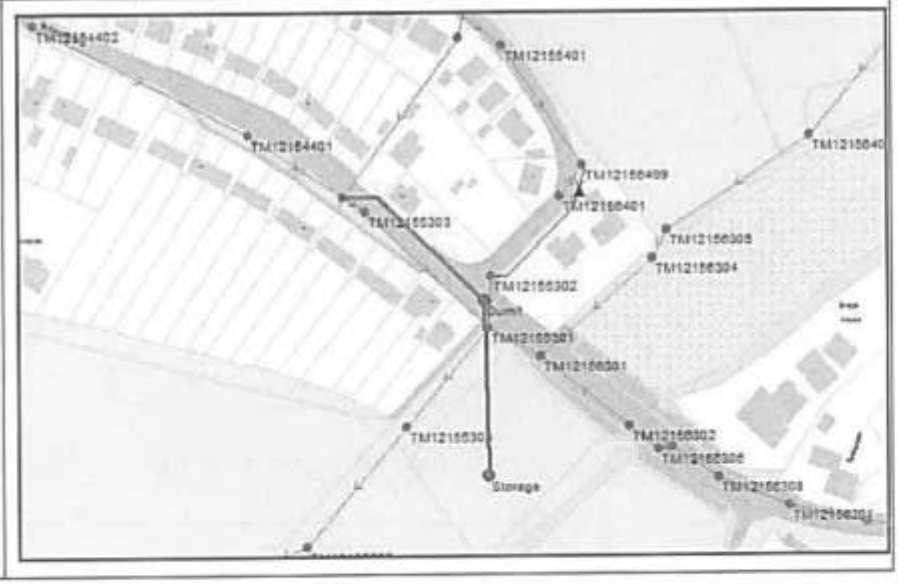


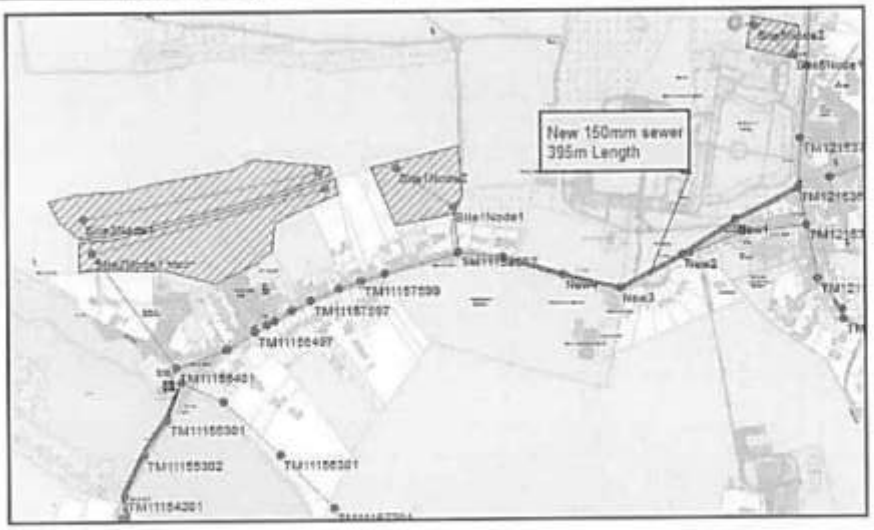
Phase 6 (Site 6)
30 year existing maximum flood volumes.



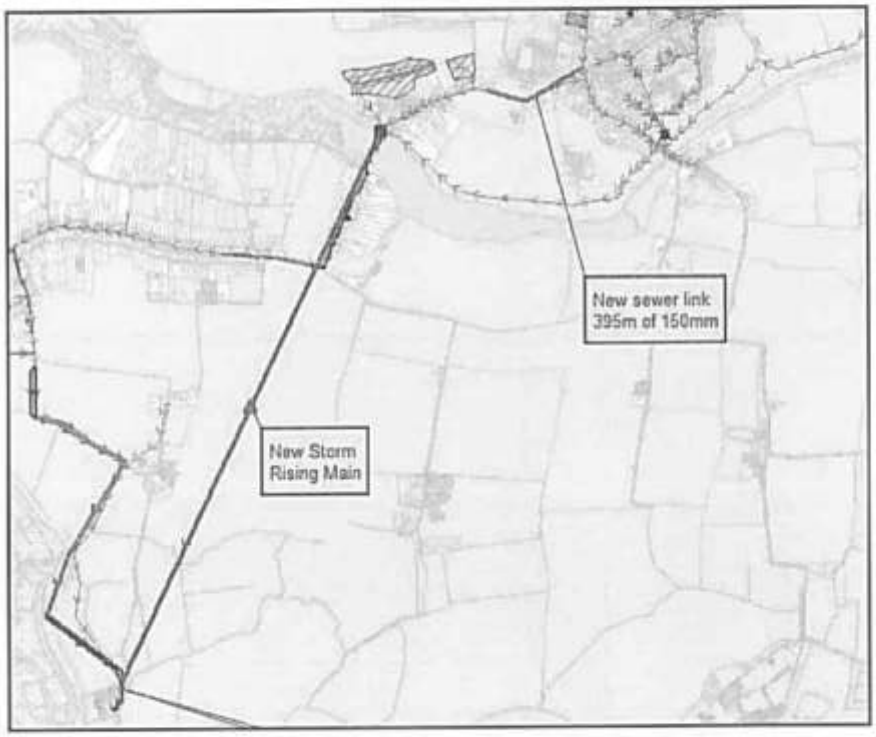
Phase 6 (Site 6)
30 year future performance long section.
As can be seen there are significant predicted surcharge levels and flooding volumes.

Therefore in order to accommodate this phase of the development off site reinforcement to the existing foul network will be required. A number of potential solutions have been assessed and they are presented below.

OPTION 1	
Infrastructure requirements (List)	• Lay a new 150mm sewer to link from TM12155404 to an Offline storage tank. (length of sewer estimated at 150 meters) • New storage tank with pump return facility. Volume estimated at 100 m3. **Estimated Cost: £634k**
Residual issues	None predicted.
Infrastructure Requirements (Highlighted)	

OPTION 2	
Infrastructure requirements (List)	• New 150mm sewer link between TM12153602 and TM11159501 (395m length) • Increase the pump rate at the SPS by 5 l/s. This should be achievable by installing a slightly larger Assist Pump. **Estimated Cost: £269k (+ UPM study and any additional requirement identified in the UPM study)**
Residual issues	This solution could be detrimental to the CSO at Point Clear Road. A UPM study will be required. It could be beneficial to carry out the UPM study as the result might be favourable to this option instead of Option 1 in terms of cost but there will be a time delay and the cost of carrying out the UPM study has not been included in this cost and will be required to be funded by the developer.
Infrastructure Requirements (Highlighted)	

OPTION 3	
Infrastructure requirements (List)	• New 150mm sewer link between TM12153602 and TM11159501 (395m length) • New storm pump and rising main installed at Mill Dam SPS discharging directly to the works. Length of Rising Main required up to 2.5km (150mm). • New storm pump rated at 20 l/s (Should be reviewed based on STW actual capacity) **Estimated Cost: £575k**
Residual issues	• The flooding predicted by the model prior to the developments still remains. The EO is still predicted as spilling although to a reduced rate. • New issue with septicity on such a long main. Consideration should be made to pump all the flows directly to the STW if the capacity is available. This study

	has not assessed the impact on the STW and this would require further investigation. There would be an additional time delay in carrying out any works required at the STW that would be identified and it is unlikely that any work, if needed, would be carried out prior to 2016. Any upgrades required at the STW would **not** be funded by the developer.
Infrastructure Requirements (Highlighted)	

5. Cost estimates

Option 1.	£634k
Option 2.	£269k (+ UPM study and any additional requirements identified from the UPM study)
Option 3.	£575k

6. Recommendations

It is recommended to allow Phases 1 and 2 to be developed without any further work being carried out.

Further investigation will be required before Phases 3 to 5 can be developed. Their impact on the EO at Mill Dam SPS needs to be assessed with an updated model. A local re-verification seems necessary. If the detriment is too high then a solution will have to be sought.

In order to accommodate Phase 6 it is recommended to carry out Option 1. If Option 2 is carried out then a UPM will be required for the CSO at Point Clear Road. It could be beneficial to carry out the UPM study as the result might be favourable to this option instead of Option 1, however it is unknown what the outcome of a UPM study may require.

A holistic approach has also been presented as Option 3. This option would accommodate all developments with scope for further growth but the impact on the STW will need to be investigated.

The impact from phase 6 on the system is significant. Although the impact on the EO at the SPS is still relatively small for a 30 year storm, the increase in flooding volumes within the catchment cannot be ignored.

Phase 6 in this report assumes that all other phases have been developed.

Option 2 will affect the CSO at Point Clear Road. ***A UPM would be required*** if this option was to be used. Upsizing of the Mill Dam SPS is required in Option 2 due to the increase flows from the new connection sewer. It could be beneficial to carry out the UPM study as the result might be favourable to this option instead of Option 1.

Option 3 would only be viable if the whole catchment was to be diverted (and the works could cope with it) otherwise septicity would be a problem. So in this case further work would be required before proceeding.

It is therefore recommended that Option 1 is taken forward to enable the full proposal of all 6 phases in this proposed development site to go ahead.