Report No. **800/235r4**

F L O O D R I S K A S S E S S M E N T R E P O R T

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B A R R I E R B A N K
S P A L D I N G

ON BEHALF OF

A S H L E Y K I N G D E V E L O P M E N T S L T D

JANUARY 2014

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1.0 INTRODUCTION

1.1 Ashley King Developments Ltd are proposing to develop a parcel of land off Barrier Bank Road, Spalding with new commercial development consisting of a business park and a consumer focus site with hotels, Petrol Filling Station (PFS), conference centre and commercial units. It was considered that a Flood Risk Assessment should be undertaken to assist in viability and planning requirements

1.2 It is within the general development strategy of the country for development in areas where there is a risk of flooding, to be assessed to avoid unnecessary increase in the requirement of flood defence. Under the National Planning Policy Framework (NPPF) and the accompanying Technical Guidance (TG), consultation is required with the Environment Agency, Land Drainage Authority and Water Authority and a Flood Risk Assessment Report should be prepared considering the development proposals and make recommendations for any flood mitigation measures.

1.3 ARP Associates have been appointed to carry out an assessment of the site, implement appropriate consultations and prepare a Flood Risk Assessment Report, in accordance with NPPF, to satisfy the requirements of the Planning Authority.

1.4 The walkover survey and report was initially prepared between February and March 2013 and has been updated in January 2014.

1.5 This assessment has been prepared for the sole use and reliance of the Client and shall not be relied upon or transferred to any other parties without the written authorisation of ARP Associates. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party.

2.0 SITE WALKOVER

General

2.1 The site is an irregular shaped piece of land equating to an area of approximately 24.7ha and is located towards the southeastern edge of Spalding Town Centre. The site is split into two separate sites by the B1173 and is located on the junction of the A16 and the A1175 main highway. The Ordnance Survey Grid Reference is TF 244 198.

2.2 A site location plan is presented in Appendix A.

Current Use

2.3 The larger site, which equates to 20.2ha, is primarily used for agricultural purposes with crops towards the eastern side. There are earth mounds to the north and west and these have been present for some time with plant growth growing throughout.

2.4 The land to the south is triangular shaped and equates to an area of 4.5ha. This part of the site may be used for grazing of cattle, but is generally not currently used for any purpose. There is a bituminous surface road running from the south through the centre of the site and is accessed from the roundabout on the A1175. This was presumably the former B1173 highway before the new A16/A1175 junction and road which splits the site was constructed. There is also a 'T' junction into this part of the site from the former highway.

Boundaries

2.5 For the northern larger part of the site, the boundaries are either formed by post and rail or close boarded fences around the whole of the development. However, the north and northeastern boundaries are open onto other agricultural fields. Beyond the northern boundary, there are fields with land drains shown on the plan, whilst the A16 forms the

southeastern boundary, B1173 the southern boundary and houses beyond the northwestern boundary.

2.6 The smaller area of land to the south is also formed by post and rail fences with the B1173 to the northeast, the A1175 to the south and open agricultural field to the west.

2.7 Beyond the agricultural fields, for a distance of approximately 70m to the west, there is the new River Drove, which is a wide channel with high banking. This passes under the A1175 to the south through an arch stone structure.

Topography and Vegetation

2.8 The northern larger site is generally level apart from the high mounds on part of the northern and eastern boundaries, with very little vegetation apart from on the boundary edge beyond the mound to the west.

2.9 On the southern smaller site, this is generally flat and low lying below the level of the adjacent highways, although the old road to the western boundary is raised up above the remainder of the site with relatively steep bankings down to the development area and the agricultural fields to the west. There is very little vegetation or plant growth on the site apart from an isolated tree, although, along the western boundary, there is a row of trees forming the boundary to the site.

2.10 A topographical survey is presented in Appendix B.

Drainage

2.11 There is no indication of positive drainage on the southern site, apart from the former B1173 road where positive kerb drainage is present. There are also other ditches/drains around the bottom of the highway in this part of the site, which outfall under the road and into the ditches around the northern part of the site.

2.12 On the northern part of the site, there is no obvious indication of positive drainage, but land drainage will almost certainly be present which will fall towards the drain adjacent to the northern boundary. This drain is part of a network of drains which outfalls to Exeter Drain to the east beyond the A16.

2.13 Adjacent to the A16 and the B1173 highways, there are ditches between the site boundary and the highway collecting highway drainage which will flow into the watercourse to the north of the site.

2.14 There are areas of standing water possibly ponds associated with the highway works, between the A16/A1175 junction and the northeastern boundary of the smaller site. Research has highlighted that these ponds have been installed as a habitat for Little Ringed Plover (birds) as part of the construction of the highways.

2.15 The River Welland is located 0.5km to the west and Coronation Channel 1.4km to the north.

3.0 ENVIRONMENT AGENCY CONSULTATION

3.1 A consultation was requested from the Environment Agency and a copy of their response, reference CCN/2013/2013/33830 dated 8th March 2013, is presented in Appendix C for reference purposes.

3.2 The Environment Agency map provided confirms that the majority of the site lies within Flood Zone 3 and is, therefore, assessed as having a 1 in 100 or greater annual probability of river flooding in any year (greater than 1%), and a 1 in 200 chance or greater annual probability of flooding from the sea (less than 0.5%). The map does not take into account flood defences as water can overtop or breach the defences in extreme conditions (Map 1).

3.3 The triangular shaped land to the south lies partially within Flood Zone 3, but a large proportion of approximately 50% is shown as lying within Flood Zone 1 and is, therefore, assessed as having a less than 1 in 1000 annual probability of flooding from river or sea in any year (less than 0.1%). The flood map also shows a flood storage area to the west for the River Welland.

3.4 An Historic Flood Extents Map (Map 2) has been provided which shows the extent of previous recorded flooding in the area, notably 1947. No incidents were recorded on site, with flood water remaining in the flood storage area. It is possible that other flooding may have occurred but there are no records held by the Environment Agency. Recommendation was made to speak with the Local Authority or Internal Drainage Boards;

3.5 The Environment Agency has also been able to provide fluvial flood levels. However, it was confirmed that these are "in channel" levels and, therefore, may not represent the flood level on the flood plain, particularly where the channel is embanked or has raised defences. These levels show that the nearest node points to the site, reference "Welland 17224" and "Welland 16724" (Map 3) have modelled flood levels of 4.50m O.D.N. and 4.49m O.D.N. respectively for the 1 in 100 year storm. The Welland Catchment model,

prepared in April 2007, also shows the 1 in 100 year inclusive of climate change levels of 4.67m O.D.N. and 4.67m O.D.N. respectively. The Bank heights are unavailable at this time, as they are currently under review.

3.6 The site is protected by Flood Defences and a list of Flood Defence Assets in the vicinity of the site has been provided (Map 4).

3.7 The Environment Agency have also provided a Modelled Flood Extents Map, with defences, (Map 5), which indicate that flooding from all modelled storm events up to the 1 in 1000 fluvial event inclusive of climate change remains within the flood storage area.

3.8 From our knowledge of the area, we have previously had confirmation from the Environment Agency that the natural channel, in conjunction with the upstream flood storage area, provides protection against a flood event for a 0.5% chance of occurring in any one year. The channel and storage area are also inspected regularly to ensure that any potential defects are identified to reduce the risk of any failure.

3.9 The Environment Agency also make recommendations for considering Sustainable Drainage Systems.

4.0 WATER AUTHORITY CONSULTATION

4.1 A consultation was requested from Anglian Water, who are the Water Authority for this area and a copy of their response, reference 0905/SP100 (001) dated 4th October 2013, is presented in Appendix D for reference purposes.

4.2 Records indicate that a public water main is crossing the site. No development shall take place over or within the 5m easement strip without prior consent. The existing underground asset should be located in highway or open space and not in private gardens.

4.3 The nearest public foul sewer to the site is located in Fen End Lane which has insufficient capacity to accommodate the proposal site.

4.4 Alternative connection points were assessed with the nearest point, where capacity would be available, is some 6.2km north of the site.

4.5 The proposed method of surface water disposal is not relevant to Anglian Water. It is recommended to contact the future SUDS Approving Body for the area, the Environment Agency and the Internal Drainage Board.

4.6 Trade effluent to the public sewerage system will need written formal consent.

5.0 LAND DRAINAGE AUTHORITY CONSULTATION

5.1 A consultation was requested from South Holland Internal Drainage Board, who are the Land Drainage Authority for this area, and a copy of their response dated 21st February 2013, is presented in Appendix E for reference purposes.

5.2 The Board has recently been involved in investigating a drainage problem along the west side of Fen End Lane. The property owners have been complaining that standing water has caused a problem in gardens and this is considered to be due to a lack of maintenance to the watercourse located running along the northern boundary. The watercourse is Riparian owned and, therefore, recommendation was made to ensure that the watercourse is maintained correctly to assist with future plans.

5.3 The Board is unaware of any other flooding issues within the area. Recommendation was made to contact the Environment Agency.

5.4 The South Holland District Council Strategic Flood Risk Assessment Report (SFRA), prepared by Haskoning UK Ltd dated January 2010, was also referred to. This shows the development site to be fully within Flood Zone 3 (without defences).

5.5 The SFRA has also been able to provide modelled flood levels adjacent to the site, which are understood to take account of the flood plain. This shows that at chainage 2.0km, see Appendix D, the 1 in 100 fluvial flood level is 2.40m O.D.N. and the 1 in 100 year inclusive of climate change level is 3.11m O.D.N. Comparing this against the defence crest level provided of 6.05m O.D.N. gives freeboard heights of 3.65m O.D.N. and 2.94m O.D.N. respectively near to the site.

5.6 From knowledge of the area, it is known that the Internal Drainage Board request a 9m easement strip adjacent to any Board maintained watercourse.

6.0 MATERIAL CONSIDERATION IN RESPECT OF NPPF AND TG

Flood Classification

6.1 The South Holland Internal Drainage Board Strategic Flood Risk Assessment has identified that, without defences, the site falls within land assessed as having a 1 in 100 or greater annual probability of river flooding in any year (greater than 1%), and a 1 in 200 chance or greater annual probability of flooding from the sea (less than 05.%). In accordance with Table 1 of the TG, the site falls within Flood Zone 3a "High Probability".

6.2 In order to construct development within this zone, it will be necessary to reduce the overall level of flood risk in the area through the layout and form of the development, and appropriate application of sustainable drainage techniques. Consideration will also be made to relocate existing development into land zones with a low probability of flooding.

End Use

6.3 The development proposal is for the construction of a commercial development consisting of a business park, and a consumer focus site with hotels, PFS, conference centre and commercial units. A masterplan layout is presented in Appendix F for reference purposes. It is assumed that the PFS will not be of a size to require a Hazardous Substances Consent.

6.4 When applying Table 2 of the TG, the flood risk vulnerability classification shows that the proposed end uses will fall into the following flood risk vulnerability classifications:-

Commercial units/offices Restaurant/Conference Centre/Shops	=	"Less Vulnerable"
Hotel/PFS	=	"More Vulnerable"

Sequential Test

6.5 As set out in the NPPF, the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding (Zone 1).

6.6 When the site is evaluated in accordance with Table 3 of the TG, the development shows that an Exception Test is required for a Flood Zone 3a, and a "More Vulnerable" flood risk vulnerability classification.

Exception Test

6.7 The ideal situation would be to relocate the proposed development into areas of land with a lower probability of flooding. Alternative sites within Flood Zone 1 are to the east and southeast, where greenfield and agricultural sites are predominant. However, the inadequate infrastructure supporting any development of this nature renders these areas unsuitable.

6.8 Furthermore, although the site is located within Flood Zone 3a, it is known that flood defences are in place to protect the surrounding areas. This is reflected in the Historic Flood Extent Map (Map 2), presented in Appendix C, showing that flooding is retained within the flood storage area located to the west of the site. Therefore, it is reasonable to accept that the site is well protected and is unlikely to flood in the future for standard storms.

6.9 There are also specific site conditions which need to be considered and these are identified blow:-

6.9.1 There are flood defences in place to prevent flooding from general storms up to the 1 in 100 year event as highlighted by the Environment Agency.

6.9.2 There are no physical or environmental constraints on the development of the site, apart from mitigation measures for flood risk.

6.9.3 Based on the level information provided in the SFRA, the freeboard to the flood defences adjacent to the site averages 2.72m for the 1 in 100 year storm event inclusive of climate change.

6.9.4 The development creates no unacceptable environmental amenity, traffic, safety or other problems.

6.9.5 The whole of the Spalding area would be stifled for new construction if restrictions on flooding were imposed, and the Exception Test not passed.

6.10 In view of the above, the site is considered to satisfy the Sequential Test and the development provides wider sustainable benefits to the community that outweigh any indications of potential flood risk. There will be a requirement, however, to introduce some mitigation measures to ensure that the development will be safe, without increasing flood risk elsewhere, and these are discussed in the flood mitigation section below.

Flood Sources

6.11 Flooding from Rivers - The River Welland is located approximately 460m to the west of the site, and the Environment Agency consultation identifies that the River has fluvial defences protecting the site which consists of earth embankments.

6.12 The defences are in good condition and provide protection against a flood event with a 1% chance of occurring in any year (1 in 100). The defences are inspected regularly to ensure that any potential defects are identified early. There is also an area of flood storage to the west of the site adjacent to the River Welland, known as Cowbit Washlands, which will significantly reduce the possibility of flooding of the Spalding town centre and adjacent areas.

6.13 The Welland catchment model, dated April 2007, shows that the water depth in the channel can be seen to be around 4.67m O.D.N. for a 1 in 100 year storm, inclusive of climate change. However, it should be realised that these are channel levels and, if there was a breach of defences or overtopping of the channel embankments, then water would be spread over a much wider area and be at a reduced level across the adjacent land. This is reflected in the SFRA flood levels where modelled flood levels are considerably less than the EA levels for the same storm event, at 2.4m O.D.N.

6.14 The Coronation Channel, which provides flood relief around the Spalding town centre, located approximately 1.4km north, is also protected by raised embankment defences to a level of 5.8m O.D.N. closest to the site, but to a level of 5.14m O.D.N. adjacent to the disused Railway bridge.

6.15 The South Holland District Council Strategic Flood Risk Assessment Report, prepared by Haskoning UK Ltd dated January 2010, shows the development site to be fully within Flood Zone 3 (without defences). Taking into account the flood defences in place, the report shows the flood hazard rating as low to moderate and there is no danger to occupants at the present time. However, by the year 2115, without any increase of defences, flooding will extend into most of the site, which would occur from Coronation Channel and not the River Welland.

6.16 The River Drove, which is a tributary to the River Welland, is close to the southern boundary, but the land to the south is much lower than the development site and any flooding from this source is unlikely to affect the development site.

6.17 Flooding from Local Watercourses - The consultation with South Holland Internal Drainage Board has identified the location of a Riparian owned watercourse following the northern boundary. Swales are also located adjacent to all highways which suggest these are all maintained by the Highway Authority. The nearest Board maintained watercourse is Exeter Drain to the east of the site beyond the A16. Flooding from these sources should be considered.

6.18 Flooding from the Sea - The site is not located near enough to the sea to cause a problem of flooding from this source.

6.19 Flooding from Land - The site is generally flat with levels on boundaries concordant with the adjoining land. Open ditches and highway swales also surround the development site. Therefore, it is highly unlikely that there would be run-off of water into the site from outside the site boundaries. Flooding from surface water run-off over adjacent land is unlikely, and flooding from this source is considered to be low risk.

6.20 Flooding from Groundwater - Whilst there has been no intrusive ground investigation undertaken on the area, the geological map shows that the natural strata will be generally cohesive in nature and the materials will be impermeable. The presence of the rivers and watercourses in the immediate and distant vicinity of the site confirms this assumption that the ground conditions are generally impermeable and, on this basis, the probability of groundwater entering the site is low risk.

6.21 Flooding from Sewer - A new positive drainage system will be introduced on site for the development. It is possible, therefore, that any blockage of the sewers will result in flooding from the lowest cover level of manholes or gullies, and this will need to be considered as part of any proposed development.

6.22 Flooding from Reservoirs, Canals or Artificial Sources - Apart from Coronation Channel, which is identified in Section 6.15, there are no other reservoirs, canals or artificial sources which would result in flooding on the site.

Climate Change

6.23 The NPPF and TG has indicated that the Global sea level will continue to rise, depending on greenhouse gas emissions, and the sensitivity of the climate system and there will be an increase in rainfall across the country. Table 5 of the TG makes an assessment of the peak rainfall intensity and states that this is likely to increase by 20% between 2055 and 2085 and by 30% between 2085 to 2115.

6.24 Due to the topography of the land and surrounding area, overland run-off from adjoining land is unlikely to be an issue. Therefore, any run-off from outside the site will be insignificant and, on this basis, only rainfall falling within the site boundaries will need to be considered in respect of climate change.

6.25 In accordance with the TG, the published figures show that, for an expected life of greater than 2085 for any new development, the anticipated increase in rainfall will be around 30%. It will be necessary to design any new positive drainage system with a 30% increase in capacity to accommodate this requirement.

Failure of Flood Defences

6.26 Consideration needs to be given to the possibility of a breach in the flood defences to the River Welland and Coronation Canal or the overtopping in the event of a catastrophic storm.

6.27 Table 9 of the EA/DEFRA document FD2321/TR2 – Flood Risks to People Phase 2, March 2006 shows the flood hazard with distance from a flood defence for breaches with different water levels above floodplain level, assuming a flat and clear flood plain.

Table 9

Distance from breach (m)	Head above floodplain (m)						
	0.5	1	2	3	4	5	6
100							
250							
500							
1000							
1500							
2000							
2500							
3000							
3500							
4000							
4500							
5000							

Key: Danger for some
Danger for most
Danger for all

6.28 Table 10 of the same document shows the flood hazard for overtopping with distance from a flood defence for different water levels above the defence crest, assuming a flat and clear floodplain.

Table 10

Distance from defence (m)	Head above crest level (m)			
	0.5	1	2	3
100				
250				
500				
1000				
1500				
2000				
2500				
3000				
3500				
4000				
4500				
5000				

Key: Danger for some
Danger for most
Danger for all

River Welland

6.29 The River Welland flood defences are located adjacent to the west of the development. Table 9 shows that, for a breach, there is a danger. However, as stated in the SFRA, raised embankments, with the road on their crest, would help resist erosion or degradation of the top part of the embankment. Also, the raised ground bounding a river is so broad and substantial that it should not be considered as an embankment, but rather as natural ground and breaching is not a plausible scenario in these locations. Furthermore, the defences are inspected regularly to ensure that any potential defects are identified early. Therefore, based on the information above, the chance of a breach is considered to be low risk.

6.30 Considering Table 10 for overtopping, it can be seen that, for a site at 0.1k from the flood source, a head of 0.5m above the crest level of the embankment is needed to cause a

danger for all people. In this case, taking the lowest defence level of 5.66m adjacent to the site, the head would need to be 2.60m above the 1 in 100 year flood level before there is danger to the occupants of the site. This is considered to be a very rare occurrence and, therefore, the risk is considered to be very low.

Coronation Channel

6.31 The Coronation Channel flood defences are located approximately 1.4km north of the site and should be considered in the event of a breach or overtopping.

When the site is assessed with Table 9, it can be seen that, for a site at 1km from the breach, the head above the flood plain would need to reach 4m before there is a risk for all. Therefore, the site is viewed to be located far enough away from Coronation Channel, and the risk to occupants of the site is considered to be low.

6.32 When the site is assessed with Table 10, it can be seen that, for a site at 1km from the flood source, a head of 1m above the crest level of the embankment is needed to cause a danger for all people. In this case, taking the lowest defence level of 5.14m A.O.D., the head would need to be 1.78m above the 1 in 100 year flood level before there is a danger to the occupants of the site. This is considered to be a very rare occurrence and, therefore, the risk is considered to be very low.

Flood Mitigation

6.33 Whilst the site falls within Flood Zone 3a and has a "More Vulnerable" flood risk classification, there are sufficient reasons, as identified in the Exception Test in paragraph 6.7 – 6.10, and the assessment of failure of flood defences in paragraphs 6.25 – 6.31, for maintaining the proposed development at its present location. However, it will be necessary to take account of potential sources of flooding through the layout and form of the development and implement the use of Sustainable Drainage techniques where possible.

6.34 The mitigation measures to be considered from flood sources of a catastrophic storm overtopping or causing failure of the river defences or blockage of the existing watercourse or existing and proposed sewers are as follows:-

General

6.34.1 The finished floor levels to buildings shall be raised above existing ground levels by 600mm, where possible.

6.34.2 It is recommended that the ground level for the new buildings is designed to be resilient to flooding in accordance with the May 2007 Communities and Local Government Report "Improving the Flood Performance of New Buildings". This will help to reduce the cost of repairs and speed up restoration times following a flood.

6.34.3 A flood resilient strategy is proposed which recommends the use of durable materials in the floor and wall construction that will not be affected by water and the use of construction methods and materials that promote easy draining and drying. Flood resilient construction will be incorporated at ground floor level.

6.34.4 There will be no lower ground basements within the construction.

6.34.5 Incoming electricity supplies shall be raised a minimum of 1m above the ground floor level and ground floor sockets shall be served by loops from first floor level and not below ground.

6.34.6 In the unlikely event of flooding of the site, it will be necessary to ensure there is a route for flood water through the site without causing flooding of buildings. To achieve this, external levels shall be designed with falls to non-critical areas, such as landscape, where the water can pond.

6.34.7 A flood evacuation plan should be in place for each development with the end user of the buildings signed up to the Environment Agency Flood Warning system of a telephone call when flooding is possible. This will ensure that the buildings are evacuated prior to the occurrence of a flood.

Hotels

6.34.9 It is recommended that no sleeping accommodation is proposed for the ground floor. However, if this cannot be avoided, it is recommended that the risks associated with fluvial flooding are dealt with principally by an evacuation strategy which would ensure the development is evacuated prior to the occurrence of a flood. This will include a strategy whereby the end user of the building signs up to the Environment Agency Flood Warning system of a telephone call when flooding is possible.

6.34.10 The upper floors of the hotel will offer a suitable refuge for any people left stranded in the building in the event of an emergency situation to protect life and limb.

Sustainable Drainage

6.35 In order to comply with the requirements of NPPF, it is necessary to consider aspects of Sustainable Drainage Techniques for the new development. No intrusive investigation of the ground conditions has been undertaken, but the Geological Survey Map of Great Britain, shows that the natural strata will be generally cohesive in nature and the materials will be impermeable. The presence of the rivers and watercourses in the immediate and distant vicinity of the site confirms this assumption that the ground conditions are impermeable. ARP Geotechnical Ltd have also carried out percolation tets to assess the suitability of soakaways, see Appendix G for the report. It has been concluded that soakaways are unlikely to be suitable. Therefore, the soils will be unsuitable for soakaways or other similar infiltration systems on the site.

Drainage

6.36 It is a requirement to ensure that surface water run-off from any proposed development has negligible consequence on downstream areas either in sewer capacity or discharge to watercourse.

Existing Surface Water Run-off

6.37 The site is Greenfield and, therefore, in accordance with current guidelines and regulations, surface water calculations have been undertaken using the IH124 method of calculating Greenfield run-off rates. This shows that a rate of 28.6l/s has been calculated for the larger northern site and a rate of 6.4l/s has been calculated for the smaller, triangular shaped, southern site. The calculations are presented in Appendix H.

Proposed Surface Water Drainage

6.38 Consideration for the proposed drainage should firstly be given to infiltration techniques (to ground). However, as infiltration techniques are considered unsuitable, it will be necessary to utilise a positive drainage system to watercourse.

6.39 An assessment of the likely impermeable area has been made from the Masterplan Layout in Appendix F to assess the implications of surface water drainage from the development. Assuming that the proposed impermeable area will not be greater than 80% of the proposed site area, calculations have been carried out using the WinDES Source Control Computer Program. The proposed surface water system should be designed to accommodate a 1 in 30 year storm event without flooding and the 1 in 100 year storm plus climate change event should be retained within the site in an area which will not affect the new buildings from flooding.

Larger Northern Site

6.40 Restricting the total discharge rate to no greater than 28.6l/s, on site storage of 6,800m³, will need to be providing for a 1 in 30 year storm. This can be achieved by several methods, including oversized pipes, underground tanks and balancing ponds. The drainage system will need to accommodate the 1 in 100 year event plus 30% climate change without causing flooding of property or third party land. In the event levels dictate that the 1 in 100 year plus climate change flood water would flow off-site, an additional or larger storage facility will be required. In these circumstances, on-site storage would increase to 12,700m³. The indicative surface water calculations are presented in Appendix I.

Smaller Southern Site

6.41 Restricting the discharge rate to no greater than 6.4l.s, on site storage of 1,550m³, will need to be provided for a 1 in 30 year storm. This can be achieved by several methods, including oversized pipes, underground tanks and balancing ponds. The drainage system will need to accommodate the 1 in 100 year event plus 30% climate change without causing flooding of property or third party land. In the event levels dictate that the 1 in 100 year plus climate change flood water would flow off-site, an additional or larger storage facility will be required. In these circumstances, on-site storage would increase to 2,850m³. The indicative surface water calculations are presented in Appendix I.

6.42 Due to the amount of attenuation required, it may not be possible to drain the site by gravity and, therefore, a package pump may be required as part of the detailed design.

6.43 The discharge for the surface water drainage will be to the existing watercourse located adjacent or near to the site. The introduction of any headwalls or works to the watercourse will need to consent of the Land Drainage Authority.

6.44 Petrol interceptors shall be provided in accordance with the Environment Agency Pollution Prevention Guidelines PPG3 prior to discharge to watercourse. Run-off from roof areas shall not discharge through petrol interceptors unless the size of the unit is increased to accommodate the additional area, subject to approval.

6.45 It was be necessary to provide detailed calculations and proposals to the Planning Authority showing the proposed method of drainage on the site, prior to construction.

Foul Drainage

6.46 There are no adopted foul drainage systems suitable for the disposal of foul drainage from the site, therefore an on-site treatment works should be used. It will be necessary, however, for a system such as this to have flush lockable covers to prevent any ingress of water in the event of flooding of the site from a breach of the flood protection, overtopping of the defences or from overland water due to a blocked surface water pipe. Discharge of treated effluent to ground or watercourse will require the formal approval and a Permit from the Environment Agency and the South Holland Internal Drainage Board.

6.47 Discharge to watercourse may not be possible via gravity. Therefore, a package pump may be required. Subject to detailed design.

Emergency Egress During Times of Flood

6.48 It is a requirement under the NPPF and its accompanying TG that occupants should be able to egress any building during times of flood, without being trapped by flood conditions.

6.49 It is not possible to provide emergency egress in circumstances of a failure of any defences or extreme storm and, therefore, it will be necessary to introduce some mitigation measures to protect and ensure safe evacuation of the occupiers of the buildings. It is recommended that the following is put in place:-

6.49.1 Registration is to be made with the Environment Agency for an early flood warning telephone contact to be made direct to the main buildings. This would enable evacuation of the building prior to flooding of the site, if necessary. The Floodline Warning details shall be incorporated into the legal documents of the sale of the buildings etc. so that this condition can be maintained in perpetuity.

6.49.2 A detailed emergency evacuation procedure (similar to a fire alarm system) is to be in place and form part of any Employee Handbook or induction procedure on joining the Companies occupying the proposed development. The procedure shall be agreed with the Planning Authority prior to any occupation and placed in prominent positions within all the buildings to ensure that all occupants are fully aware of the evacuation procedure.

7.0 COMMENTS

7.1 The site falls within Flood Zone 3a in accordance with the NPPF, but there are flood defence measures for the River Welland and Coronation Channel in place to protect against flooding. There are also sufficient exceptions, which satisfy the Sequential Test, and the site is considered to be suitable for construction at its present location. However, it is recommended that some flood mitigation measures are put in place and these are as follows:-

General

7.1.1 The finished floor levels to buildings shall be raised above existing ground levels by 600mm.

7.1.2 It is recommended that the ground level for the new buildings is designed to be resilient to flooding in accordance with the May 2007 Communities and Local Government Report "Improving the Flood Performance of New Buildings". This will help to reduce the cost of repairs and speed up restoration times following a flood.

7.1.3 A flood resilient strategy is proposed which recommends the use of durable materials in the floor and wall construction that will not be affected by water and the use of construction methods and materials that promote easy draining and drying. Flood resilient construction will be incorporated at ground floor level.

7.1.4 The buildings shall be constructed with an area of first floor, either by offices, mezzanine, or roof space to ensure that, in the event of a catastrophic flood, there would be no risk to life or limb and that occupants would be able to find safe haven at upper floor levels. A Velux window or similar will need to be provided in the roof in order to evacuate the building, if required

7.1.5 There will be no lower ground basements within the construction.

7.1.6 Incoming electricity supplies shall be raised a minimum of 1m above the ground floor level and ground floor sockets shall be served by loops from first floor level and not below ground.

7.1.7 In the unlikely event of flooding of the site, it will be necessary to ensure there is a route for flood water through the site without causing flooding of buildings. To achieve this, external levels shall be designed with falls to non-critical areas, such as landscape, where the water can pond.

7.1.8 A flood evacuation plan should be in place for the development.

Hotels

7.1.9 It is recommended that no sleeping accommodation is proposed for the ground floor. However, if this cannot be avoided, it is recommended that the risks associated with fluvial flooding are dealt with principally by an evacuation strategy which would ensure the development is evacuated prior to the occurrence of a flood. This will include a strategy whereby the end user of the building signs up to the Environment Agency Flood Warning system of telephone call when flooding is possible.

7.1.10 The upper floors of the hotel will offer a suitable refuge for any people left stranded in the building in the event of an emergency situation to protect life and limb.

7.2 A 30% increase in rainfall shall be incorporated into any new positive drainage system to satisfy the requirements of climate change for developments extending beyond 2085.

7.3 Sustainable Drainage Systems of infiltration techniques are considered unsuitable on this particular site, but an appraisal of localised systems such as permeable pavements, will be considered in the detailed design and proposals submitted to the Planning Authority for approval prior to construction.

7.4 The proposed surface water drainage system shall be designed to the agreed discharge rate and attenuated to ensure that a 1 in 30 year storm can be accommodated within the drainage system. Furthermore, the volume of water from a 1 in 100 year storm plus climate change shall be accommodated within the system without causing flooding of buildings or overflow back into a watercourse. The design, details and calculations shall be submitted to the Planning Authority for approval prior to construction on site.

7.5 Due to the amount of attenuation required, it may not be possible to drain the site by gravity and, therefore, a package pump may be required.

7.6 Petrol interceptors shall be provided in accordance with the Environment Agency Pollution Prevention Guidelines PPG3 prior to discharge to watercourse. Run-off from roof areas shall not discharge through petrol interceptors unless the size of the unit is increased to accommodate the additional area, subject to approval.

7.7 A 9m easement strip shall be provided adjacent to any watercourse maintained by South Holland Internal Drainage Board, although it is anticipated there are no such watercourses in the immediate vicinity of the site.

7.8 There are no adopted foul drainage systems suitable for the disposal of foul drainage from the site, therefore, an on-site treatment works should be used. It will be necessary, however, for a system such as this to have flush lockable covers to prevent any ingress of water in the event of flooding on the site from a breach of the flood protection, overtopping of the defences or from overland water due to a blocked surface water pipe. Discharge of treated effluent to ground or watercourse will require the formal approval and a Permit from the Environment Agency and/or the South Holland Internal Drainage Board.

7.9 Discharge of foul drainage to watercourse may not be possible via gravity and, therefore, a package pump may be required, subject to detailed design.

7.10 It is a requirement under the and its accompanying TG that occupants should be able to egress any building during times of flood, without being trapped by flood conditions.

7.11 It is not possible to provide emergency egress in circumstances of a failure of any defences or extreme storm and, therefore, it will be necessary to introduce some mitigation measures to protect and ensure safe evacuation of the occupiers of the buildings. It is recommended that the following is put in place:-

7.11.1 The buildings will be constructed with an area of first floor, either in the form of offices, mezzanine, or roof space which will enable occupiers to quickly and easily gain access to the upper levels away from any flood level occupying the building. This will protect life and limb and provide sufficient safety in the event of a catastrophic floor or failure of the flood defences.

7.11.2 Registration is to be made with the Environment Agency for an early flood warning telephone contact to be made direct to the main buildings. This would enable evacuation of the building prior to flooding of the site, if necessary. The Floodline Warning details shall be incorporated into the legal documents of the sale of the buildings so that this condition can be maintained in perpetuity.

7.11.3 A detailed emergency evacuation procedure (similar to a fire alarm system) is to be in place and form part of any Employee Handbook or induction procedure on joining the Companies occupying the proposed development. The procedure shall be agreed with the Planning Authority prior to any occupation and placed in prominent positions within all the buildings to ensure that all occupants are fully aware of the evacuation procedure.

7.12 Subject to compliance with the above, the proposed development can satisfy the requirements of the National Planning Policy Framework and its accompanying Technical Guidance in relation to flood risk.

A P P E N D I X A

SITE LOCATION PLAN



OS Grid Reference: TF244198

Rev	By	Date	Amendment	Chk
/	MW	28.03.13	Issued for approval	WMW

Title

SITE LOCATION PLAN

Project/Client

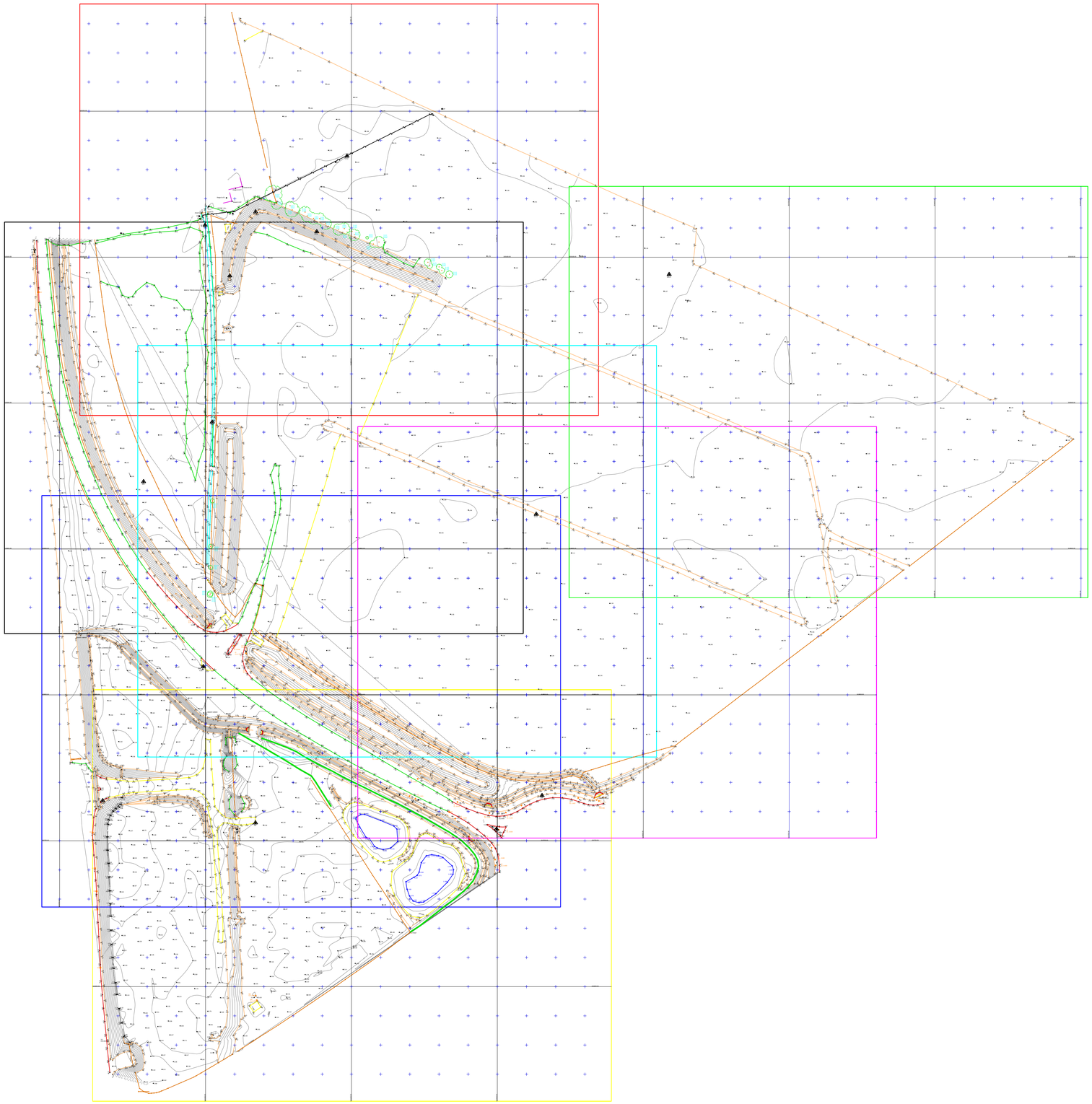
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MORAN RAC LTD.

ARP ASSOCIATES
CHARTERED CONSULTING ENGINEERS
Northwest House • 5/6 Northwest Business Park
Servia Hill • Leeds LS6 2QH
Telephone : 0113 245 8498 • Fax : 0113 244 3864
E-Mail : leeds@arpassociates.co.uk

Scale 1:1000 @ A4	Drawn MW
Date MARCH 2013	Chk. WMW
Drg. No. 800/235/SK.01	Rev /

A P P E N D I X B

TOPOGRAPHICAL SURVEY



N

GRID NORTH

SURVEY TO ORDNANCE SURVEY GPS DATUM AND GRID, OSGB36(02) TRANSLATED FROM ETRS89 USING OSGMO2 AND OSTN02 MODELS

Co-Ordinates

D1	524229.534	319727.595	5.4120
D2	524334.242	319712.356	2.4995
D3	524298.568	319819.368	4.2460
D3A	524299.758	319785.665	3.8090
D4	524499.389	319708.013	3.5200
D5	524530.650	319731.093	3.4750

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B/W	Barbed Wire	C/P	Chestnut Paling	P/S	Palisade
C/B	Close Boarded	I/R	Iron Railing	P/W	Post & Wire
C/I	Corrugated Iron	I/W	Interwoven		
C/L	Chainlink	P/R	Post & Rail		

LEGEND

AV	Air Valve	MH	Manhole
BD	Bollard	MK	Marker
BH	Borehole	NP	Street Name Plate
CB	Cable Box	O/H	Overhead
CHY	Chimney	OSBM	Ordnance Bench Mark
CL	Cover Level	P	Post Or Pillar
CONC	Concrete	PM	Parking Meter
CTV	Cable Television	RE	Rodding Eye
DK	Drop Kerb	RS	Road Sign
DP	Down Pipe	SAP	Sapling
DR	Drain	SC	Stop Cock
ELC	Electricity	SL	Sump Level
EP	Electricity Pole	ST	Stop Tap
ER	Earth Rod	SV	Sluice Valve
FB	Flower Bed	TAR	Tarmac
FH	Fire Hydrant	TCB	Telephone Call Box
FP	Flag Pole	TL	Traffic Lights
GY	Gully	TP	Telegraph Pole
GP	Gate Post	TV	Television Box
GV	Gas Valve	UTL	Unable to lift
IC	Inspection Cover	VP	Vent Pipe
IL	Invert Level	WL	Water Level
JB	Junction Box	WM	Water Meter
KO	Kerb Outlet	WO	Wash Out
LB	Letter Box		
LP	Lamp Post		

Banking
Hedge
Tree
Bush
Gate
O/H Electric
O/H Telecom
S1 Control Station

Drawn by:- RB Surveyed by:- DC Checked by:- JT

Date: January 2013

Scale:- 1:1500

Drawing Number: ALS5957/1500/08 Overview

Client: Ashley King Developments Ltd

Project: Barrier Bank Spalding

Surveyed By:-

ALS EST 1976
Anglia Land Surveys Ltd

Bowthorpe Hall,
Bowthorpe Hall Road,
Norwich, NR5 9AA

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Website: www.als-surveys.com

ISO 9001 REGISTERED FIRM

A P P E N D I X C

ENVIRONMENT AGENCY CONSULTATION

W M Walker
<leeds@arpassociates.co.uk>

Our ref: CCN/2013/2013/33830
Your ref: 800/235/WMWjc
Date: 8 March 2013

Dear W M Walker

Detailed Flood Risk Assessment Data Request for Barrier Bank, Spalding (grid reference number TF246 200).

Thank you for your request of 7 February 2013 to use Environment Agency data, Product 4 in the development of the Flood Risk Assessment for the above site. The information is attached.

If you have requested this information to help inform a development proposal, then you should note the detail in the attached advisory text on the use of Environment Agency Information for Flood Risk Assessments / Flood Consequence Assessments.

Map 1 – Flood Map
A copy of the current Flood Map for the area is enclosed. The Flood Map indicates the area at risk of flooding, assuming no flood defences exist, for a flood event with a 0.5% chance of occurring in any year for flooding from the sea, or a 1% chance of occurring for fluvial (river) flooding. It also shows the extent of the Extreme Flood Outline which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

The Flood Map only indicates the extent and likelihood of flooding from rivers or the sea. It should also be remembered that flooding may occur from other sources such as surface water sewers, road drainage, etc.

Map 2 – Historic Flood Extent Map
A copy of the Historic Flood Extent Map for your area is enclosed. This shows the extent of previous recorded flooding in your area, notably 1947. Further information about this event is shown on the attached datasheet.

It is possible that other flooding may have occurred that we do not have records for, and other organisations, such as the Local Authority or Internal Drainage Boards, may have records.

Map 3 – Node Map
Please find attached a map showing a selection of model node points near to your site. The fluvial levels, flows and bank levels for these node points are shown in the attached datasheet. This information is from the Welland Catchment FMI Model (August 2007).

Map 4 – National Flood and Coastal Defence Database (NFCDD) Information
Map 4 shows the location of the fluvial defences protecting this site. This information is obtained from the National Flood and Coastal Defence Database (NFCDD). Further information about these defences is shown on the attached datasheet.

The **fluvial** defences protecting this site consist of earth embankments. They are in good condition and provide protection against a flood event with a 1% chance of occurring in any year (1 in 100). We inspect these defences regularly to ensure that any potential defects are identified early.

Map 5 – Modelled Flood Extents
Please find attached a map showing the results of the Welland Catchment FMI Model (August 2007) for your area. This shows modelled flood extents, taking into account flood defences.

Climate change will increase flood risk due to overtopping of defences. Please contact our Welland and Nene Partnership and Strategic Overview Team to discuss how this risk should be considered within your Flood Risk Assessment.

Land Drainage
The information provided is limited to flood risk from the sea and rivers with catchment areas greater than 3km^2. The site is in an area of extensive land drainage which may pose an additional risk of flooding. Further information should be sought from the South Holland Internal Drainage Board (tel: 01553 819600).

This information is provided subject to the enclosed notice, which you should read.

If you have any queries or would like to discuss the content of this letter further please contact Heather Claase using the telephone/email details below. Please quote our CCN reference number in all correspondence where data is referenced, including the Flood Risk Assessment.

Yours sincerely

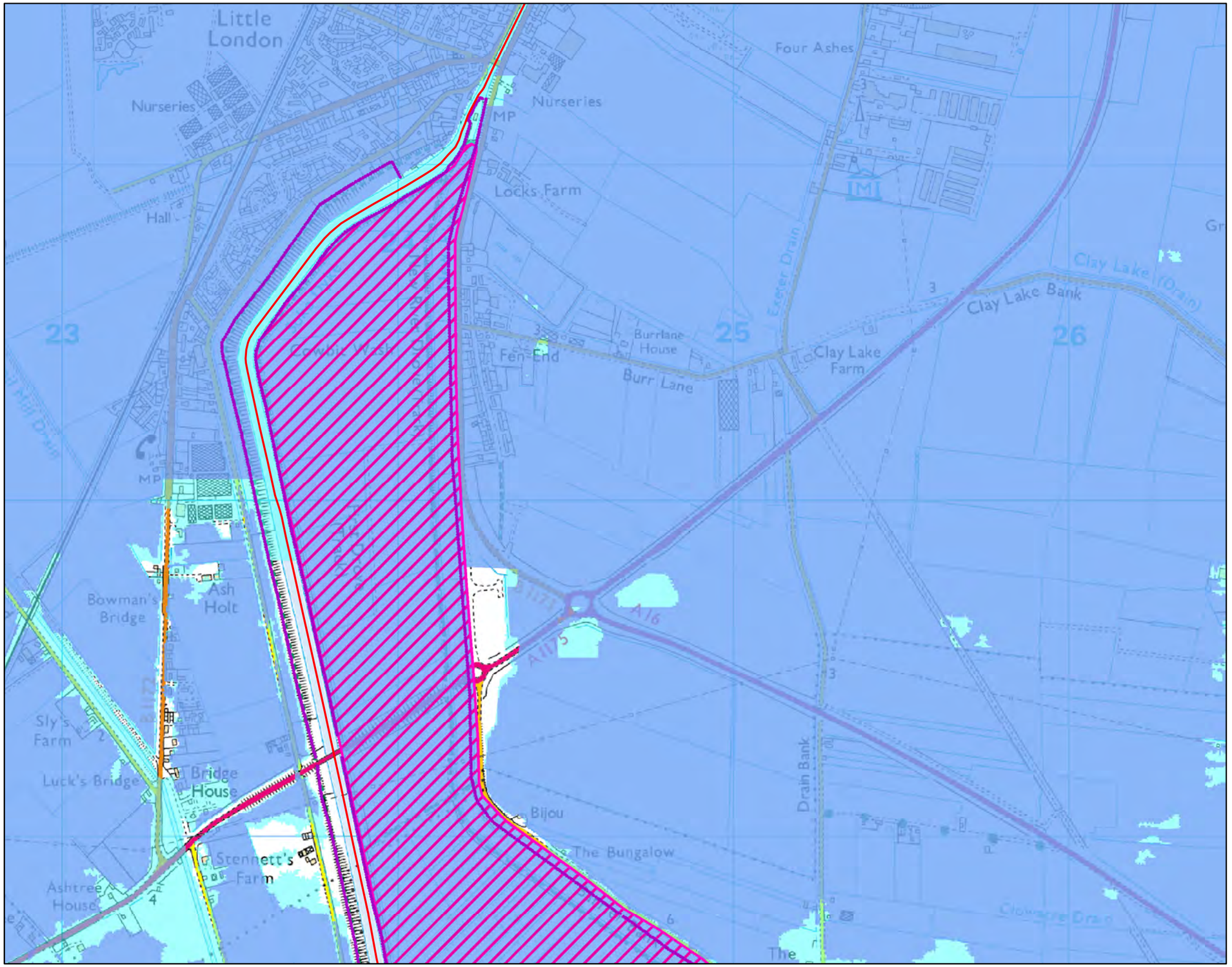


FOR Ben Thornely
Welland and Nene Partnerships and Strategic Overview Team Leader

Direct dial 01536 385126
Direct e-mail psown@environment-agency.gov.uk

Enc.
FRA/FCA Advisory Text
Detailed FRA Maps
Datasheet
Standard Notice

Map 1. Flood Map
Map centred on TF2451919978 - created March 2013 [Ref: CCN-2013-33830]



Environment Agency

Scale 1:11,797

N
W E
S

- Main River
- Raised Defences
- Flood Storage Areas
- Area at Risk of Flooding from Rivers or The Sea
- Extreme Flood Outline

Dark blue shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded:

- from the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year.

- or from a river by a flood that has a 1% (1 in 100) or greater chance of happening each year.

Light blue shows the extent of the Extreme Flood Outline, which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements. Sites outside the two extents, but behind raised defences, may be affected by flooding if the defences are overtopped or fail.

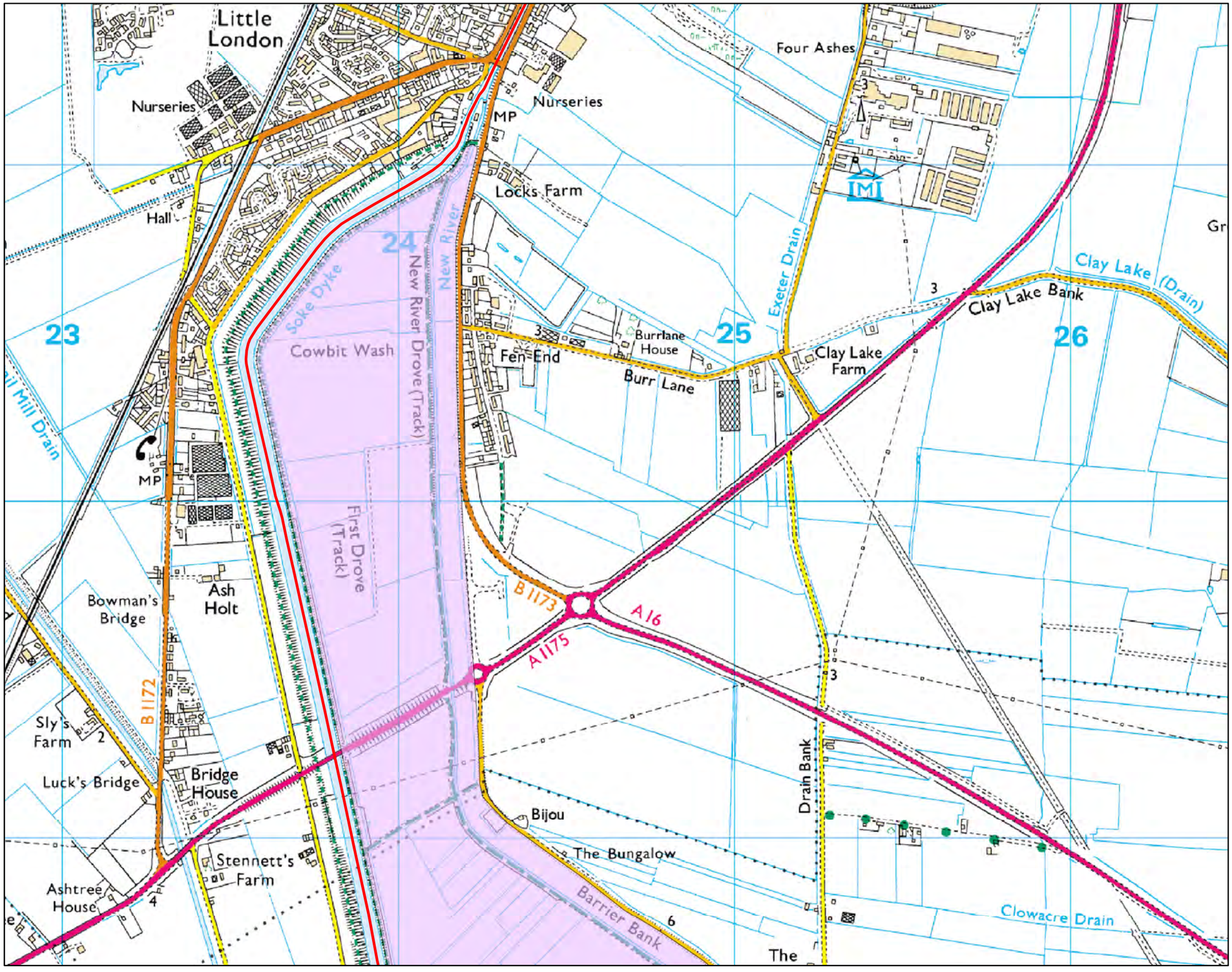
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Map 2. Historic Flood Extent Map

Map centred on TF 24519 19978 - created mARCH 2013 [Ref: CCN-2013-33830]



Environment Agency

Scale 1:11,797

N W E S

Main River

March 1947 on the River Welland near Cowbit

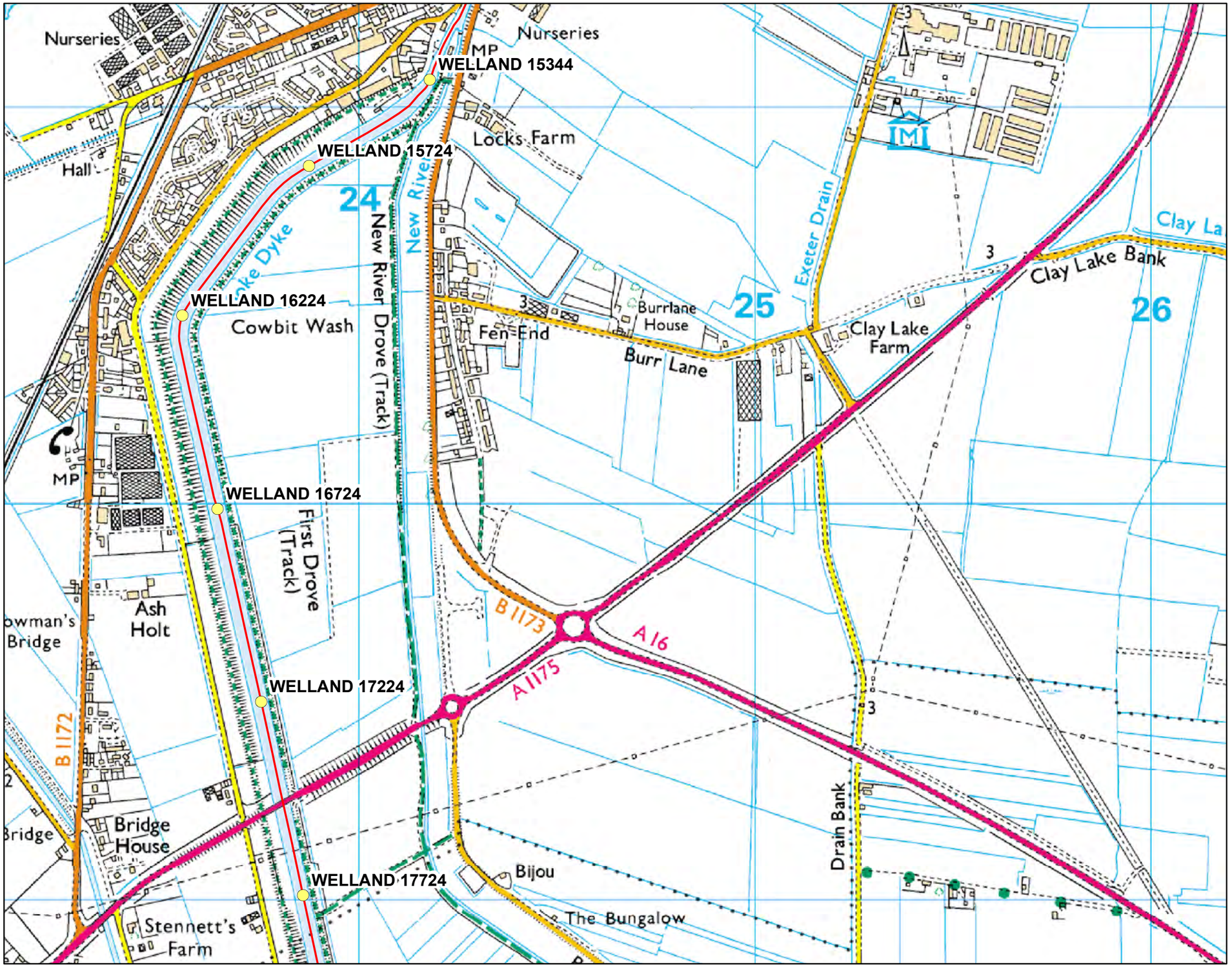
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Map 3. Node Map

Map centred on TF 24598 19998 - created March 2013 [Ref: CCN-2013-33830]



Environment Agency

Scale 1:10,000

N
W E
S

River Welland Nodes

Main River

Please refer to the attached datasheet for more information

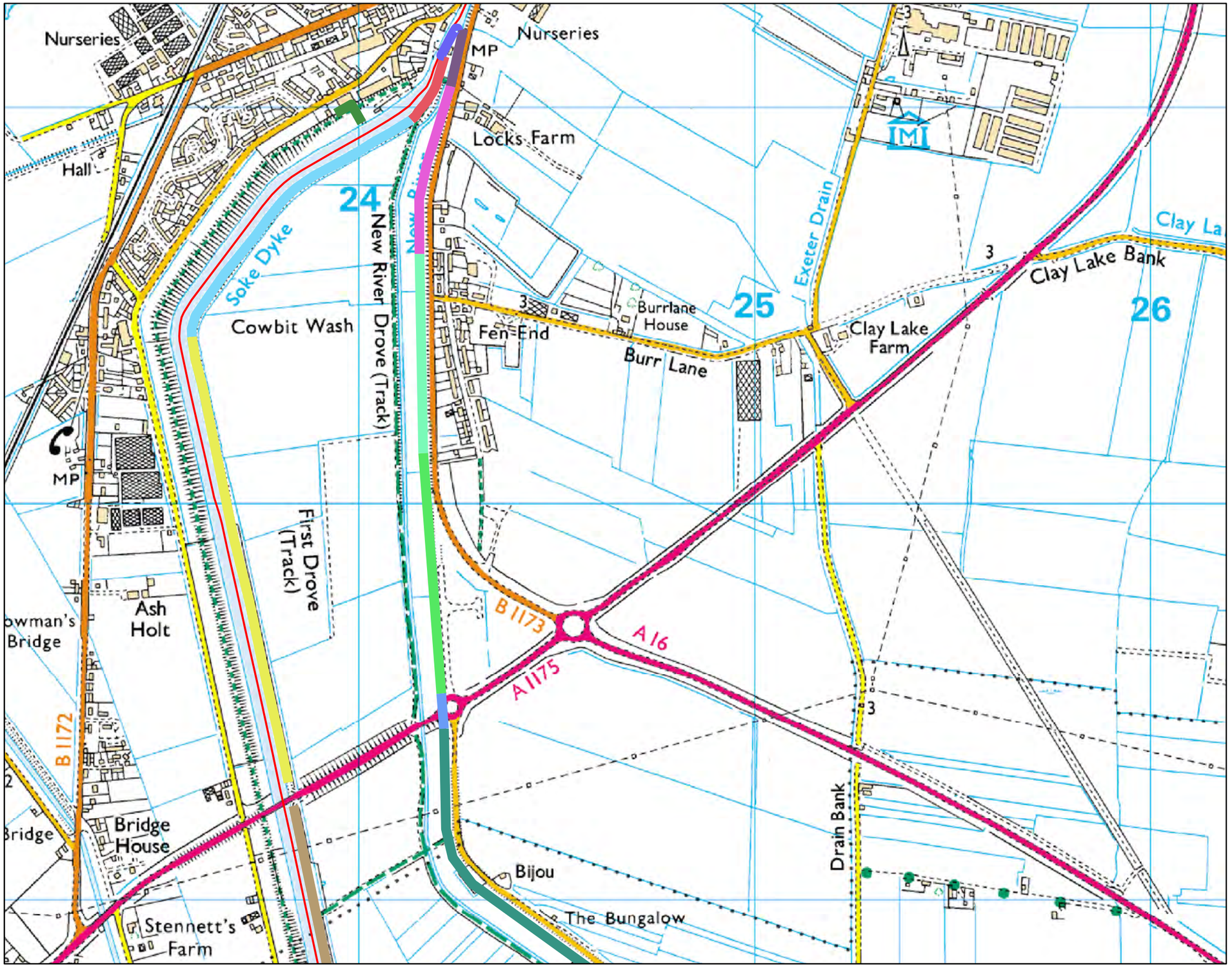
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Map 4. National Flood and Coastal Defence Database (NFCDD) Information

Map centred on TF 24519 19978 - created March 2013 [Ref: CCN-2013-33830]



Environment Agency

Scale 1:10,000

N W E S

Asset Reference Numbers

- 0553050510301L58
- 0553050510301R52
- 0553050510301R53
- 0553050510301R54
- 0553050510301R55
- 0553050510301R57
- 0553050700101R51
- 0553050700101R52
- 0553050700101R53
- 0553050700101R54
- 0553050700101R55
- 0553050700101R56
- Main River

Please refer to the attached datasheet for more information

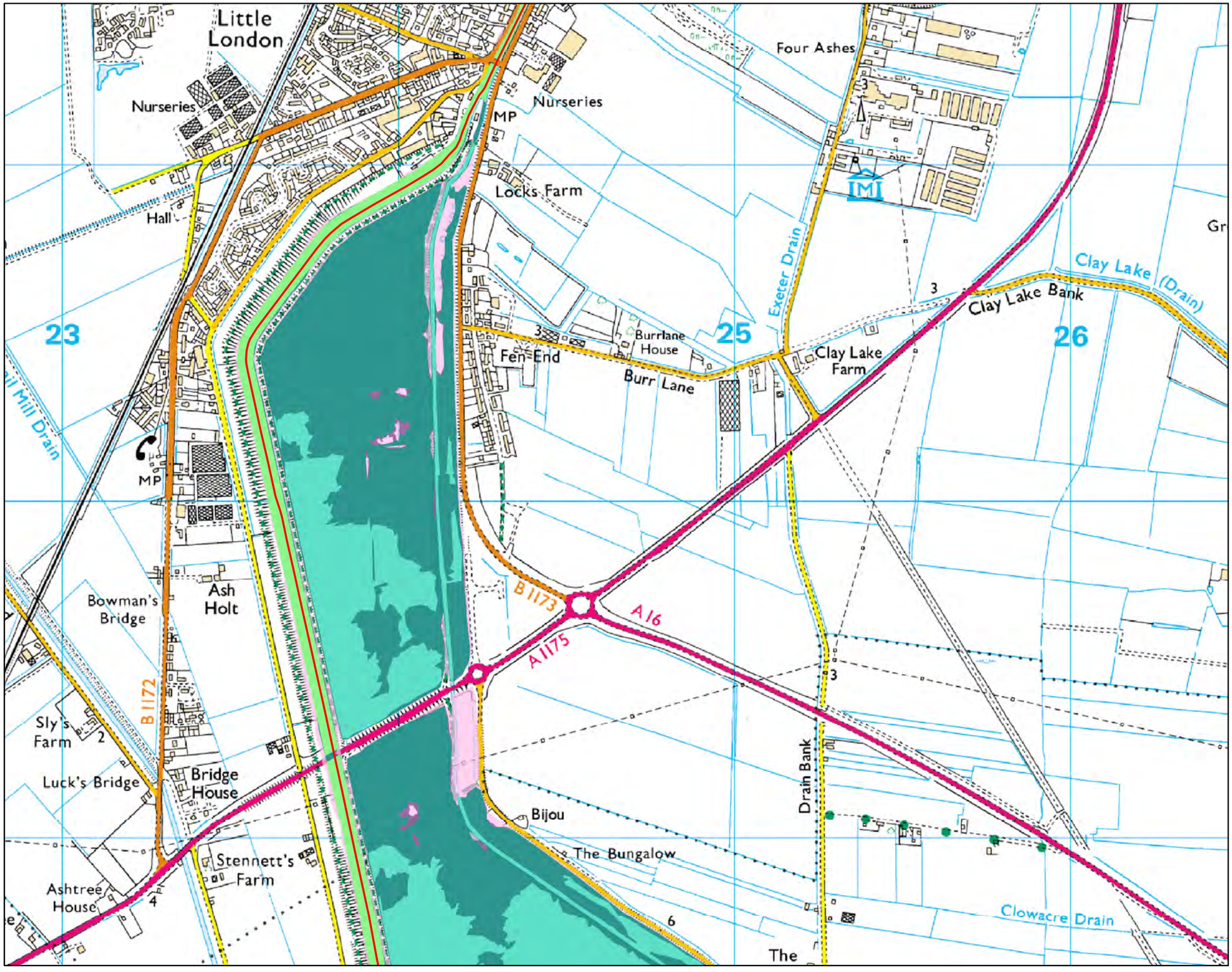
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Map 5. Modelled Flood Extents (with defences)

Map centred on TF 24519 19978 - created March 2013 [Ref: CCN-2013-33830]



Environment Agency

Scale 1:11,797

N W E S

Modelled Flood Extents (with defences)

- Main River
- 4% (1 in 25) Fluvial Event
- 1% (1 in 100) Fluvial Event
- 1% (1 in 100) inc Climate Change
- 0.1% (1 in 1000) Fluvial Event
- 0.1% (1 in 1000) Fluvial Event inc Climate Change

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Historic Flooding Information

Flood Event Code	Name	Start Date	End Date	Source of Flooding	Cause of Flooding
EA055194703	March 1947 on the River Welland near Cowbit	16/03/1947	18/03/1947	main river	other

NFCDD Defence Information

Asset Reference	Maintainer	Asset Type	Asset Description	Standard of Protection	Overall Condition
0553050510301R55	Environment Agency	raised defence (man-made)	raised earth embankment	100	2
0553050700101R54	Environment Agency	raised defence (man-made)	Floodbank (End of Houses to Roundabout)	100	2
0553050700101R53	Environment Agency	raised defence (man-made)	Floodbank (Opposite Fen End Road to End of Houses)	100	2
0553050510301R54	Environment Agency	raised defence (man-made)	raised channel embankment	100	2
0553050700101R52	Environment Agency	raised defence (man-made)	Floodbank (Access Bridge to Opposite Fen End Road)	100	2
0553050510301L58	Environment Agency	raised defence (man-made)	earth embankment with stone revetment	100	3
0553050510301R53	Environment Agency	raised defence (man-made)	raised earth embankment	100	2
0553050700101R51	Environment Agency	raised defence (man-made)	Floodbank (Locks Mill to Access Bridge)	100	2
0553050510301R52	Environment Agency	raised defence (man-made)	steel piled channel side	100	2
0553050510301R57	Environment Agency	raised defence (man-made)	Crowland and Cowbit Washes (MA)	100	2
0553050700101R55	Local authority	raised defence (man-made)	Floodbank (A16 - A1073 Roundabout)	100	2
0553050700101R56	Environment Agency	raised defence (man-made)	Floodbank (Roundabout to Cowbit Village)	100	2

Key to Overall Condition Grades

Grade	Rating	Description
1	Very Good	Cosmetic Defects that will have no effect on performance
2	Good	Minor defects that will not reduce the overall performance of the asset
3	Fair	Defects that could reduce performance of the asset
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation needed.
5	Very Poor	Severe defects resulting in complete performance failure.

Fluvial Flood Levels (mODN)

These levels are "in-channel" levels and therefore may not represent the flood level on the floodplain, particularly where the channel is embanked or has raised defences.

			Annual Exceedance Probability - Maximum Water Levels (mODN)					Defence Crest Levels (mODN)	
Node Label	Easting	Northing	4% (1 in 25)	1% (1 in 100)	1% (1 in 100) inc Climate Change	0.1% (1 in 1000)	0.1% (1 in 1000) inc Climate Change	Left Bank	Right Bank
WELLAND 15344	524181	321070	4.39	4.45	4.67	4.47	4.68	Bank Heights are unavailable at this time (currently under review)	
WELLAND 15724	523876	320852	4.41	4.47	4.67	4.48	4.68		
WELLAND 16224	523556	320474	4.42	4.48	4.67	4.49	4.68		
WELLAND 16724	523645	319986	4.43	4.49	4.67	4.50	4.67		
WELLAND 17224	523755	319499	4.44	4.50	4.67	4.51	4.67		
WELLAND 17724	523861	319010	4.46	4.51	4.67	4.52	4.67		

Modelled Flows (Cumecs)

			Annual Exceedance Probability - Peak Flows (Cumecs)				
Node Label	Easting	Northing	4% (1 in 25)	1% (1 in 100)	1% (1 in 100) inc Climate Change	0.1% (1 in 1000)	0.1% (1 in 1000) inc Climate Change
WELLAND 15344	524181	321070	87.24	90.87	90.59	91.37	91.31
WELLAND 15724	523876	320852	87.26	90.87	90.56	91.35	91.30
WELLAND 16224	523556	320474	87.29	90.87	90.51	91.32	91.29
WELLAND 16724	523645	319986	87.35	90.87	90.47	91.29	91.27
WELLAND 17224	523755	319499	87.40	90.87	90.46	91.36	91.27
WELLAND 17724	523861	319010	87.45	90.87	90.46	91.43	91.26

The flows given are for the node points identified and do not necessarily equate to the total flow down the valley, as there may also be flow along the floodplain.

Source of Information: Welland Catchment FMI (August 2007)

These are the most up-to-date levels and flows currently available. We aim to review our models on a regular basis, so if you are using this information in more than twelve months' time, please contact us again to check that they are still valid.

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A P P E N D I X D

WATER AUTHORITY CONSULTATION

Pre Planning

Assessment Report

Barrier Bank, SPALDING
ARP Associates

Reference Number: 0905/SP100(001)

Anglian Water Services contact:
Sandeep Bains
Growth Planning Advisor
Thorpe Wood House
Thorpe Wood
Peterborough
PE3 6WT
Telephone Number: 01733 414690
Please use the above reference number in all communications

YOUR DEVELOPMENT SITE: Barrier Bank, SPALDING

The information provided within this report has been generated based on the following information provided in your application form:

- The grid reference for the site is TF24602000.
- The site currently does not have planning permission and is located on a Greenfield site.
- The development site will contain 20 commercial units and 2 hotels across 24.7 Hectares.

The comments contained within this report relate to the public water mains and sewers indicated on our records. Your attention is drawn to the disclaimer in the useful information section of this report.

Due to the recent adoption of private sewers in October 2011 many newly adopted public wastewater assets and their history are not indicated on our records. You also need to be aware that your development site may contain private water mains, drains or other assets not shown on our records. These are private assets and not the responsibility of Anglian Water but that of the landowner.

ASSETS AFFECTED

Our records indicate that we have a public water main within the boundary of your development site. Additionally, it is highly recommended that you carry out a thorough investigation of your proposed working area to establish whether any unmapped public or private sewers and lateral drains are in existence.

We are unable to permit development either over or within the easement strip without prior consent. The extent of the easement is provided in the table below. Please be aware that the existing underground assets should be located in highway or open space and not in private gardens. This is to ensure available access for any future maintenance and repair. This should be taken into consideration when planning your site layout.

Water Easement Information	
Pipe Size (inch)	Total Easement Required (m)
3	2.25m either side of the centre line

If it is not possible to avoid our asset then the water main may need to be diverted in accordance with Section 185 of the Water Industry Act (1991). We have a duty to divert our sewerage infrastructure if requested to do so although this would be at your expense. You will need to make a formal application if you would like a diversion to be considered. A copy of the section 185 diversion application form can be found at www.anglianwater.co.uk /developers

WASTEWATER SERVICES

In examining the wastewater system we assess the ability for your site to connect to the public sewerage network without causing a detriment to the operation of the system. We also assess the receiving sewage works and determine whether the sewage works can cope with the increased flow and influent quality arising from your development.

Wastewater Treatment

The foul drainage from this development is in the catchment of Spalding Sewage Treatment Works, which has capacity to treat the flows from your development site. Anglian Water cannot reserve capacity at this sewage works and you are recommended to formally apply for a connection at your earliest convenience. Please note that capacity at the sewage works can be reduced at any time due to increased requirements from existing businesses and houses, from new housing and new commercial developments as well as from environmental and regulation driven changes.

Foul Sewerage Network

As per your request we have assessed a gravity solution to your preferred connection point in Fen End Lane. As you are no doubt aware, the sewers in this area are of a small diameter and designed to serve the current connected properties only, therefore we can confirm that there is insufficient capacity in this sewer to accommodate your site.

Taking into consideration the proposed site usage, we have assessed alternative connection points; unfortunately the nearest point where capacity would be available is some 6.2 kilometres north of the site in West Marsh Road north of Spalding where the sewer increases in diameter to 1050mm. As a river crossing will be required, the flows would need to be pumped and the anticipated connection point would be to manhole 9302 in West Marsh Road at grid reference TF2592124355.

To assist in your budgeting process, we have calculated that the cost of the necessary works to connect flows to the system would be £2,054,225. Please be aware that this is an indicative solution and should planning approval be granted, we would carry out detailed modelling and optioneering under the requisition process in order to provide the most cost effective solution.

The Water Industry Act enables the developer to benefit from any wastewater revenue generated from the commercial site they have built. In simplified terms, future revenue from the new development is offset from the scheme cost. Instead of paying the full contribution the developer pays the difference between their capital contribution and the future revenue. This is calculated on an annual basis for 12 years. The developer has the option of paying this annually (relevant deficit) or upfront as a commuted sum (discounted aggregate deficit). The developer contribution applicable for this site can be provided on submission of firm site usage details.

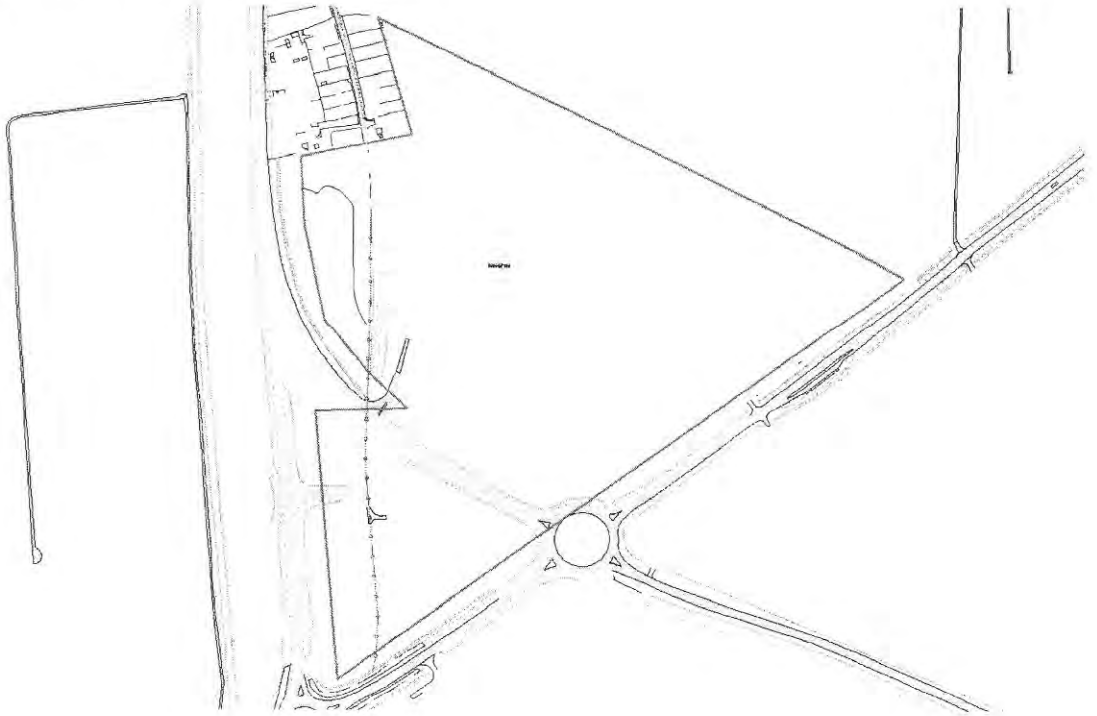
Surface Water Disposal
The proposed method of surface water disposal is not relevant to Anglian Water; we suggest that you contact the future SuDS Approving Body for the area, the Environment Agency, the Internal Drainage Board.

Trade Effluent
Trade effluent to the public sewerage system will need our written formal consent. This is in accordance with Section 118 of the Water Industry Act (1991). To proceed with the trade effluent application you will need to contact your local Catchment Quality Scientist. The Scientist for this area is Andy Gunn and he is available on 07710608720. You are advised to contact them before any work commences in order to discuss your proposed trade waste process. Please note that it is an offence to discharge a trade effluent without our consent.

Wastewater Budget Costs
It has been assumed that the onsite foul network will be provided under a section 104 Water Industry Act application. It is recommended that you also budget for both infrastructure charges and connection costs. The 2013/14 charges are:

Infrastructure Charge	
S104 Supervision and inspection costs	
S104 Surety costs	

Map of proposed development site



USEFUL INFORMATION

Sustainable Drainage Systems: Many existing urban drainage systems can cause problems of flooding, pollution or damage to the environment and are resilient to climate change in the long term. Therefore our preferred method of surface water disposal is through the use of Sustainable Drainage Systems (SuDS). SuDS are a range of techniques that aim to mimic the way surface water drains in natural systems within urban areas. For more information on SuDS, please visit our website at http://anglianwater.co.uk/developers/sewer-connection/suds.aspx. We also recommend that you contact the future SuDS Approving Body (SAB) for the area to discuss your application.

Water Industry Act - Key Wastewater Sections:

- Section 98: This provides you with the right to requisition a new public sewer. The new public sewer can be constructed by Anglian Water on your behalf. Alternatively, you can construct the sewer yourself under section 30 of the Anglian Water Authority Act 1977.
- Section 102: This provides you with the right to have an existing sewerage asset vested by us. It is your responsibility to bring the infrastructure to an adoptable condition ahead of the asset being vested.
- Section 104: This provides you with the right to have a design technically vetted and an agreement reached that will see us adopt your assets following their satisfactory construction and connection to the public sewer.
- Section 106: This provides you with the right to have your constructed sewer connected to the public sewer.
- Section 185: This provides you with the right to have a public sewerage asset diverted.

Details on how to make a formal application for a new sewer, new connection or diversion are available on our website at www.anglianwater.co.uk/developers/application-form or via our Developer Services team on 08457 60 66 087.

Private Sewer Transfers: Sewers and lateral drains connected to the public sewer on the 1 July 2011 transferred into Water Company ownership on the 1 October 2011. This follows the implementation of the Floods and Water Management Act (FWMA). This included sewers and lateral drains that were subject to an existing Section 104 Adoption Agreement and those that were not. There were exemptions and the main non-transferable assets were as follows:

- Surface water sewers and lateral drains that did not discharge to the public sewer, e.g. those that discharged to a watercourse.
- Foul sewers and lateral drains that discharged to a privately owned sewage treatment/collection facility.
- Pumping stations and rising mains will transfer between 1 October 2011 and 1 October 2016.

The implementation of Section 42 of the FWMA will ensure that future private sewers will not be created. It is anticipated that all new sewer applications will need to have an approved section 104 application ahead of a section 106 connection.

Encroachment: Anglian Water operates a risk based approach to development encroaching close to our wastewater infrastructure. We assess the issue of encroachment if you are planning to build within 400 metres of a Sewage Treatment Works or, within 15 metres to 100 metres of a pumping station. We have more information available on our website at http://anglianwater.co.uk/developers/ encroachment.aspx

Water Industry Act - Key Water Sections:

- Section 41: This provides you with the right to requisition a new water main to connect your site to the public water network.
- Section 45: This provides you with a right to have a connection from a building or part of a building to the public water main.
- Section 51A: This provides you with the right to provide the water main or service connection yourselves and for us to vest them into our company.
- Section 185: This provides you with the right to have a public water asset diverted. Details on how to make an application and the s185 form is available on our website at www.anglianwater.co.uk /developers/application-forms or via our Developer Services team on 08457 60 66 087.

Details on how to make a formal application for a new water main, new connection or diversion are available on our website at www.anglianwater.co.uk/developers/ application-form or via our Developer Services team on 08457 60 66 087.

If you have any other queries on your rights to requisition or connect your housing to the public water and wastewater infrastructure then please contact our developer services team at: Developer Services, Anglian Water, PO Box 495, Huntingdon, PE29 6YY or Tel: 0845 60 66 087 or Email: developerservices@anglianwater.co.uk

Self Lay of Water Mains: A list of accredited Self Lay Organisations can be found at www.lloydsregister.co.uk/schemes/WIRS/providers-list.aspx.

Water pressure and flow rate: The water pressure and consistency that we must meet for your site is laid out in the Water Industry Act (1991). This states that we must supply a flow rate of 9 litres per second at a pressure of 10 metres of head to the external stop tap. If your water pressure requirements exceed this then you will need to provide and maintain any booster requirements to the development site.

Locating our assets: Maps detailing the location of our water and wastewater infrastructure including both underground assets and above ground assets such as pumping stations and treatment works are available from www.digdat.co.uk . All requests from members of the public or non-statutory bodies for maps showing the location of our assets will be subject to an appropriate administrative charge. We have more information on our website at: www.anglianwater.co.uk/developers/our-assets/

Summary of charges: A summary of this year's water and wastewater connection and infrastructure charges can be found at www.anglianwater.co.uk/developers /charges/

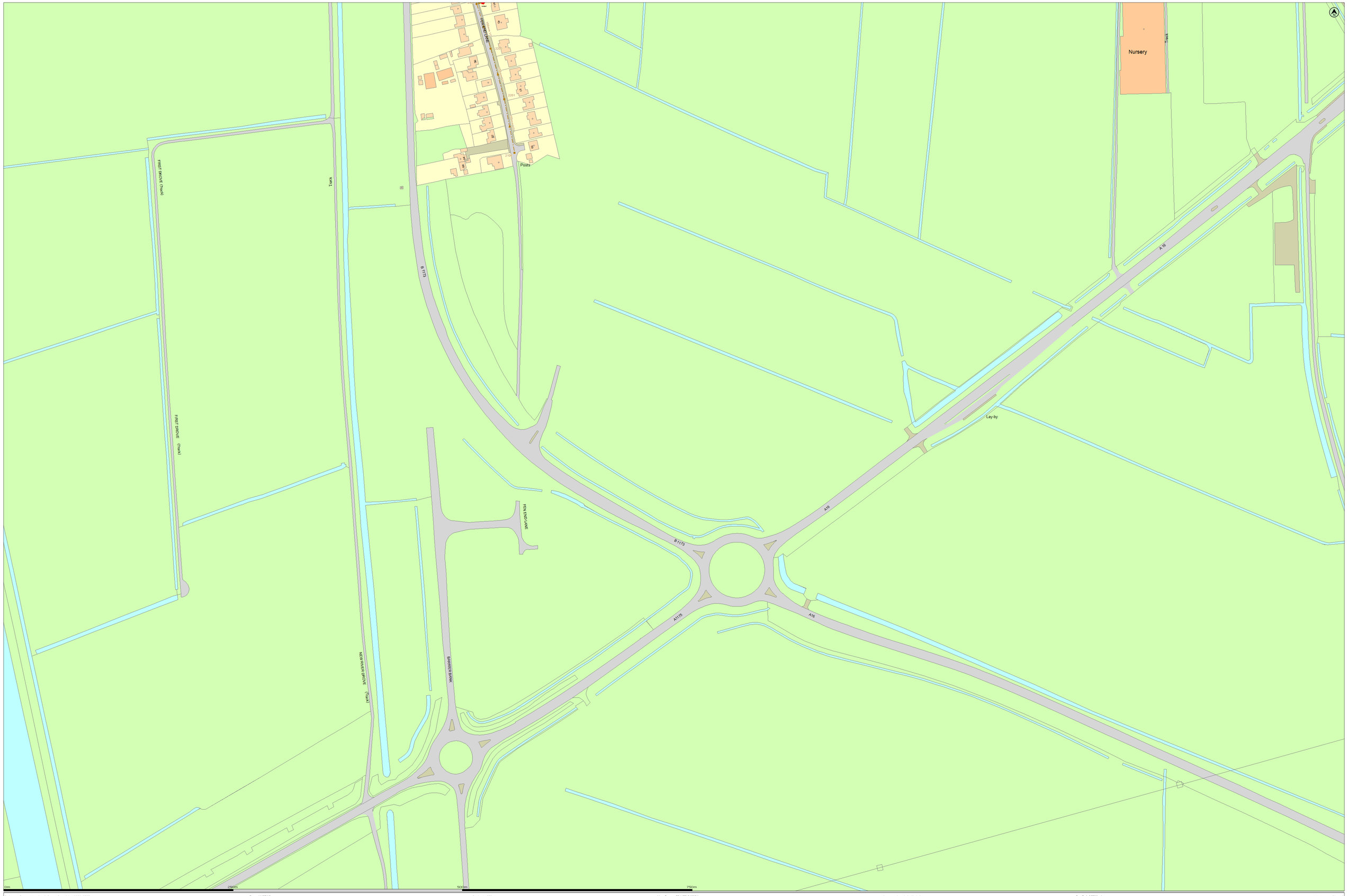
Disclaimer: The information provided within this report is based on the best data currently recorded, recorded within the last 12 months or provided by a third party. The position must be regarded as approximate. If there is further development in the area or for other reasons the position may change.

The accuracy of this report is therefore not guaranteed and does not obviate the need to make additional appropriate searches, inspections and enquiries. You are advised therefore to renew your enquiry should there be a delay in submitting your application for water supply/sewer connection to re-confirm the situation.

Any cost calculations provided within the report are estimated only and may be subject to change.

No liability whatsoever including liability for negligence is accepted by Anglian Water Services Limited for any error or inaccuracy or omission including the failure to accurately record or record at all, the location of any water main, discharge pipe, sewer, or drain or disposal main or any item of apparatus.

Contacting us: If you have any comments or suggestions based on the information provided in this report then please feel free to contact me on 01733 414690.



Ordinance Survey Mapping © Crown Copyright 1000018507

Date: 11/07/13

Scale: 1:1250

Map Centre: 524472,319824

Data updated: 01/04/13

Our Ref: 66786 - 1

Wastewater Plan A0

This plan is provided by Anglian Water pursuant its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. The plan is produced by Anglian Water Services Limited from Ordnance Survey © Crown Copyright, 100018507. This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other uses of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

- Foul Sewer
- Surface Sewer
- Combined Sewer
- Final Effluent
- Rising Main (Colour denotes effluent type)
- Pressure Sewer (Colour denotes effluent type)
- Decommissioned Sewer (Colour denotes effluent type)
- Outfall (Colour denotes effluent type)
- Inlet (Colour denotes effluent type)
- Manhole (Colour denotes effluent type)
- Sewage Treatment Works
- Pumping Station

waynewalker@arpassociates.co.uk

Barrier Bank

anglianwater

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
2100	524299	320144	F	1.725	1.883	1.725
2200	524273	320258	F	2.656	1.244	2.656
2201	524288	320203	F	2.26	1.55	2.26
2301	524258	320307	F	3.74	0.501	3.74

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

A P P E N D I X E

LAND DRIANAGE AUTHORITY CONSULTATION

Allan Poyser

From: Andrew Radcliffe
Sent: Thursday 21 February, 2013 5:07 pm
To: Allan Poyser
Subject: FW: Barrier Bank Spalding
Attachments: FEN END LANE 1.doc

From: Dominic Morris [mailto:Dominic@wlma.org.uk]
Sent: Thursday 21 February, 2013 4:43pm
To: Andrew Radcliffe
Subject: Barrier Bank Spalding

Dear Sirs

Please see attachment regarding the site at Barrier Bank Spalding, the Board have no information on flood levels for this area and do not have any known information on flooding apart from that which has been mentioned in the attachment.

Regards

Dom

Dom Morris
Assistant Engineer, South Holland IDB
dd: +44 (0)1406 421702 | **m:** +44 (0)7920 792389 | **e:** dominic@wlma.org.uk

Water Management Alliance
Kettlewell House, Austin Fields Industrial Estate, King's Lynn, Norfolk, PE30 1PH, UK
t: +44 (0)1553 819600 | **f:** +44 (0)1553 819639 | **e:** info@wlma.org.uk | www.wlma.org.uk

Consisting of:
Broads Drainage Board, East Suffolk Drainage Board, King's Lynn Drainage Board
Norfolk Rivers Drainage Board and South Holland Drainage Board

Defenders of the Lowland Environment

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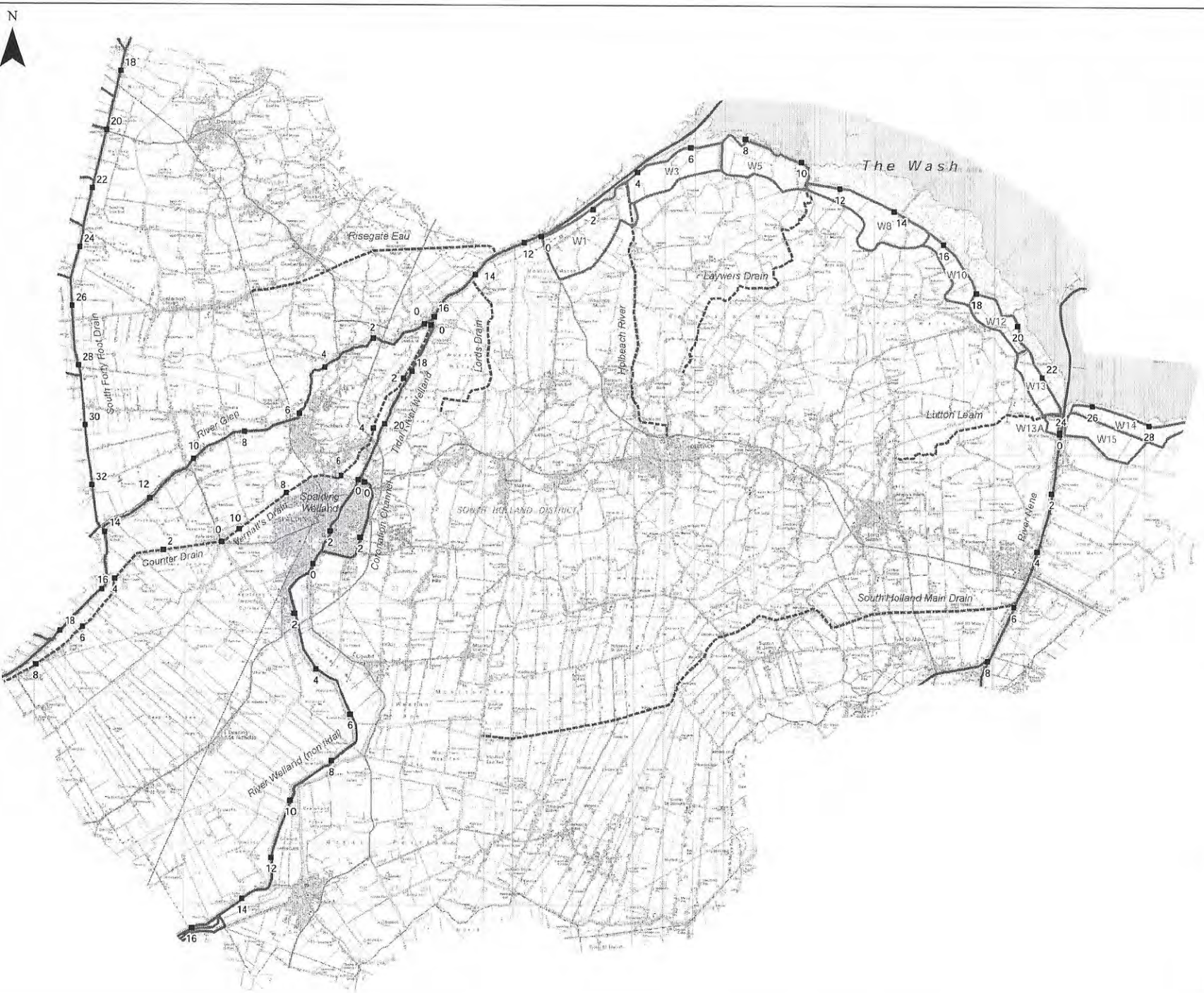
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FEN END LANE SPALDING



THE BOARD HAVE RECENTLY BEEN INVOLVED IN INVESTIGATING A DRAINAGE PROBLEM ALONG THE WEST SIDE OF FEN END LANE. THE PROPERTY OWNERS HAVE BEEN COMPLAINING THAT THERE HAS BEEN STANDING WATER IN THE MAJORITY OF THEIR GARDENS AND FEEL THAT ONE OF THE CAUSES OF THE PROBLEM IS THAT THE OPEN WATERCOURSE SHOWN FROM A-B ON THE MAP ABOVE IS NOT BEING MAINTAINED PROPERLY. ALL THE PIPED AND OPEN WATERCOURSES ARE RIPERIAN OWNED AND IT IS THE DUTY OF EACH ADJACENT RIPERIAN OWNER TO MAINTAIN THEIR SECTION OF WATERCOURSE. IT MAY BE IN YOUR CLIENTS INTEREST TO MAKE SURE THEIR SECTION OF WATERCOURSE IS MAINTAIN CORRECTLY TO ASSIST WITH THEIR FUTURE PLANS.

THE BOARD IS UNAWARE OF ANY OTHER FLOODING ISSUES WITHIN THIS AREA, THE EA MAY HAVE FURTHER INFORMATION ON FLOOD LEVELS AND FLOODING WITHIN THIS LOCATION.



NOTES

Map Legend

- Chainage Points (Km)
- Main River
- IDB Main Drains
- Wash Cells

0 2.5 5 Kilometers

REV	DATE	REMARKS

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SOUTH HOLLAND DISTRICT COUNCIL
COUNCIL OFFICES
PRIORY ROAD
SPALDING
LINCOLNSHIRE
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UPDATE OF STRATEGIC FLOOD RISK ASSESSMENT

Reference Chainages

DATE OF ISSUE: Jan 2010 REV NO:

SCALE: 1:120,000

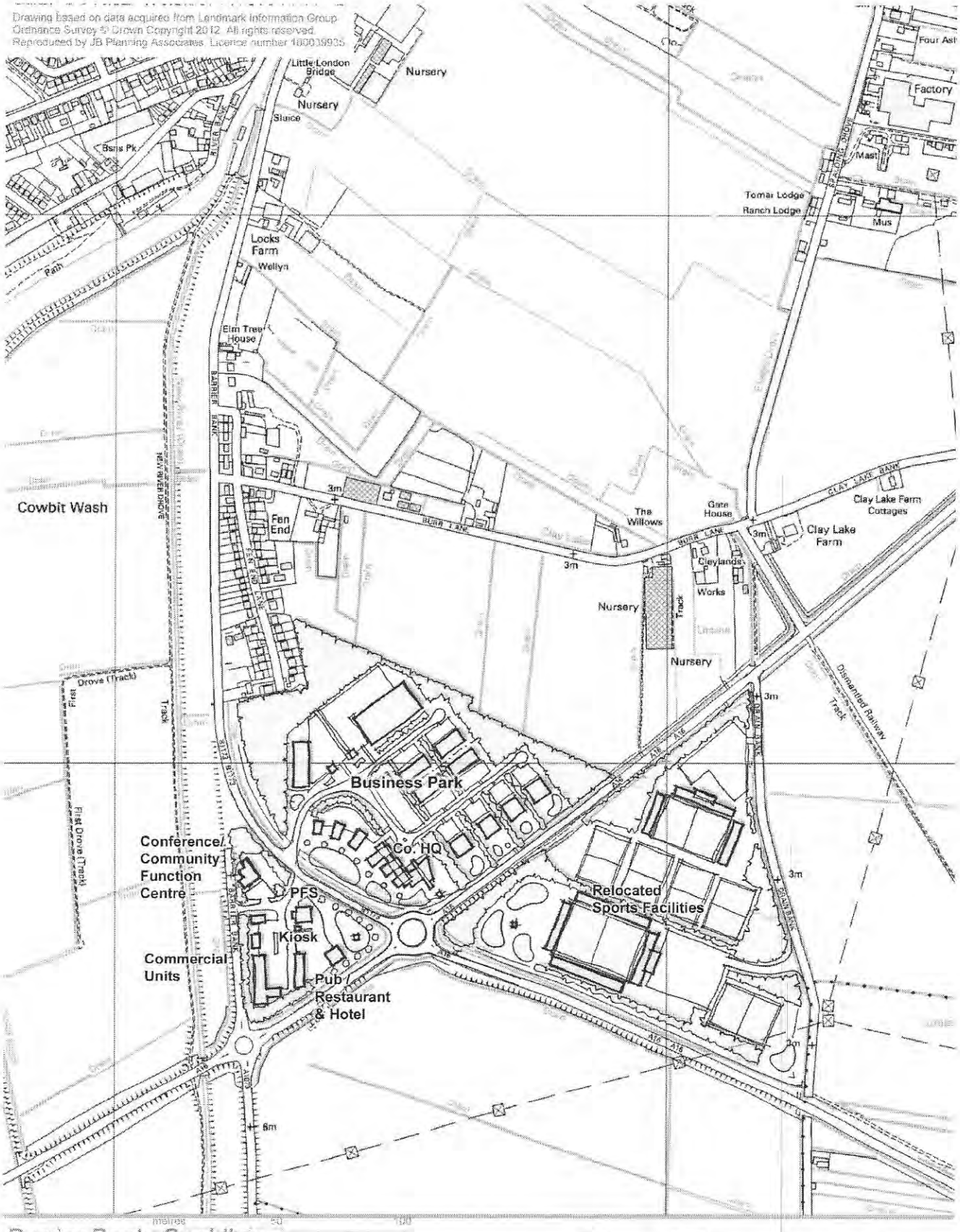
FIGURE NO: 8

Location	Chainage	Peak 1 in 100 year fluvial flood level (mOD)		Peak 1 in 1000 year fluvial flood level (mOD)		Defence crest level (mOD)	Defence type	Freeboard (m) 1 in 100 Year Level		Freeboard (m) 1 in 1000 Year Level	
	(km)	2007	2055/2115	2007	2055/2115			2007	2055/2115	2007	2055/2115
Little London Bridge	0.0	4.42	4.67	4.43	4.68	5.99	Bank with road on crest	1.57	1.32	1.56	1.31
Sluice	0.1	2.40	3.11	3.18	4.10	5.99	Bank with road on crest	3.59	2.88	2.81	1.89
	0.2	2.40	3.11	3.18	4.10	6.04	Bank with road on crest	3.64	2.93	2.86	1.94
	0.3	2.40	3.11	3.18	4.10	6.09	Bank with road on crest	3.68	2.97	2.91	1.99
	0.4	2.40	3.11	3.18	4.10	6.13	Bank with road on crest	3.73	3.02	2.95	2.03
	0.5	2.40	3.11	3.18	4.10	6.18	Bank with road on crest	3.78	3.07	3.00	2.08
	0.6	2.40	3.11	3.18	4.10	6.11	Bank with road on crest	3.71	3.00	2.93	2.01
	0.7	2.40	3.11	3.18	4.10	6.04	Bank with road on crest	3.64	2.93	2.86	1.94
	0.8	2.40	3.11	3.18	4.10	5.98	Bank with road on crest	3.57	2.87	2.80	1.88
Fen End	0.9	2.40	3.11	3.18	4.10	5.91	Bank with road on crest	3.51	2.80	2.73	1.81
	1.0	2.40	3.11	3.18	4.10	5.84	Bank with road on crest	3.44	2.73	2.66	1.74
	1.1	2.40	3.11	3.18	4.10	5.80	Bank with road on crest	3.40	2.69	2.62	1.70
	1.2	2.40	3.11	3.18	4.10	5.77	Bank with road on crest	3.37	2.66	2.59	1.67
	1.3	2.40	3.11	3.18	4.10	5.73	Bank with road on crest	3.33	2.62	2.55	1.63
	1.4	2.40	3.11	3.18	4.10	5.70	Bank with road on crest	3.29	2.59	2.52	1.60
	1.5	2.40	3.11	3.18	4.10	5.66	Bank with road on crest	3.26	2.55	2.48	1.56
	1.6	2.40	3.11	3.18	4.10	5.74	Bank with road on crest	3.34	2.63	2.56	1.64
	1.7	2.40	3.11	3.18	4.10	5.82	Bank with road on crest	3.41	2.71	2.64	1.72
	1.8	2.40	3.11	3.18	4.10	5.89	Bank with road on crest	3.49	2.78	2.71	1.79
	1.9	2.40	3.11	3.18	4.10	5.97	Bank with road on crest	3.57	2.86	2.79	1.87
	2.0	2.40	3.11	3.18	4.10	6.05	Bank with road on crest	3.65	2.94	2.87	1.95
	2.1	2.40	3.11	3.18	4.10	6.03	Bank with road on crest	3.63	2.92	2.85	1.93
	2.2	2.40	3.11	3.18	4.10	6.01	Bank with road on crest	3.61	2.90	2.83	1.91
	2.3	2.40	3.11	3.18	4.10	5.98	Bank with road on crest	3.58	2.87	2.80	1.88
A16 Road Bridge	2.4	2.40	3.11	3.18	4.10	5.96	Bank with road on crest	3.56	2.85	2.78	1.86
	2.5	2.40	3.11	3.18	4.10	5.94	Bank with road on crest	3.54	2.83	2.76	1.84
	2.6	2.40	3.11	3.18	4.10	5.96	Bank with road on crest	3.56	2.85	2.78	1.86
	2.7	2.40	3.11	3.18	4.10	5.98	Bank with road on crest	3.58	2.87	2.80	1.88
	2.8	2.40	3.11	3.18	4.10	6.01	Bank with road on crest	3.61	2.90	2.83	1.91
	2.9	2.40	3.11	3.18	4.10	6.03	Bank with road on crest	3.63	2.92	2.85	1.93
	3.0	2.40	3.11	3.18	4.10	6.05	Bank with road on crest	3.65	2.94	2.87	1.95
	3.1	2.40	3.11	3.18	4.10	6.02	Bank with road on crest	3.62	2.91	2.84	1.92
	3.2	2.40	3.11	3.18	4.10	5.99	Bank with road on crest	3.59	2.88	2.81	1.89

Location	Chainage	Peak 1 in 100 year fluvial flood level (mOD)		Peak 1 in 1000 year fluvial flood level (mOD)		Defence crest level (mOD)	Defence type	Freeboard (m) 1 in 100 Year Level		Freeboard (m) 1 in 1000 Year Level	
	(km)	2007	2055/2115	2007	2055/2115			2007	2055/2115	2007	2055/2115
Marsh Road Sluice	0.0	4.32	4.69	4.34	4.69	5.84	Earth bank	1.52	1.15	1.50	1.15
	0.1	4.32	4.69	4.34	4.69	6.99	Earth bank	2.67	2.30	2.65	2.30
Springfields	0.2	4.32	4.69	4.34	4.69	7.19	Earth bank	2.87	2.50	2.85	2.50
A151 Bridge	0.3	4.32	4.69	4.34	4.69	6.37	Earth bank	2.05	1.68	2.03	1.68
	0.4	4.32	4.69	4.34	4.69	6.16	Earth bank	1.84	1.47	1.82	1.47
	0.5	4.32	4.69	4.34	4.69	6.13	Earth bank	1.81	1.44	1.79	1.44
	0.6	4.32	4.69	4.34	4.69	6.10	Earth bank	1.78	1.41	1.76	1.41
	0.7	4.33	4.69	4.35	4.69	6.06	Earth bank	1.73	1.37	1.71	1.37
	0.8	4.33	4.69	4.35	4.69	5.92	Earth bank	1.59	1.23	1.57	1.23
	0.9	4.33	4.69	4.35	4.69	5.64	Earth bank	1.31	0.95	1.29	0.95
	1.0	4.34	4.69	4.36	4.69	5.58	Earth bank	1.24	0.89	1.22	0.89
	1.1	4.34	4.69	4.36	4.69	5.38	Earth bank	1.04	0.69	1.02	0.69
	1.2	4.34	4.69	4.36	4.69	5.35	Earth bank	1.01	0.66	0.99	0.66
B1165 Bridge	1.3	4.34	4.69	4.36	4.69	5.35	Earth bank	1.01	0.66	0.99	0.66
	1.4	4.34	4.69	4.36	4.69	5.46	Earth bank	1.12	0.77	1.10	0.77
	1.5	4.34	4.69	4.36	4.69	6.00	Earth bank	1.66	1.31	1.64	1.31
	1.6	4.34	4.69	4.36	4.69	5.72	Earth bank	1.38	1.03	1.36	1.03
	1.7	4.35	4.69	4.37	4.69	5.63	Earth bank	1.28	0.94	1.26	0.94
	1.8	4.35	4.69	4.37	4.69	5.35	Earth bank	1.00	0.66	0.98	0.66
	1.9	4.35	4.69	4.37	4.69	5.14	Earth bank	0.79	0.45	0.77	0.45
Disused Railway bridge	2.0	4.35	4.69	4.37	4.69	5.37	Earth bank	1.02	0.68	1.00	0.68
	2.1	4.36	4.69	4.37	4.69	5.40	Earth bank	1.04	0.71	1.03	0.71
Road bridge	2.2	4.36	4.69	4.37	4.69	5.70	Earth bank	1.34	1.01	1.33	1.01
	2.3	4.36	4.68	4.38	4.69	5.56	Earth bank	1.20	0.88	1.18	0.87
	2.4	4.36	4.68	4.38	4.69	5.41	Earth bank	1.05	0.73	1.03	0.72
Road bridge	2.5	4.36	4.68	4.38	4.69	5.33	Earth bank	0.97	0.65	0.95	0.64
	2.6	4.36	4.68	4.38	4.69	5.91	Earth bank	1.55	1.23	1.53	1.22
	2.7	4.36	4.68	4.38	4.69	5.37	Earth bank	1.01	0.69	0.99	0.68
	2.8	4.36	4.68	4.39	4.69	5.80	Earth bank	1.44	1.12	1.41	1.11
	2.9	4.37	4.68	4.39	4.69	5.89	Earth bank	1.52	1.21	1.50	1.20
Spalding Drove bridge	3.0	4.37	4.68	4.39	4.69	5.97	Earth bank	1.60	1.29	1.58	1.28
	3.1	4.37	4.68	4.39	4.69	5.77	Earth bank	1.40	1.09	1.38	1.08
	3.2	4.37	4.68	4.39	4.69	5.85	Earth bank	1.48	1.17	1.46	1.16

A P P E N D I X F

MASTERPLAN LAYOUT



Barrier Bank, Spalding

LOCATION PLAN + SITES 1 & 2 - CONCEPT PLANS

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1219/35
Rev DRAFT VERSION 3
Not to Scale

26/12/12

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A P P E N D I X G

PERCOLATION TEST REPORT

A R P G E O T E C H N I C A L L T D
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Mr M Moran
Moran RAC Limited
Eastlands Court
St Peters Road
Rugby
CV21 3QP

BY E-MAIL

Our Ref: MMO/01/JRPNM

10th July 2013

-- Dear Mr Moran

Barrier Bank, Spalding

In accordance with your instruction, we visited the above site on Tuesday 2nd and Wednesday 3rd July 2013, to carry out percolation tests and calculate infiltration rates to assess the suitability of soakaways for surface water drainage. Tests were implemented at 9No. positions marked SK1 to SK9 on the enclosed plan. The trial pits were excavated to depths of between 1.5m (SK3) and 1.9m (SK8 and SK9), and were generally terminated on encountering water seepages.

Trial Pits

The 9No. trial pits were excavated using a tracked excavator fitted with a 900mm wide bucket and revealed a surface covering, across the majority of the site, of brown silty topsoil. To the south of the site (TP6 to TP8) granular made ground was encountered, to depths of between 0.2m and 0.45m. In TP9 only, natural subsoils were exposed at the surface beneath long grass.

Beneath the topsoil and made ground, and from the surface in TP9 only, generally locally orangey, brown and grey clayey, sandy silt or silty to very silty clay was encountered at every location, to the bases of the trial pits at depths of between 1.5m and 1.9m. In SK7 and SK8 only, a 0.25m to 0.3m thickness of peat was encountered at depths of 1.2m and 1.45m respectively, with further silt or clay beneath. No bedrock was encountered at any location. Water seepages were encountered at the majority of locations, and the trial pits were generally terminated on encountering the seepages.

The trial pit logs are enclosed.

Soakaway Tests

On completion of each excavation, water was discharged quickly into each pit using prefilled 1000ltr tanks, and the water levels were monitored. It was intended to monitor the water levels until a fall below 25% of maximum depth of water was achieved. However, due to generally slow percolation rates, this was not possible.

The readings and curves are enclosed and a summary table of the results is given below:-

Location / Test No. / Material	Water Level Drop / Time	Infiltration Rate (m/s)
SK1 (Test 1)	0.03m in 203 minutes	Very Low*
SK2 (Test 1)	0.04m in 188 minutes	Very Low*
SK3 (Test 1)	0.04m in 153 minutes	Very Low*
SK4 (Test 1)	0m in 153 minutes	Impervious*
SK5 (Test 1)	0.05m in 135 minutes	Very Low*
SK6 (Test 1)	0m in 121 minutes	Impervious*
SK7 (Test 1)	0.24m in 137 minutes	1.46×10^{-5}
SK8 (Test 1)	0.45m in 110 minutes	2.69×10^{-5}
SK8 (Test 2)	0.13m in 90 minutes	2.35×10^{-5}
SK9 (Test 1)	0.05m in 132 minutes	Very Low*

*Due to very low percolation rates, no meaningful infiltration rates could be calculated, and the soils can be classed as very low permeability to practically impervious in these areas.

Some drop in water level was recorded in SK7 and SK8, in the south of the site, resulting in good infiltration rates in these areas. However, as these two pits were the only ones to encounter peat, it is likely that the water was entering the peat horizon, and the sustainability of such flow in the long term is not certain, as the peat may swell with increasing moisture, reducing the infiltration rates.

Conclusion

The results show the majority of locations tested to have poor infiltration rates, or practically impervious ground. In the vicinity of SK7 and SK8, in the south of the site, good infiltration rates were achieved, compatible with the use of soakaways. However, at these locations, the infiltration rates were probably dependent on peat horizons (peat was only encountered in SK7 and SK8). Whether the peat horizons will maintain sufficient infiltration rates in the longer term is not certain. Unless this can be demonstrated, it would be prudent to assume a positive surface water drainage is required for the site.

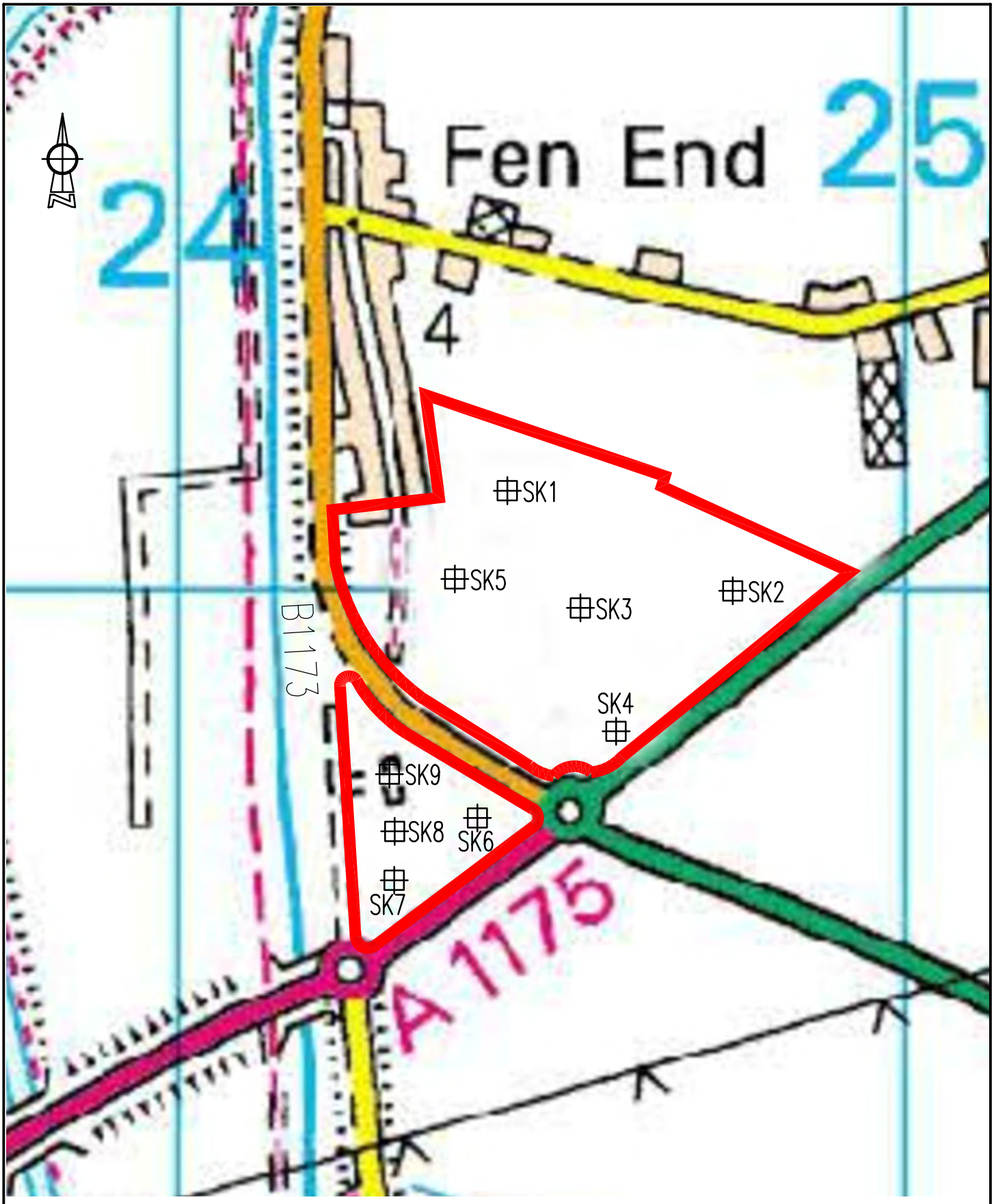
We trust that the above information is satisfactory. However, if you have any queries, please do not hesitate to contact us at your convenience.

Yours sincerely
for ARP GEOTECHNICAL LTD

J Parkinson

Encs

11



OS Grid Reference: TF244198

Rev	By	Date	Amendment	Chk
/			Issued for approval	

Title

SOAKAWAY LOCATION PLAN

Project/Client

BARRIER BANK, SPALDING.
MORAN RAC LTD.

ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS
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Scale	Drawn
NTS @ A4	MW
Date	**Chk.**
JULY 13	JRP

Drg. No.	Rev
MMO/01/SI.02	/

ARP GEOTECHNICAL LIMITED
CHARTERED CONSULTING ENGINEERS

Site	Trial Pit Number
Barrier Bank, Spalding	SK1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
JCB 3CX Backhoe Excavator.			Moran RAC Limited	MMO/01
	Location (Observed measurements)	**Dates** 02/07/2013	**Engineer** ARP Geotechnical	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown silty TOPSOIL.		
					0.30	Soft to firm grey/brown very silty CLAY.		
					(1.65)	...from 1.5m, becoming slightly silty.		1
			Seepage(1) at 1.95m, rose to 1.90m in 10 mins.		1.95	Complete at 1.95m		1

Plan

Remarks

Slight groundwater entry at 1.95m depth.
Sides remained stable.
1No. soakaway test undertaken.
Hole was backfilled with arisings on completion.

Scale (approx)	Logged By	Figure No.
1:20	JRP	MMO/01.SK1

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ARP GEOTECHNICAL LIMITED
CHARTERED CONSULTING ENGINEERS

Site Barrier Bank, Spalding			**Trial Pit Number** SK2
Excavation Method JCB 3CX Backhoe Excavator.	**Dimensions**	**Ground Level (mOD)**	**Client** Moran RAC Limited	**Job Number** MMO/01
	Location (Observed measurements)	**Dates** 02/07/2013	**Engineer** ARP Geotechnical	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown silty TOPSOIL.		
					0.30	Orangey brown and light grey mottled slightly clayey SILT.		
					(1.40)			
			Seepage(1) at 1.70m.		1.70	Complete at 1.70m		1

Plan

Remarks

Slight groundwater entry at 1.7m depth.
Sides remained stable.
1No. soakaway test undertaken.
Hole was backfilled with arisings on completion.

Scale (approx)	Logged By	Figure No.
1:20	JRP	MMO/01.SK2

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Site Barrier Bank, Spalding			**Trial Pit Number** SK3
Excavation Method JCB 3CX Backhoe Excavator.	**Dimensions**	**Ground Level (mOD)**	**Client** Moran RAC Limited	**Job Number** MMO/01
	Location (Observed measurements)	**Dates** 02/07/2013	**Engineer** ARP Geotechnical	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown silty TOPSOIL.		
					0.30	Orangey brown and light grey mottled slightly sandy SILT.		
					(1.20)			
			Seepage(1) at 1.50m.		1.50	Complete at 1.50m		1

Plan

Remarks

Slight groundwater entry at 1.5m depth.
Sides remained stable.
1No. soakaway test undertaken.
Hole was backfilled with arisings on completion.

Scale (approx)	Logged By	Figure No.
1:20	JRP	MMO/01.SK3

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Site Barrier Bank, Spalding			**Trial Pit Number** SK4
Excavation Method JCB 3CX Backhoe Excavator.	**Dimensions**	**Ground Level (mOD)**	**Client** Moran RAC Limited	**Job Number** MMO/01
	Location (Observed measurements)	**Dates** 02/07/2013	**Engineer** ARP Geotechnical	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown silty TOPSOIL.		
					0.30	Soft to firm grey/brown very silty CLAY.		
					(0.80)			
					1.10	Orangey brown and light grey mottled slightly clayey SILT.		1
					(0.65)			
			Seepage(1) at 1.75m, rose to 1.65m in 10 mins.		1.75	Complete at 1.75m		1

Plan

Remarks

Slight groundwater entry at 1.75m depth.
Sides remained stable.
1No. soakaway test undertaken.
Hole was backfilled with arisings on completion.

Scale (approx)	Logged By	Figure No.
1:20	JRP	MMO/01.SK4

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Site Barrier Bank, Spalding			**Trial Pit Number** SK5
Excavation Method JCB 3CX Backhoe Excavator.	**Dimensions**	**Ground Level (mOD)**	**Client** Moran RAC Limited	**Job Number** MMO/01
	Location (Observed measurements)	**Dates** 02/07/2013	**Engineer** ARP Geotechnical	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25)	Brown silty TOPSOIL.		
					0.25	Soft to firm grey/brown very silty CLAY.		
					(1.45)			1
			Seepage(1) at 1.70m, rose to 1.60m in 10 mins.		1.70	Complete at 1.70m		1

Plan

Remarks

Slight groundwater entry at 1.75m depth.
Sides remained stable.
1No. soakaway test undertaken.
Hole was backfilled with arisings on completion.

Scale (approx)	Logged By	Figure No.
1:20	JRP	MMO/01.SK5

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Site Barrier Bank, Spalding			**Trial Pit Number** SK6
Excavation Method JCB 3CX Backhoe Excavator.	**Dimensions**	**Ground Level (mOD)**	**Client** Moran RAC Limited	**Job Number** MMO/01
	Location (Observed measurements)	**Dates** 03/07/2013	**Engineer** ARP Geotechnical	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20)	MADE GROUND: Sand and gravel of brick.		
					0.20	Brown silty TOPSOIL.		
					(0.20)			
					0.40	Soft to firm orangey brown and light grey mottled very silty CLAY.		
					(1.45)			
			Seepage(1) at 1.85m.		1.85	Complete at 1.85m		1

Plan

Remarks

Slight groundwater entry at 1.85m depth.
Sides remained stable.
1No. soakaway test undertaken.
Hole was backfilled with arisings on completion.

Scale (approx)	Logged By	Figure No.
1:20	JRP	MMO/01.SK6

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Site Barrier Bank, Spalding			**Trial Pit Number** SK7
Excavation Method JCB 3CX Backhoe Excavator.	**Dimensions**	**Ground Level (mOD)**	**Client** Moran RAC Limited	**Job Number** MMO/01
	Location (Observed measurements)	**Dates** 03/07/2013	**Engineer** ARP Geotechnical	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.45)	MADE GROUND: Sand, gravel and cobbles of mainly brick and occasional limestone. Trace plastic sheet.		
					0.45	Orangey brown and light grey mottled slightly clayey slightly sandy SILT.		
					(0.75)			
					1.20	Dark brown clayey PEAT.		
					(0.30)			
					1.50	Orangey brown and light grey mottled clayey SILT.		
					(0.30)			
					1.80	Complete at 1.80m		

Plan

Remarks

No groundwater entries.
Sides remained stable.
1No. soakaway test undertaken.
Hole was backfilled with arisings on completion.

Scale (approx)	Logged By	Figure No.
1:20	JRP	MMO/01.SK7

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Site Barrier Bank, Spalding			**Trial Pit Number** SK8
Excavation Method JCB 3CX Backhoe Excavator.	**Dimensions**	**Ground Level (mOD)**	**Client** Moran RAC Limited	**Job Number** MMO/01
	Location (Observed measurements)	**Dates** 03/07/2013	**Engineer** ARP Geotechnical	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25) 0.25	MADE GROUND: Sand and gravel of limestone and occasional brick.		
					(1.20)	Orangey brown and light grey mottled slightly clayey slightly sandy SILT.		
					1.45 (0.25) 1.70	Dark brown clayey PEAT.		
					(0.20) 1.90	Orangey brown and light grey mottled very silty slightly sandy CLAY.		
						Complete at 1.90m		

Plan

Remarks

No groundwater entries.
Sides remained stable.
2No. soakaway tests undertaken.
Hole was backfilled with arisings on completion.

Scale (approx)	Logged By	Figure No.
1:20	JRP	MMO/01.SK8

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Site Barrier Bank, Spalding			**Trial Pit Number** SK9
Excavation Method JCB 3CX Backhoe Excavator.	**Dimensions**	**Ground Level (mOD)**	**Client** Moran RAC Limited	**Job Number** MMO/01
	Location (Observed measurements)	**Dates** 03/07/2013	**Engineer** ARP Geotechnical	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(1.90)	Light brown slightly clayey SILT.		
						...from 1.7m, becoming grey.		1
			Seepage(1) at 1.90m, rose to 1.75m in 10 mins.		1.90	Complete at 1.90m		1

Plan

Remarks

Slight groundwater entry at 1.9m depth.
Sides remained stable.
1No. soakaway test undertaken.
Hole was backfilled with arisings on completion.

Scale (approx)	Logged By	Figure No.
1:20	JRP	MMO/01.SK9

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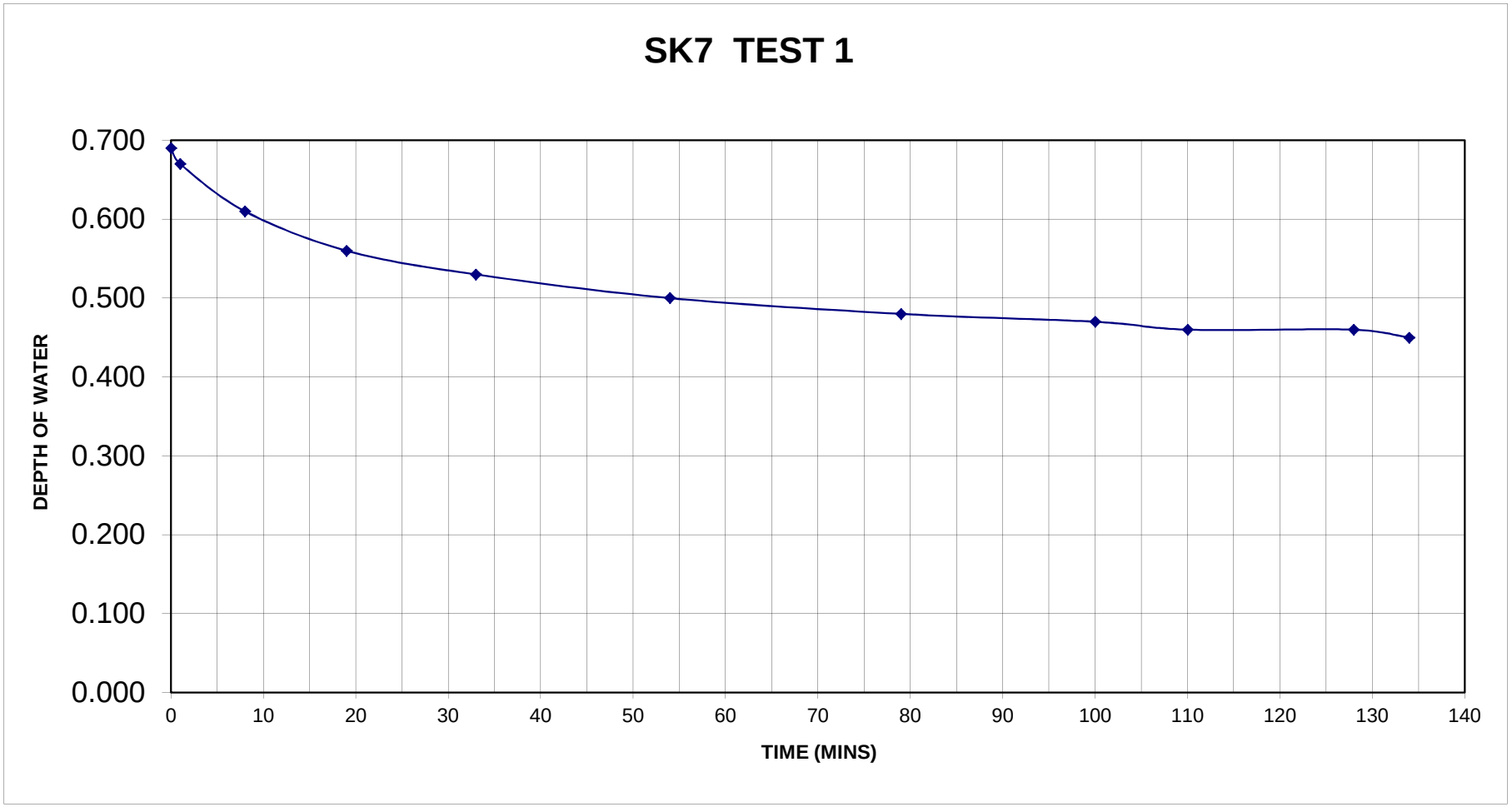
SITE: Barrier Bank, Spalding
CLIENT: Moran RAC Limited
JOB No: MMO/01

PIT DEPTHS	1.77	1.91	1.90
DEPTH READING AT 25% OF MAX. FILLED DEPTH	1.60	1.76	1.74
TEST TAKEN BELOW 25% OF MAX. FILLED DEPTH? (TRU/FALSE) *	FALSE	TRUE	FALSE

SK7 TEST 1	Time (mins)	Depth to Water Level (m.b.g.l)	Depth of water in hole
	0	1.080	0.690
	1	1.100	0.670
	8	1.160	0.610
	19	1.210	0.560
	33	1.240	0.530
	54	1.270	0.500
	79	1.290	0.480
	100	1.300	0.470
	110	1.310	0.460
	128	1.310	0.460
	134	1.320	0.450

SK8 TEST 1	Time (mins)	Depth to Water Level (m.b.g.l)	Depth of water in hole
	0	1.320	0.590
	1	1.330	0.580
	9	1.390	0.520
	23	1.490	0.420
	43	1.580	0.330
	68	1.670	0.240
	88	1.710	0.200
	100	1.740	0.170
	110	1.770	0.140

SK8 TEST 2	Time (mins)	Depth to Water Level (m.b.g.l)	Depth of water in hole
	0	1.270	0.630
	1	1.280	0.620
	5	1.300	0.600
	9	1.330	0.570
	13	1.340	0.560
	31	1.420	0.480
	58	1.520	0.380
	90	1.460	0.283


SK7 TEST 1
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
DEPTH OF WATER
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
TIME (MINS)

SK7 TEST 1

Depth of pit		1.770
Depth to filled water level immediately after filling		1.080
Depth to water or base of pit at finish (see note 3 below)		1.320
Length of hole at max. filled water level		1.900
Length of hole at base		1.000
Average		1.450
Width of hole at surface		0.900
Width of hole at base		0.900
Average		0.900
Maximum effective depth		0.690
	75%	**0.630**
	50%	0.570
	25%	**0.510**
Depth when empty or end of test		0.450
Depth of hole		1.770
50% Effective depth		0.570
Time in mins at 75% effective depth (see curve)		5.000
Time in mins at 25% effective depth (see curve)		50.000

Volume outflowing beween 75% and 25% effective depth: V_{p75}

V_{p75} = 0.16 m^3

Mean surface area through which outflow occurs, taken to be the pit sides to 50% effective depth and including the base of the pit: a_{p50}

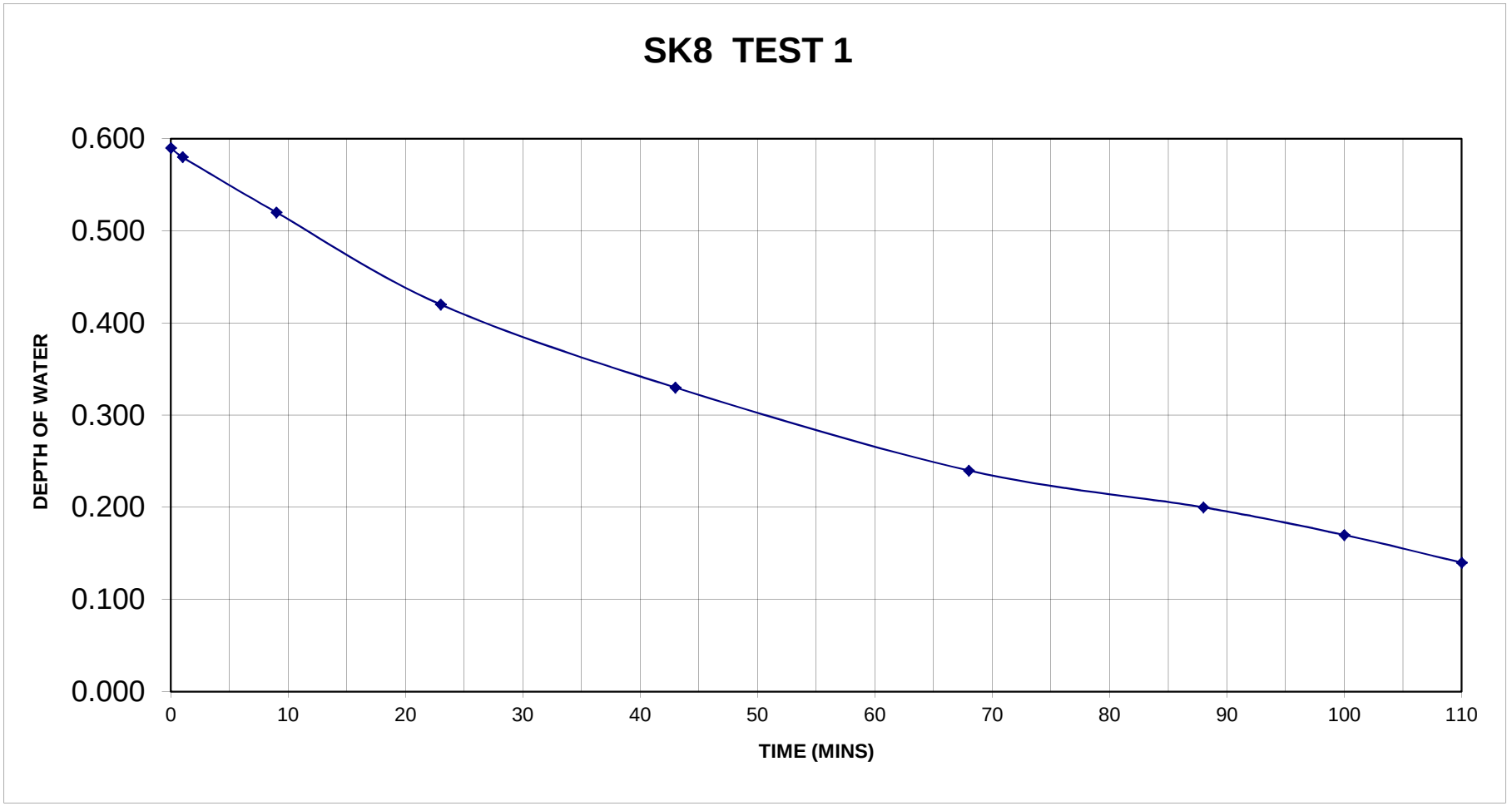
a_{p50} = 3.984 m^2

The time for outflow between 75% and 25% effective depth: t_{p75-25}

t_{p75-25} = 45 minutes

Soil infiltration rate: f

f = 1.46E-05


SK8 TEST 1
0.600
0.500
0.400
0.300
0.200
0.100
0.000
DEPTH OF WATER
0
10
20
30
40
50
60
70
80
90
100
110
TIME (MINS)

SK8 TEST 1

Depth of pit		1.910
Depth to filled water level immediately after filling		1.320
Depth to water or base of pit at finish		1.900
Length of hole at max. filled water level		1.800
Length of hole at base		0.900
Average		1.350
Width of hole at surface		0.900
Width of hole at base		0.900
Average		0.900
Maximum effective depth		0.590
	75%	**0.445**
	50%	0.300
	25%	**0.155**
Depth when empty or end of test		0.010
Depth of hole		1.910
50% Effective depth		0.300
Time in mins at 75% effective depth (see curve)		20.000
Time in mins at 25% effective depth (see curve)		105.000

Volume outflowing beween 75% and 25% effective depth: V_{p75}

$V_{p75 =}$ 0.35 m^3

Mean surface area through which outflow occurs, taken to be the pit sides to 50% effective depth and including the base of the pit: a_{p50}

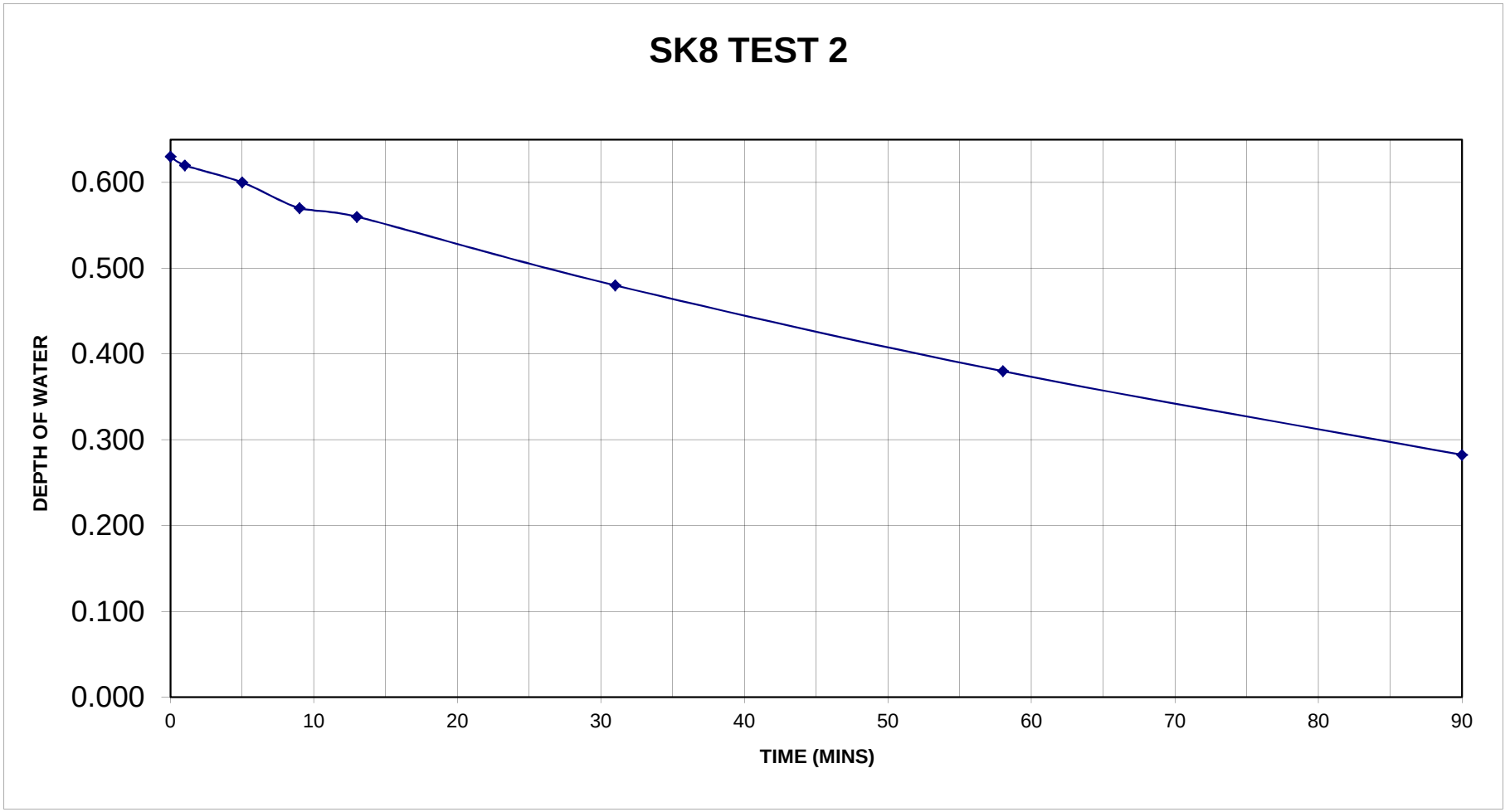
$a_{p50 =}$ 2.565 m^2

The time for outflow between 75% and 25% effective depth: t_{p75-25}

$t_{p75-25 =}$ 85.000 minutes

Soil infiltration rate: f

f = 2.69E-05


SK8 TEST 2
DEPTH OF WATER
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
10
20
30
40
50
60
70
80
90
TIME (MINS)

SK8 TEST 2

Depth of pit		1.900
Depth to filled water level immediately after filling		1.270
Depth to water or base of pit at finish (see note 3 below)		1.460
Length of hole at max. filled water level		1.800
Length of hole at base		0.900
Average		1.350
Width of hole at surface		0.900
Width of hole at base		0.900
Average		0.900
Maximum effective depth		0.630
	75%	**0.583**
	50%	0.535
	25%	**0.488**
Depth when empty or end of test		0.440
Depth of hole		1.900
50% Effective depth		0.535
Time in mins at 75% effective depth (see curve)		8.400
Time in mins at 25% effective depth (see curve)		31.000

Volume outflowing beween 75% and 25% effective depth: V_{p75}

$V_{p75 =}$ 0.12 m^3

Mean surface area through which outflow occurs, taken to be the pit sides to 50% effective depth and including the base of the pit: a_{p50}

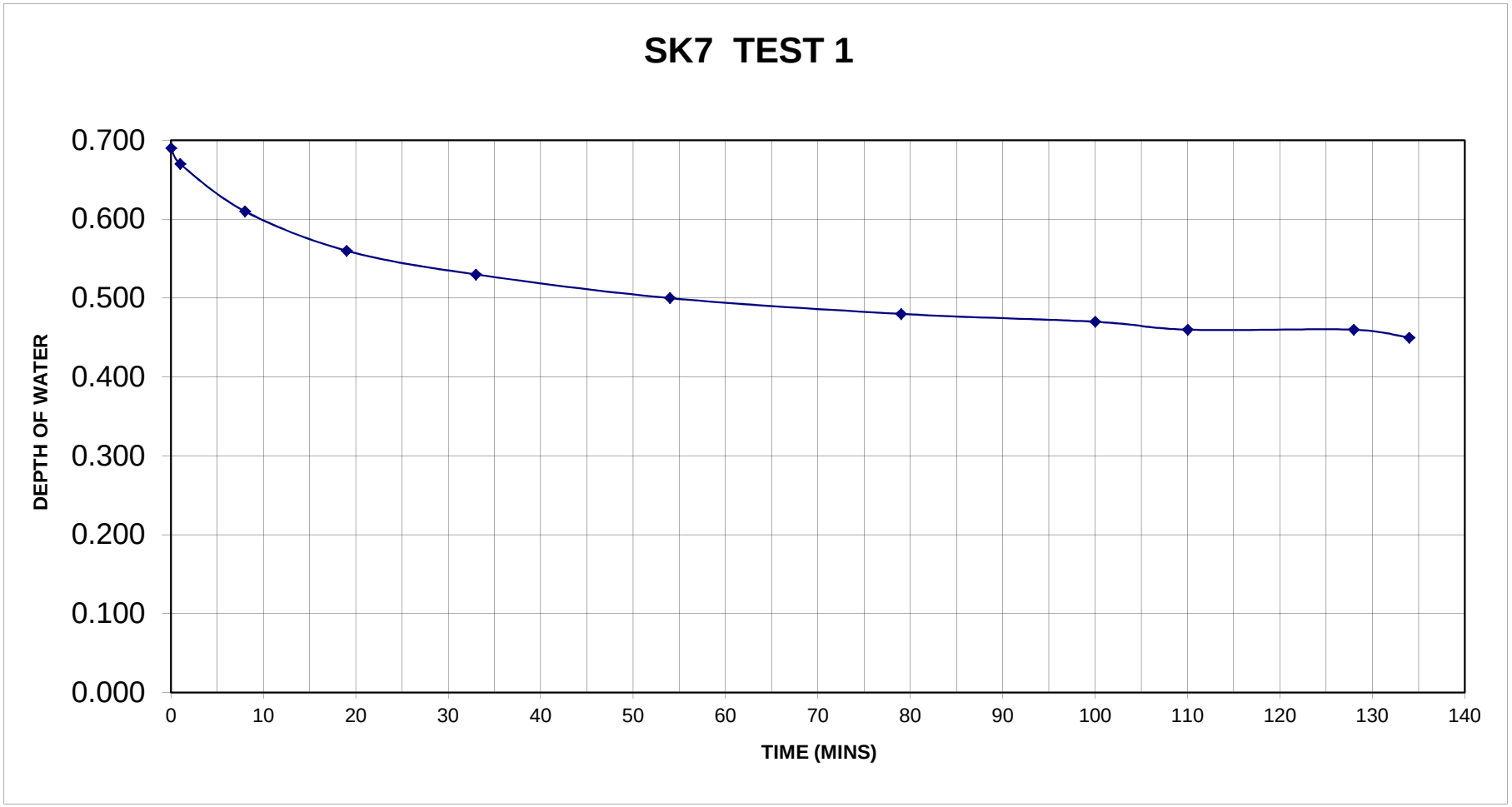
$a_{p50 =}$ 3.6225 m^2

The time for outflow between 75% and 25% effective depth: t_{p75-25}

$t_{p75-25 =}$ 22.6 minutes

Soil infiltration rate: f

f = 2.35E-05


SK7 TEST 1
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
DEPTH OF WATER
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
TIME (MINS)

SK7 TEST 1

Depth of pit		1.770
Depth to filled water level immediately after filling		1.080
Depth to water or base of pit at finish (see note 3 below)		1.320
Length of hole at max. filled water level		1.900
Length of hole at base		1.000
Average		1.450
Width of hole at surface		0.900
Width of hole at base		0.900
Average		0.900
Maximum effective depth		0.690
	75%	**0.630**
	50%	0.570
	25%	**0.510**
Depth when empty or end of test		0.450
Depth of hole		1.770
50% Effective depth		0.570
Time in mins at 75% effective depth (see curve)		5.000
Time in mins at 25% effective depth (see curve)		50.000

Volume outflowing beween 75% and 25% effective depth: V_{p75}

V_{p75} = 0.16 m^3

Mean surface area through which outflow occurs, taken to be the pit sides to 50% effective depth and including the base of the pit: a_{p50}

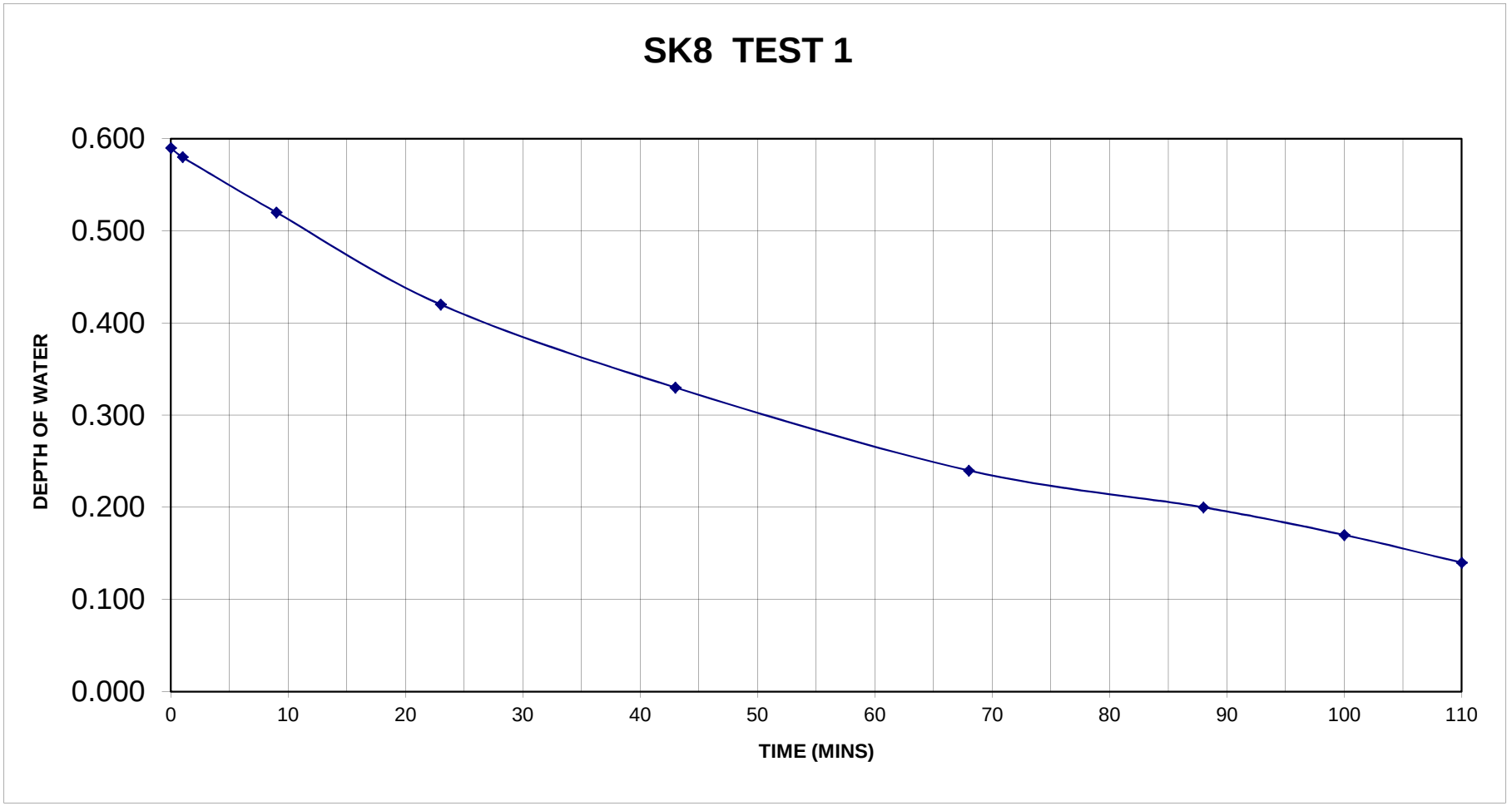
a_{p50} = 3.984 m^2

The time for outflow between 75% and 25% effective depth: t_{p75-25}

t_{p75-25} = 45 minutes

Soil infiltration rate: f

f = 1.46E-05


SK8 TEST 1
0.600
0.500
0.400
0.300
0.200
0.100
0.000
DEPTH OF WATER
0
10
20
30
40
50
60
70
80
90
100
110
TIME (MINS)

SK8 TEST 1

Depth of pit		1.910
Depth to filled water level immediately after filling		1.320
Depth to water or base of pit at finish		1.900
Length of hole at max. filled water level		1.800
Length of hole at base		0.900
Average		1.350
Width of hole at surface		0.900
Width of hole at base		0.900
Average		0.900
Maximum effective depth		0.590
	75%	**0.445**
	50%	0.300
	25%	**0.155**
Depth when empty or end of test		0.010
Depth of hole		1.910
50% Effective depth		0.300
Time in mins at 75% effective depth (see curve)		20.000
Time in mins at 25% effective depth (see curve)		105.000

Volume outflowing beween 75% and 25% effective depth: V_{p75}

$V_{p75 =}$ 0.35 m^3

Mean surface area through which outflow occurs, taken to be the pit sides to 50% effective depth and including the base of the pit: a_{p50}

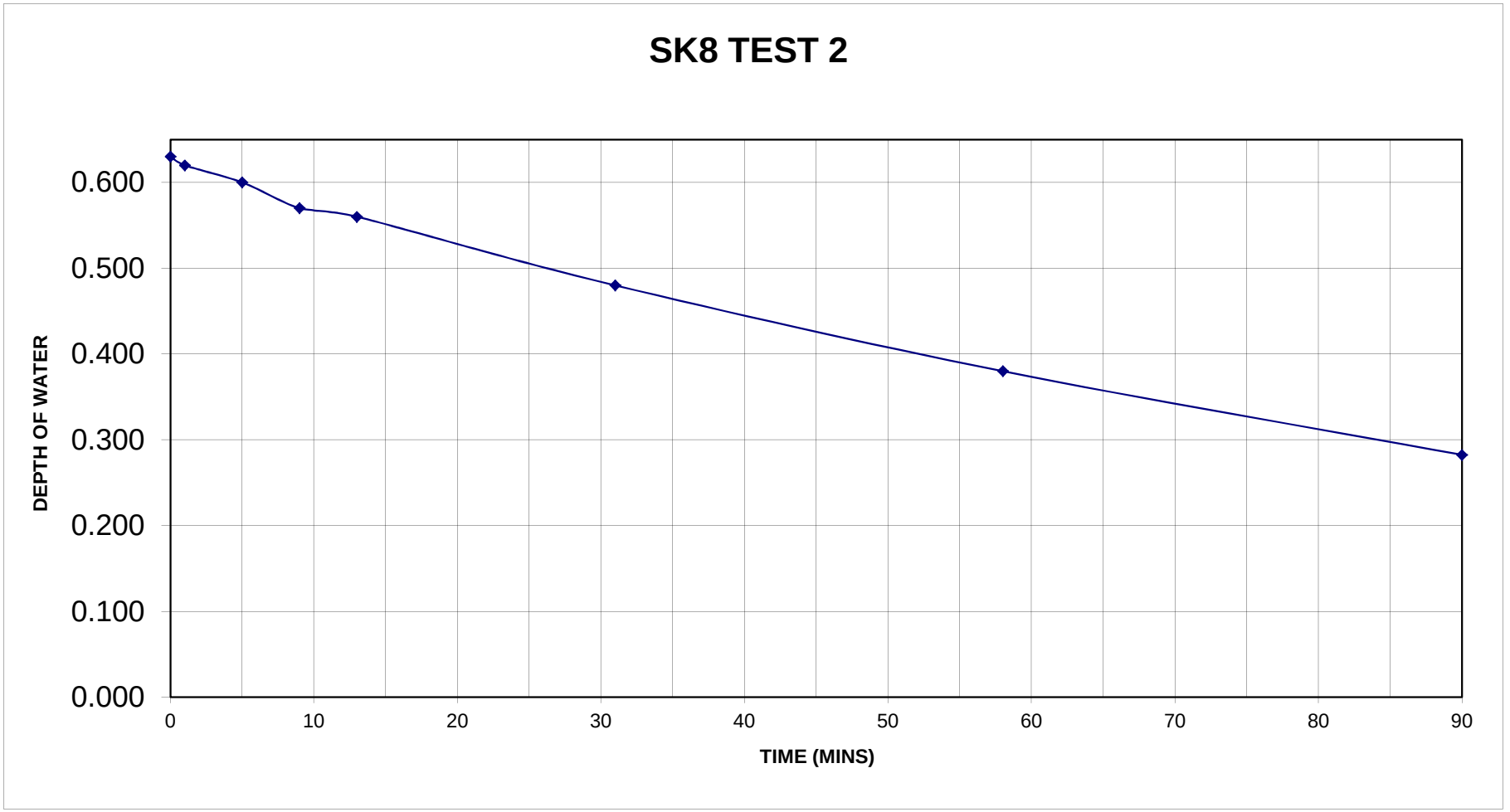
$a_{p50 =}$ 2.565 m^2

The time for outflow between 75% and 25% effective depth: t_{p75-25}

$t_{p75-25 =}$ 85.000 minutes

Soil infiltration rate: f

f = 2.69E-05


SK8 TEST 2
DEPTH OF WATER
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
10
20
30
40
50
60
70
80
90
TIME (MINS)

SK8 TEST 2

Depth of pit		1.900
Depth to filled water level immediately after filling		1.270
Depth to water or base of pit at finish (see note 3 below)		1.460
Length of hole at max. filled water level		1.800
Length of hole at base		0.900
Average		1.350
Width of hole at surface		0.900
Width of hole at base		0.900
Average		0.900
Maximum effective depth		0.630
	75%	**0.583**
	50%	0.535
	25%	**0.488**
Depth when empty or end of test		0.440
Depth of hole		1.900
50% Effective depth		0.535
Time in mins at 75% effective depth (see curve)		8.400
Time in mins at 25% effective depth (see curve)		31.000

Volume outflowing beween 75% and 25% effective depth: V_{p75}

$V_{p75 =}$ 0.12 m^3

Mean surface area through which outflow occurs, taken to be the pit sides to 50% effective depth and including the base of the pit: a_{p50}

$a_{p50 =}$ 3.6225 m^2

The time for outflow between 75% and 25% effective depth: t_{p75-25}

$t_{p75-25 =}$ 22.6 minutes

Soil infiltration rate: f

f = 2.35E-05

A P P E N D I X H

EXISTING GREENFIELD RUN-OFF RATE CALCULATIONS

Larger Northern Site

ARP Associates		Page 1
Northwest House Servia Hill Leeds LS6 2QH		
Date 28/03/2013 08:55 File	Designed by WayneWalker Checked by	
Elstree Computing Ltd	Source Control 2013.1.1	

IH 124 Mean Annual Flood

Input

Return Period (years)	30	Soil	0.300
Area (ha)	50.000	Urban	0.000
SAAR (mm)	565	Region Number	Region 5

Results	l/s
QBAR Rural	70.9
QBAR Urban	70.9
Q30 years	170.4
Q1 year	61.7
Q2 years	63.4
Q5 years	91.5
Q10 years	117.4
Q20 years	148.3
Q25 years	160.4
Q30 years	170.4
Q50 years	201.5
Q100 years	252.5
Q200 years	297.1
Q250 years	311.3
Q1000 years	408.5

Above calculation based on 50ha.

∴ 70.9 l/s ÷ 50 = 1.418 l/s/ha

1.418 × 20.2ha = 28.6 l/s

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Smaller Southern Site

ARP Associates		Page 1
Northwest House Servia Hill Leeds LS6 2QH		
Date 28/03/2013 08:56 File	Designed by WayneWalker Checked by	
Elstree Computing Ltd	Source Control 2013.1.1	

IH 124 Mean Annual Flood

Input

Return Period (years)	30	Soil	0.300
Area (ha)	50.000	Urban	0.000
SAAR (mm)	565	Region Number	Region 5

Results	l/s
QBAR Rural	70.9
QBAR Urban	70.9
Q30 years	170.4
Q1 year	61.7
Q2 years	63.4
Q5 years	91.5
Q10 years	117.4
Q20 years	148.3
Q25 years	160.4
Q30 years	170.4
Q50 years	201.5
Q100 years	252.5
Q200 years	297.1
Q250 years	311.3
Q1000 years	408.5

Above calculation based on 50ha.

∴ 70.9 l/s ÷ 50 = 1.418 l/s/ha

1.418 × 4.5ha = 6.4 l/s

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A P P E N D I X I

INDICATIVE SURFACE WTAER CALCULATIONS

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	100.800	0.800	20.2	2173.3	O K
30 min Summer	101.040	1.040	20.1	2822.7	O K
60 min Summer	101.288	1.288	20.8	3496.6	O K
120 min Summer	101.541	1.541	22.5	4184.2	O K
180 min Summer	101.687	1.687	23.5	4580.6	O K
240 min Summer	101.786	1.786	24.2	4850.2	O K
360 min Summer	101.916	1.916	25.0	5201.2	O K
480 min Summer	102.002	2.002	25.6	5436.1	O K
600 min Summer	102.062	2.062	26.0	5598.4	O K
720 min Summer	102.104	2.104	26.2	5713.2	O K
960 min Summer	102.155	2.155	26.5	5850.3	O K
1440 min Summer	102.178	2.178	26.7	5914.6	O K
2160 min Summer	102.147	2.147	26.5	5828.7	O K
2880 min Summer	102.106	2.106	26.2	5717.0	O K
4320 min Summer	102.011	2.011	25.6	5460.6	O K
5760 min Summer	101.912	1.912	25.0	5191.3	O K
7200 min Summer	101.816	1.816	24.4	4929.9	O K
8640 min Summer	101.724	1.724	23.8	4681.4	O K
10080 min Summer	101.636	1.636	23.2	4442.5	O K
15 min Winter	100.897	0.897	20.2	2435.3	O K
30 min Winter	101.165	1.165	20.2	3163.2	O K
60 min Winter	101.444	1.444	21.9	3919.9	O K
120 min Winter	101.730	1.730	23.8	4695.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	72.014	0.0	1636.0	19
30 min Summer	46.909	0.0	1627.0	34
60 min Summer	29.238	0.0	3184.9	64
120 min Summer	17.704	0.0	3393.1	124
180 min Summer	13.070	0.0	3437.4	184
240 min Summer	10.495	0.0	3483.9	244
360 min Summer	7.666	0.0	3569.4	362
480 min Summer	6.135	0.0	3639.1	482
600 min Summer	5.158	0.0	3690.9	602
720 min Summer	4.475	0.0	3727.8	722
960 min Summer	3.575	0.0	3767.8	962
1440 min Summer	2.602	0.0	3755.9	1440
2160 min Summer	1.892	0.0	7085.1	1816
2880 min Summer	1.508	0.0	6981.2	2192
4320 min Summer	1.094	0.0	6678.4	2984
5760 min Summer	0.871	0.0	10108.8	3808
7200 min Summer	0.729	0.0	10557.7	4616
8640 min Summer	0.631	0.0	10891.9	5456
10080 min Summer	0.558	0.0	10977.0	6264
15 min Winter	72.014	0.0	1653.3	19
30 min Winter	46.909	0.0	1628.0	34
60 min Winter	29.238	0.0	3359.6	64
120 min Winter	17.704	0.0	3468.0	122

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Summary of Results for 30 year Return Period

	Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
180	min Winter	101.895	1.895	24.9	5145.6	O K
240	min Winter	102.009	2.009	25.6	5453.8	O K
360	min Winter	102.158	2.158	26.6	5858.9	O K
480	min Winter	102.259	2.259	27.2	6134.2	O K
600	min Winter	102.331	2.331	27.6	6329.1	O K
720	min Winter	102.384	2.384	27.9	6471.4	O K
960	min Winter	102.451	2.451	28.3	6653.1	O K
1440	min Winter	102.499	2.499	28.6	6786.1	O K
2160	min Winter	102.473	2.473	28.4	6715.4	O K
2880	min Winter	102.417	2.417	28.1	6562.3	O K
4320	min Winter	102.296	2.296	27.4	6232.9	O K
5760	min Winter	102.156	2.156	26.6	5853.6	O K
7200	min Winter	102.016	2.016	25.7	5473.8	O K
8640	min Winter	101.881	1.881	24.8	5107.6	O K
10080	min Winter	101.753	1.753	24.0	4760.6	O K

	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180	min Winter	13.070	0.0	3560.9	182
240	min Winter	10.495	0.0	3644.6	240
360	min Winter	7.666	0.0	3770.0	358
480	min Winter	6.135	0.0	3859.8	476
600	min Winter	5.158	0.0	3922.5	592
720	min Winter	4.475	0.0	3965.4	708
960	min Winter	3.575	0.0	4009.6	936
1440	min Winter	2.602	0.0	3992.0	1384
2160	min Winter	1.892	0.0	7466.8	2012
2880	min Winter	1.508	0.0	7433.7	2280
4320	min Winter	1.094	0.0	7154.9	3200
5760	min Winter	0.871	0.0	11312.9	4144
7200	min Winter	0.729	0.0	11799.2	5040
8640	min Winter	0.631	0.0	12098.3	5888
10080	min Winter	0.558	0.0	11802.9	6760

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 16.200

Time (mins) From:	To:	Area (ha)
0	4	16.200

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Model Details

Storage is Online Cover Level (m) 103.000

Tank or Pond Structure

Invert Level (m) 100.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2715.0	0.700	2715.0	1.400	2715.0	2.100	2715.0
0.100	2715.0	0.800	2715.0	1.500	2715.0	2.200	2715.0
0.200	2715.0	0.900	2715.0	1.600	2715.0	2.300	2715.0
0.300	2715.0	1.000	2715.0	1.700	2715.0	2.400	2715.0
0.400	2715.0	1.100	2715.0	1.800	2715.0	2.500	2715.0
0.500	2715.0	1.200	2715.0	1.900	2715.0		
0.600	2715.0	1.300	2715.0	2.000	2715.0		

Hydro-Brake® Outflow Control

Design Head (m) 2.500 Hydro-Brake® Type Md6 SW Only Invert Level (m) 100.000
Design Flow (l/s) 28.6 Diameter (mm) 178

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.9	1.200	20.2	3.000	31.3	7.000	47.8
0.200	14.6	1.400	21.6	3.500	33.8	7.500	49.5
0.300	19.5	1.600	22.9	4.000	36.2	8.000	51.1
0.400	20.2	1.800	24.3	4.500	38.3	8.500	52.7
0.500	19.8	2.000	25.6	5.000	40.4	9.000	54.2
0.600	19.1	2.200	26.8	5.500	42.4	9.500	55.7
0.800	18.5	2.400	28.0	6.000	44.3		
1.000	19.1	2.600	29.1	6.500	46.1		

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Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	100.723	0.723	20.2	3669.6	O K
30 min Summer	100.949	0.949	20.1	4815.1	O K
60 min Summer	101.185	1.185	20.1	6013.5	O K
120 min Summer	101.427	1.427	21.8	7241.1	O K
180 min Summer	101.567	1.567	22.7	7950.5	O K
240 min Summer	101.662	1.662	23.4	8434.1	O K
360 min Summer	101.788	1.788	24.2	9072.1	O K
480 min Summer	101.878	1.878	24.8	9531.0	O K
600 min Summer	101.945	1.945	25.2	9872.4	O K
720 min Summer	101.997	1.997	25.6	10136.8	O K
960 min Summer	102.072	2.072	26.0	10514.8	O K
1440 min Summer	102.152	2.152	26.5	10923.6	O K
2160 min Summer	102.188	2.188	26.7	11105.4	O K
2880 min Summer	102.174	2.174	26.7	11032.4	O K
4320 min Summer	102.113	2.113	26.3	10725.8	O K
5760 min Summer	102.050	2.050	25.9	10405.9	O K
7200 min Summer	101.987	1.987	25.5	10082.1	O K
8640 min Summer	101.923	1.923	25.1	9759.9	O K
10080 min Summer	101.861	1.861	24.7	9443.1	O K
15 min Winter	100.810	0.810	20.0	4111.2	O K
30 min Winter	101.063	1.063	20.1	5394.8	O K
60 min Winter	101.328	1.328	21.1	6738.6	O K
120 min Winter	101.600	1.600	22.9	8118.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	121.269	0.0	1664.8	19
30 min Summer	79.695	0.0	1599.1	34
60 min Summer	49.937	0.0	3265.5	64
120 min Summer	30.267	0.0	3381.5	124
180 min Summer	22.297	0.0	3493.5	184
240 min Summer	17.851	0.0	3576.4	244
360 min Summer	12.957	0.0	3684.5	364
480 min Summer	10.330	0.0	3756.9	484
600 min Summer	8.659	0.0	3803.6	602
720 min Summer	7.492	0.0	3832.7	722
960 min Summer	5.959	0.0	3854.8	962
1440 min Summer	4.309	0.0	3811.0	1442
2160 min Summer	3.110	0.0	7545.7	2160
2880 min Summer	2.466	0.0	7483.3	2856
4320 min Summer	1.775	0.0	7127.8	3540
5760 min Summer	1.405	0.0	13728.7	4272
7200 min Summer	1.171	0.0	13372.6	5048
8640 min Summer	1.008	0.0	12965.3	5880
10080 min Summer	0.889	0.0	12466.7	6752
15 min Winter	121.269	0.0	1629.3	19
30 min Winter	79.695	0.0	1614.5	34
60 min Winter	49.937	0.0	3324.7	64
120 min Winter	30.267	0.0	3533.8	122

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Summary of Results for 100 year Return Period (+30%)

	Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
180	min Winter	101.757	1.757	24.0	8918.6	O K
240	min Winter	101.865	1.865	24.7	9465.6	O K
360	min Winter	102.008	2.008	25.6	10191.7	O K
480	min Winter	102.112	2.112	26.3	10717.6	O K
600	min Winter	102.190	2.190	26.8	11112.4	O K
720	min Winter	102.250	2.250	27.1	11420.5	O K
960	min Winter	102.339	2.339	27.6	11868.8	O K
1440	min Winter	102.440	2.440	28.2	12381.4	O K
2160	min Winter	102.497	2.497	28.6	12672.4	O K
2880	min Winter	102.499	2.499	28.6	12683.9	O K
4320	min Winter	102.431	2.431	28.2	12336.6	O K
5760	min Winter	102.353	2.353	27.7	11941.2	O K
7200	min Winter	102.273	2.273	27.3	11535.2	O K
8640	min Winter	102.188	2.188	26.7	11104.7	O K
10080	min Winter	102.103	2.103	26.2	10670.7	O K

	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180	min Winter	22.297	0.0	3679.8	182
240	min Winter	17.851	0.0	3779.9	242
360	min Winter	12.957	0.0	3904.6	360
480	min Winter	10.330	0.0	3985.0	478
600	min Winter	8.659	0.0	4035.5	596
720	min Winter	7.492	0.0	4065.9	714
960	min Winter	5.959	0.0	4086.6	950
1440	min Winter	4.309	0.0	4032.0	1412
2160	min Winter	3.110	0.0	8032.9	2096
2880	min Winter	2.466	0.0	7958.9	2764
4320	min Winter	1.775	0.0	7562.3	3976
5760	min Winter	1.405	0.0	14550.3	4496
7200	min Winter	1.171	0.0	14282.8	5408
8640	min Winter	1.008	0.0	13899.0	6320
10080	min Winter	0.889	0.0	13390.5	7264

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 16.200

Time (mins) From:	To:	Area (ha)
0	4	16.200

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Model Details

Storage is Online Cover Level (m) 103.000

Tank or Pond Structure

Invert Level (m) 100.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5075.0	0.700	5075.0	1.400	5075.0	2.100	5075.0
0.100	5075.0	0.800	5075.0	1.500	5075.0	2.200	5075.0
0.200	5075.0	0.900	5075.0	1.600	5075.0	2.300	5075.0
0.300	5075.0	1.000	5075.0	1.700	5075.0	2.400	5075.0
0.400	5075.0	1.100	5075.0	1.800	5075.0	2.500	5075.0
0.500	5075.0	1.200	5075.0	1.900	5075.0		
0.600	5075.0	1.300	5075.0	2.000	5075.0		

Hydro-Brake® Outflow Control

Design Head (m) 2.500 Hydro-Brake® Type Md6 SW Only Invert Level (m) 100.000
Design Flow (l/s) 28.6 Diameter (mm) 178

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.9	1.200	20.2	3.000	31.3	7.000	47.8
0.200	14.6	1.400	21.6	3.500	33.8	7.500	49.5
0.300	19.5	1.600	22.9	4.000	36.2	8.000	51.1
0.400	20.2	1.800	24.3	4.500	38.3	8.500	52.7
0.500	19.8	2.000	25.6	5.000	40.4	9.000	54.2
0.600	19.1	2.200	26.8	5.500	42.4	9.500	55.7
0.800	18.5	2.400	28.0	6.000	44.3		
1.000	19.1	2.600	29.1	6.500	46.1		

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Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	100.794	0.794	3.6	483.4	O K
30 min Summer	101.031	1.031	4.1	627.6	O K
60 min Summer	101.277	1.277	4.5	777.4	O K
120 min Summer	101.528	1.528	5.0	930.6	O K
180 min Summer	101.674	1.674	5.2	1019.2	O K
240 min Summer	101.773	1.773	5.4	1079.6	O K
360 min Summer	101.903	1.903	5.6	1158.8	O K
480 min Summer	101.990	1.990	5.7	1212.1	O K
600 min Summer	102.052	2.052	5.8	1249.4	O K
720 min Summer	102.095	2.095	5.8	1276.1	O K
960 min Summer	102.149	2.149	5.9	1308.9	O K
1440 min Summer	102.180	2.180	5.9	1327.4	O K
2160 min Summer	102.158	2.158	5.9	1313.9	O K
2880 min Summer	102.124	2.124	5.9	1293.3	O K
4320 min Summer	102.038	2.038	5.7	1241.0	O K
5760 min Summer	101.944	1.944	5.6	1184.1	O K
7200 min Summer	101.856	1.856	5.5	1130.0	O K
8640 min Summer	101.773	1.773	5.4	1079.9	O K
10080 min Summer	101.695	1.695	5.2	1032.5	O K
15 min Winter	100.889	0.889	3.8	541.5	O K
30 min Winter	101.155	1.155	4.3	703.3	O K
60 min Winter	101.431	1.431	4.8	871.7	O K
120 min Winter	101.715	1.715	5.3	1044.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	72.014	0.0	269.2	19
30 min Summer	46.909	0.0	304.7	34
60 min Summer	29.238	0.0	605.3	64
120 min Summer	17.704	0.0	669.7	124
180 min Summer	13.070	0.0	709.1	184
240 min Summer	10.495	0.0	735.9	244
360 min Summer	7.666	0.0	770.2	362
480 min Summer	6.135	0.0	792.4	482
600 min Summer	5.158	0.0	807.2	602
720 min Summer	4.475	0.0	816.9	722
960 min Summer	3.575	0.0	826.6	962
1440 min Summer	2.602	0.0	822.1	1440
2160 min Summer	1.892	0.0	1501.1	1816
2880 min Summer	1.508	0.0	1509.9	2188
4320 min Summer	1.094	0.0	1459.7	2984
5760 min Summer	0.871	0.0	2251.3	3808
7200 min Summer	0.729	0.0	2349.8	4616
8640 min Summer	0.631	0.0	2387.0	5448
10080 min Summer	0.558	0.0	2306.2	6256
15 min Winter	72.014	0.0	282.8	19
30 min Winter	46.909	0.0	324.3	34
60 min Winter	29.238	0.0	642.7	64
120 min Winter	17.704	0.0	717.5	122

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Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
180 min Winter	101.880	1.880	5.5	1145.1	O K
240 min Winter	101.994	1.994	5.7	1214.1	O K
360 min Winter	102.143	2.143	5.9	1305.4	O K
480 min Winter	102.246	2.246	6.0	1367.8	O K
600 min Winter	102.319	2.319	6.1	1412.3	O K
720 min Winter	102.373	2.373	6.2	1445.1	O K
960 min Winter	102.443	2.443	6.3	1487.9	O K
1440 min Winter	102.499	2.499	6.4	1522.0	O K
2160 min Winter	102.483	2.483	6.3	1512.4	O K
2880 min Winter	102.437	2.437	6.3	1484.0	O K
4320 min Winter	102.329	2.329	6.1	1418.6	O K
5760 min Winter	102.200	2.200	6.0	1339.7	O K
7200 min Winter	102.071	2.071	5.8	1261.1	O K
8640 min Winter	101.949	1.949	5.6	1187.2	O K
10080 min Winter	101.836	1.836	5.5	1118.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	13.070	0.0	760.3	182
240 min Winter	10.495	0.0	788.8	240
360 min Winter	7.666	0.0	824.8	358
480 min Winter	6.135	0.0	847.7	476
600 min Winter	5.158	0.0	862.7	592
720 min Winter	4.475	0.0	872.5	708
960 min Winter	3.575	0.0	881.5	936
1440 min Winter	2.602	0.0	874.2	1384
2160 min Winter	1.892	0.0	1619.0	2012
2880 min Winter	1.508	0.0	1624.4	2280
4320 min Winter	1.094	0.0	1563.6	3200
5760 min Winter	0.871	0.0	2518.7	4104
7200 min Winter	0.729	0.0	2614.5	5040
8640 min Winter	0.631	0.0	2580.3	5880
10080 min Winter	0.558	0.0	2513.3	6760

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 3.600

Time (mins) From:	To:	Area (ha)
0	4	3.600

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Model Details

Storage is Online Cover Level (m) 103.000

Tank or Pond Structure

Invert Level (m) 100.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	609.0	0.700	609.0	1.400	609.0	2.100	609.0
0.100	609.0	0.800	609.0	1.500	609.0	2.200	609.0
0.200	609.0	0.900	609.0	1.600	609.0	2.300	609.0
0.300	609.0	1.000	609.0	1.700	609.0	2.400	609.0
0.400	609.0	1.100	609.0	1.800	609.0	2.500	609.0
0.500	609.0	1.200	609.0	1.900	609.0		
0.600	609.0	1.300	609.0	2.000	609.0		

Hydro-Brake® Outflow Control

Design Head (m) 2.500 Hydro-Brake® Type Md6 SW Only Invert Level (m) 100.000
Design Flow (l/s) 6.4 Diameter (mm) 84

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	4.4	3.000	7.0	7.000	10.7
0.200	3.1	1.400	4.8	3.500	7.5	7.500	11.0
0.300	2.9	1.600	5.1	4.000	8.1	8.000	11.4
0.400	2.8	1.800	5.4	4.500	8.5	8.500	11.7
0.500	3.0	2.000	5.7	5.000	9.0	9.000	12.1
0.600	3.2	2.200	6.0	5.500	9.4	9.500	12.4
0.800	3.6	2.400	6.2	6.000	9.9		
1.000	4.0	2.600	6.5	6.500	10.3		

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Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	100.716	0.716	3.4	815.9	O K
30 min Summer	100.940	0.940	3.9	1070.5	O K
60 min Summer	101.174	1.174	4.4	1336.8	O K
120 min Summer	101.413	1.413	4.8	1609.9	O K
180 min Summer	101.552	1.552	5.0	1768.0	O K
240 min Summer	101.647	1.647	5.2	1875.9	O K
360 min Summer	101.772	1.772	5.4	2018.8	O K
480 min Summer	101.863	1.863	5.5	2121.9	O K
600 min Summer	101.931	1.931	5.6	2198.9	O K
720 min Summer	101.983	1.983	5.7	2258.9	O K
960 min Summer	102.059	2.059	5.8	2345.3	O K
1440 min Summer	102.143	2.143	5.9	2440.9	O K
2160 min Summer	102.184	2.184	5.9	2488.0	O K
2880 min Summer	102.175	2.175	5.9	2477.8	O K
4320 min Summer	102.125	2.125	5.9	2419.9	O K
5760 min Summer	102.068	2.068	5.8	2356.0	O K
7200 min Summer	102.009	2.009	5.7	2288.4	O K
8640 min Summer	101.949	1.949	5.6	2219.6	O K
10080 min Summer	101.889	1.889	5.5	2152.0	O K
15 min Winter	100.802	0.802	3.6	914.0	O K
30 min Winter	101.053	1.053	4.1	1199.3	O K
60 min Winter	101.315	1.315	4.6	1498.1	O K
120 min Winter	101.585	1.585	5.1	1805.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	121.269	0.0	272.2	19
30 min Summer	79.695	0.0	310.2	34
60 min Summer	49.937	0.0	648.4	64
120 min Summer	30.267	0.0	719.1	124
180 min Summer	22.297	0.0	756.6	184
240 min Summer	17.851	0.0	780.4	244
360 min Summer	12.957	0.0	808.6	364
480 min Summer	10.330	0.0	826.1	484
600 min Summer	8.659	0.0	836.8	602
720 min Summer	7.492	0.0	843.0	722
960 min Summer	5.959	0.0	846.6	962
1440 min Summer	4.309	0.0	833.2	1442
2160 min Summer	3.110	0.0	1654.4	2160
2880 min Summer	2.466	0.0	1637.8	2856
4320 min Summer	1.775	0.0	1550.7	3504
5760 min Summer	1.405	0.0	2937.0	4264
7200 min Summer	1.171	0.0	2901.5	5048
8640 min Summer	1.008	0.0	2829.1	5880
10080 min Summer	0.889	0.0	2723.6	6752
15 min Winter	121.269	0.0	286.9	19
30 min Winter	79.695	0.0	329.2	34
60 min Winter	49.937	0.0	691.2	64
120 min Winter	30.267	0.0	766.6	122

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Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
180 min Winter	101.741	1.741	5.3	1983.5	O K
240 min Winter	101.849	1.849	5.5	2105.6	O K
360 min Winter	101.991	1.991	5.7	2268.1	O K
480 min Winter	102.095	2.095	5.8	2386.2	O K
600 min Winter	102.173	2.173	5.9	2475.1	O K
720 min Winter	102.234	2.234	6.0	2544.8	O K
960 min Winter	102.324	2.324	6.1	2646.9	O K
1440 min Winter	102.428	2.428	6.3	2765.8	O K
2160 min Winter	102.491	2.491	6.4	2837.5	O K
2880 min Winter	102.499	2.499	6.4	2846.7	O K
4320 min Winter	102.442	2.442	6.3	2781.0	O K
5760 min Winter	102.374	2.374	6.2	2703.7	O K
7200 min Winter	102.301	2.301	6.1	2621.3	O K
8640 min Winter	102.223	2.223	6.0	2531.8	O K
10080 min Winter	102.143	2.143	5.9	2440.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	22.297	0.0	806.1	182
240 min Winter	17.851	0.0	831.0	242
360 min Winter	12.957	0.0	860.4	360
480 min Winter	10.330	0.0	878.3	478
600 min Winter	8.659	0.0	889.1	596
720 min Winter	7.492	0.0	895.1	714
960 min Winter	5.959	0.0	897.9	950
1440 min Winter	4.309	0.0	881.6	1412
2160 min Winter	3.110	0.0	1764.3	2096
2880 min Winter	2.466	0.0	1743.0	2764
4320 min Winter	1.775	0.0	1643.9	3976
5760 min Winter	1.405	0.0	3165.7	4496
7200 min Winter	1.171	0.0	3120.3	5408
8640 min Winter	1.008	0.0	3036.8	6320
10080 min Winter	0.889	0.0	2920.3	7264

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 3.600

Time (mins) From:	To:	Area (ha)
0	4	3.600

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Model Details

Storage is Online Cover Level (m) 103.000

Tank or Pond Structure

Invert Level (m) 100.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1139.0	0.700	1139.0	1.400	1139.0	2.100	1139.0
0.100	1139.0	0.800	1139.0	1.500	1139.0	2.200	1139.0
0.200	1139.0	0.900	1139.0	1.600	1139.0	2.300	1139.0
0.300	1139.0	1.000	1139.0	1.700	1139.0	2.400	1139.0
0.400	1139.0	1.100	1139.0	1.800	1139.0	2.500	1139.0
0.500	1139.0	1.200	1139.0	1.900	1139.0		
0.600	1139.0	1.300	1139.0	2.000	1139.0		

Hydro-Brake® Outflow Control

Design Head (m) 2.500 Hydro-Brake® Type Md6 SW Only Invert Level (m) 100.000
Design Flow (l/s) 6.4 Diameter (mm) 84

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	4.4	3.000	7.0	7.000	10.7
0.200	3.1	1.400	4.8	3.500	7.5	7.500	11.0
0.300	2.9	1.600	5.1	4.000	8.1	8.000	11.4
0.400	2.8	1.800	5.4	4.500	8.5	8.500	11.7
0.500	3.0	2.000	5.7	5.000	9.0	9.000	12.1
0.600	3.2	2.200	6.0	5.500	9.4	9.500	12.4
0.800	3.6	2.400	6.2	6.000	9.9		
1.000	4.0	2.600	6.5	6.500	10.3		

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