CAPITA | AECOM

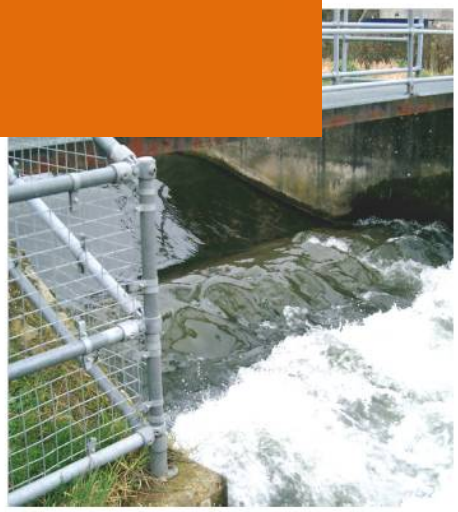
Water and Environment Management Framework
Lot 3 – Engineering and Related Services

Hildenborough Flood Alleviation Scheme

Option Appraisal Report

August 2016

Environment Agency



Document overview

Capita AECOM was commissioned by the Environment Agency in May 2015 to undertake a feasibility assessment, for outline design, of flood alleviation options for properties in Hildenborough, Kent.

Document history

Version	Status	Issue date	Prepared by	Reviewed by	Approved by
1	Draft	5th February 2016	James Walsh Principal Engineer	John Rapley Associate	John Rapley Associate
2	Final	13th April 2016	James Walsh Principal Engineer	John Rapley Associate	Emily Craven Associate
3	Final	8th August 2016	James Walsh Principal Engineer	Emily Craven Associate	Emily Craven Associate

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1. Executive Summary

1.1 Hildenborough Flood Alleviation Scheme

Capita AECOM, formerly Capita URS, was commissioned by the Environment Agency in May 2015 to undertake an options appraisal and outline design of a flood alleviation scheme (FAS) for the village of Hildenborough in Kent. Owing to other wider project drivers, the requirements of the Hildenborough FAS project changed to undertaking a feasibility assessment for outline design which will require further assessment and development in future project stages.

Capita AECOM were required to investigate up to three options, within the Tonbridge School playing fields and neighbouring farmland study area, which vary on a 950m embankment defence option suggested by the Environment Agency, to alleviate flooding from the Hawden Stream, Hilden Brook and River Medway in the Hildenborough area.

As part of the feasibility assessment for outline design, the following assessments were undertaken and data obtained:

- Topographical survey in the vicinity of the proposed flood defence;
- Hydraulic model flood levels for the River Medway, and hydrological assessments of the Hilden Brook and Hawden Stream;
- Geotechnical assessment for the study area; and
- Environmental assessment of the study area.

The geotechnical assessment suggested that the geology beneath the proposed flood defence alignment is largely Alluvium. However, there are greater volumes of River Terrace Deposits near the Hilden Brook watercourse. The Alluvium has a low permeability and as such would provide a suitable foundation for construction of an earth embankment; whereas the River Terrace Deposits have a higher permeability and would require the installation of a cut-off, such as sheet piles, to avoid seepage under the defence.

The environmental assessment identified a number of issues that require mitigation to ensure adverse impacts on the environment. Some of the more significant issues include: the presence of great crested newts in vicinity of the proposed flood defence and potential for impacting of habitats along the Hilden Brook with the installation of sheet piles.

The flood levels determined as part of the River Medway hydraulic model compared with the topography made it apparent that a 950m long embankment would leave the Hawden Oast property susceptible to flooding. As a consequence, the flood embankment has been extended to a length of approximately 1.25km. The raised defences tie into high ground at either end and require a flow control structure where the defence crosses the Hawden Stream. The defence would also require the inclusion of large pumps (total capacity of $2m^3/s$) to discharge flood waters from the Hawden Stream, as identified in Options 2 and 3 in Sections 7.1.2 and 7.1.3.

With limited hydraulic modelling data available during the design process, feasibility assessments for outline design have been based largely on hydrological data and flood levels on the River Medway. Consequently, it has not been possible to determine the effectiveness of the flood defence options. Options 2 and 3 appear to be suitable at preventing flooding of the Hildenborough properties from the River Medway. However, whilst the proposed pumps should be sufficient to ensure that flooding from the peak flows in the Hawden Stream was no worse than at present, it is not possible to determine whether the pumped $2m^3/s$ would be able to keep flood water levels below property threshold levels throughout Hildenborough without further and more detailed hydraulic modelling.

2. Introduction

2.1 Brief

Capita AECOM, formerly Capita URS, was commissioned by the Environment Agency in May 2015 to undertake an options appraisal and outline design of a flood alleviation scheme (FAS) for the village of Hildenborough in Kent.

Please note: since project award, other wider project drivers has resulted in a requirement to present the Strategic Outline Case for Hildenborough FAS, as part of the wider Medway FSA project, in February 2016, prior to completion of the hydraulic modelling. Consequently, this report provides a feasibility assessment for outline design and will require further assessment and development in future project stages.

Prior to tendering for this project, the Environment Agency identified a possible flood alleviation solution with a 950m long flood embankment within Tonbridge School playing fields and neighbouring farmland. The Environment Agency has subsequently approached the respective landowners to advise that this option is being considered further. As such, Capita AECOM were required to investigate up to three options, within the Tonbridge School playing fields and neighbouring farmland study area, which vary on this 950m embankment to alleviate flooding from the Hawden Stream, Hilden Brook and River Medway in the Hildenborough area. The suggested embankment location is presented in Figure 1.

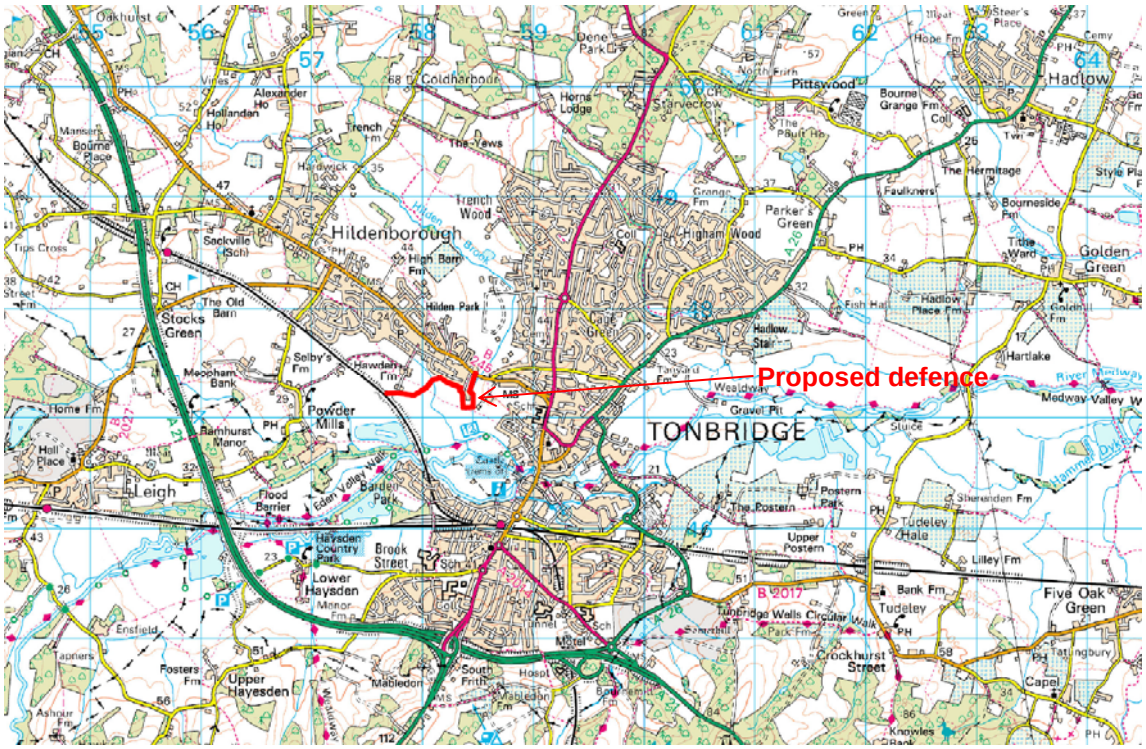

Figure 1: Site location plan showing the proposed defence relative to Hildenborough

2.2 Background

The village of Hildenborough, near Tonbridge, is situated at the confluence of three water courses: the River Medway, Hawden Stream and Hilden Brook. During December 2013 properties within the Hildenborough area experienced fluvial flooding. The actual number of properties flooded during this time is unknown but it is understood from the Environment Agency that in the region of 180 were affected. It is estimated that a total of 185 homes in Hildenborough are at risk of fluvial flooding from 1 in 100 year, including allowance for climate change, flood event. The flood extent for 1 in 100 year, including allowance for climate change, flood event is illustrated in Figure 2.

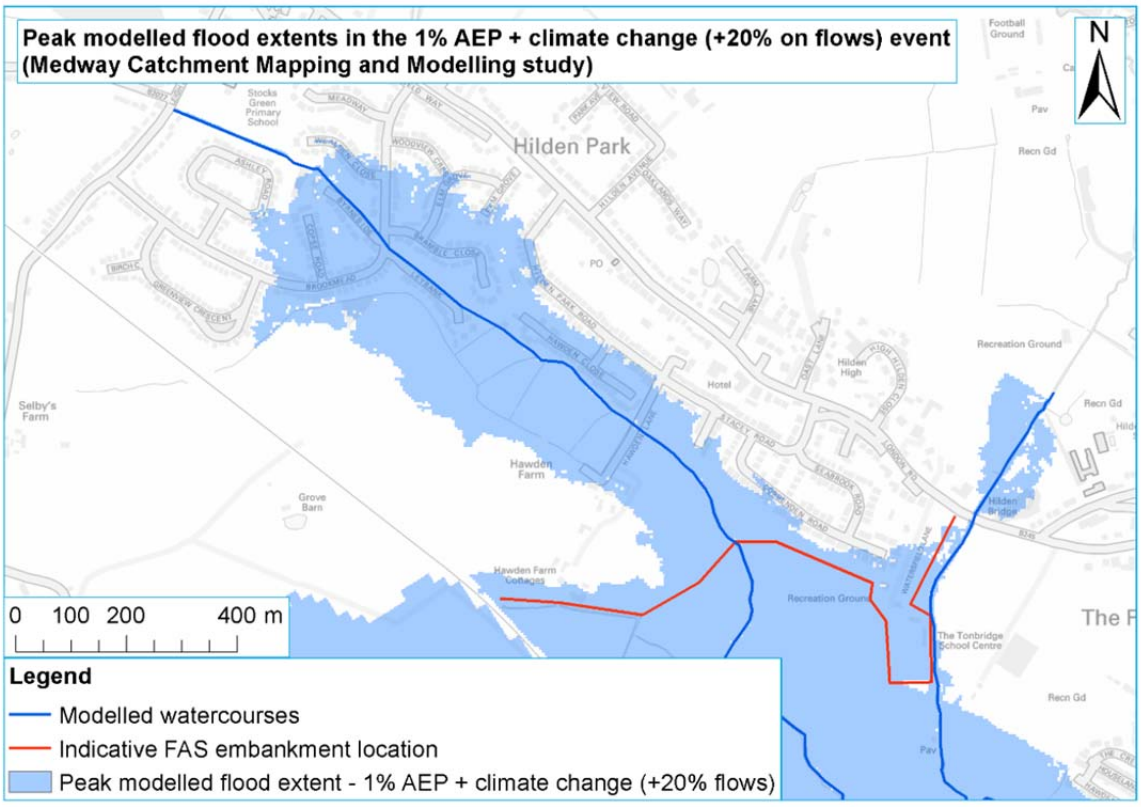

Figure 2: Flood extent for 1 in 100 year, including allowance for climate change, flood event

2.2.1 Catchment Watercourses

The Hawden Stream and Hilden Brook are tributaries of the River Medway, which is the largest of the three watercourses in the study area.

The Hawden Stream joins Hilden Brook approximately 500m upstream of the confluence with the River Medway. The Hilden Brook catchment is rural and drains an area of 17.7km^2.

The Hawden Stream catchment, upstream of the proposed flood defence, is approximately 2.3km^2. The Hawden Stream runs through some urbanised area and is culverted through a

600mm diameter pipe for a length of approximately 490m, 600m upstream of the proposed defence.

2.2.2 Medway FSA

Following on from the Middle Medway Strategy, the Medway FSA project is aimed at developing options to reduce the risk of flooding to communities in the vicinity of the middle Medway through the Initial Assessment process. These communities include Tonbridge, Hildenborough, Yalding and Collier Street, through an Initial assessment.

The Hildenborough FAS project links to the wider Medway FSA project, due to some of the benefits between the two projects being shared. At the next project stage, Outline Business Case, the benefits of the two projects are expected to be assessed together.

2.3 Objectives

The objectives for the Hildenborough FAS project are as follows:

1. Identify options to provide a 1 in 100 year including allowance for climate change standard of protection to properties within Hildenborough that are at risk of flooding from the River Medway, Hawden Stream and Hilden Brook.
2. Select a preferred option to take forward to the next stage of project development.
3. Ensure that the preferred option will not have any detrimental impact on the environment.

3. Information and Data Received

3.1 Data Provided by the Environment Agency

The following information and data was provided by the Environment Agency to aid design development:

- Topographical survey cross sections on the Hilden Brook and Hawden Stream (outside of proposed study area);
- Photographs of the December 2013 floods;
- Threshold levels of properties in Hildenborough that experienced flooding;
- Drainage network plan for Hildenborough;
- ARC GIS data for the Hildenborough study area;
- Bat Roost Potential survey notes, dated 14/08/15.
- Strategic Environment Assessment for The Middle Medway Strategy Study for Flood Risk Management Scheme;
- Land registry information for the study area;
- Ground investigation information held by Tonbridge School;

3.2 Data Obtained by Capita AECOM

The following information and data was obtained by the Capita AECOM to aid design development:

- A topographical survey in the vicinity of the proposed flood defence alignment, and cross sections of the Hawden Stream and Hilden Brook. The survey extent is present in Appendix A;
- Geological records and a Landmark Envirocheck Report for the study area;
- Services searches in the vicinity of the proposed flood defence alignment;
- Trial pits and window samples along the proposed flood defence alignment;
- Hydrological and hydraulic modelling data from JBA Consulting:
    - 2015s3163 - Task 1 - 1% Annual Exceedance Probability (AEP) + allowance for Climate Change (CC) peak flood extent (from Environment Agency mapping study)
    - 2015s3163 - Task 1 - 1% AEP +CC water levels adjacent to proposed embankment (from Environment Agency mapping study)
    - Flood Estimation Calculation Record

3.3 Implications of Data Received on Design Development

The items of data received that have a significant bearing on the development of the design are presented in Table 1.

Item	Comment
22.9mAOD lowest property threshold	Flooding upstream of the defence should be limited to the lowest property threshold level
Southern Water foul water rising main beneath Tonbridge School playing field	Southern Water has advised that construction over their asset should not take place. Refer to Appendix B for details

Table 1: Significant design implications from data received

4. Hydraulic Modelling

4.1 Hydrological and Hydraulic Modelling Approach

The hydrology and hydraulic modelling of the Hildenborough FAS has been undertaken by Jeremy Benn Associates (JBA Consulting). The scope for the modelling, prepared by Capita AECOM, is summarised below in Section 4.1.1. The intention of this scope was to obtain a level of understanding of the scheme hydrology and hydraulics that is appropriate to inform concept and outline design.

The hydraulic model used to inform flood risk within Tonbridge for the Medway Catchment Mapping and Modelling study ('Model 2') is the basis of this commission. This 1D-2D ISIS-TUFLOW model has a grid size resolution of 5m within Tonbridge and along Hilden Brook and Hawden Stream, and 20m upstream of the railway line at Tonbridge and also downstream of Cannon Lane/Vale Road in Tonbridge. Throughout the modelling process JBA Consulting used LiDAR data for the topography of the catchment.

4.1.1 Hydrological & Hydraulic Modelling Scope

Following a meeting held on 26th June 2015 between AECOM and the Environment Agency, it was agreed that the approach to modelling should be suitable to enable assessment of the defence height, the likely control structure size and the likely size of any pump required. As such, the scope for modelling to be undertaken by JBA was as follows:

1. *Provide the 100yr and/or 100yr +CC flood levels (as per JBA Medway model) on the floodplain near Hildenborough, to include expected inflows from the Hilden Brook and the Hawden Stream. This information is expected to be provided as early as possible.*
2. *Provide baseline flood risk modelling results for the River Medway, Hilden Brook and Hawden Stream for 5No. return periods on each watercourse, which are to be agreed (one of which will be the Probable Maximum Flood on Hawden Stream).*
3. *Summarise baseline flood risk modelling (items 1 and 2 above, although the results of item 1 are expected earlier) within a technical note and provide model outputs.*
4. *Following the provision of the embankment design options by AECOM, JBA are required to model 3No. events (to be confirmed) in the Hawden Stream through an outlet structure, sized broadly on the existing channel, using varying downstream conditions. The likely combinations are as follows:*
    a. *1yr conditions in the Hawden Stream with the flow control being flood locked;*
    b. *PMF in the Hawden Stream through the control structure with 1yr conditions in the River Medway;*
    c. *100yr + CC conditions in the Hawden Stream through the control structure with 1yr conditions in the River Medway.*
5. *Advise on freeboard requirements for each of the proposed options.*

4.2 Modelling and Hydrology Results

At the time of preparation of this report, the results for the hydraulic model simulations were not available. Consequently, the Hildenborough FAS feasibility assessment for outline design presented in this report is based on the following:

- Flood levels for a 1 in 100 year + climate change event in the River Medway; and
- Hydrological data for the River Medway, Hawden Stream and Hilden Brook.

4.2.1 *River Medway 1 in 100 year + CC flood levels*

The River Medway is by far the largest of the three watercourses in the vicinity of Hildenborough and has the greatest influence on the flood levels. The change in water levels with time is shown in Figure 3, and flood levels along the proposed flood defence alignment are presented in Appendix C. The flood level design has therefore been based on a River Medway 1 in 100 year + CC flood level of 23.43mAOD.

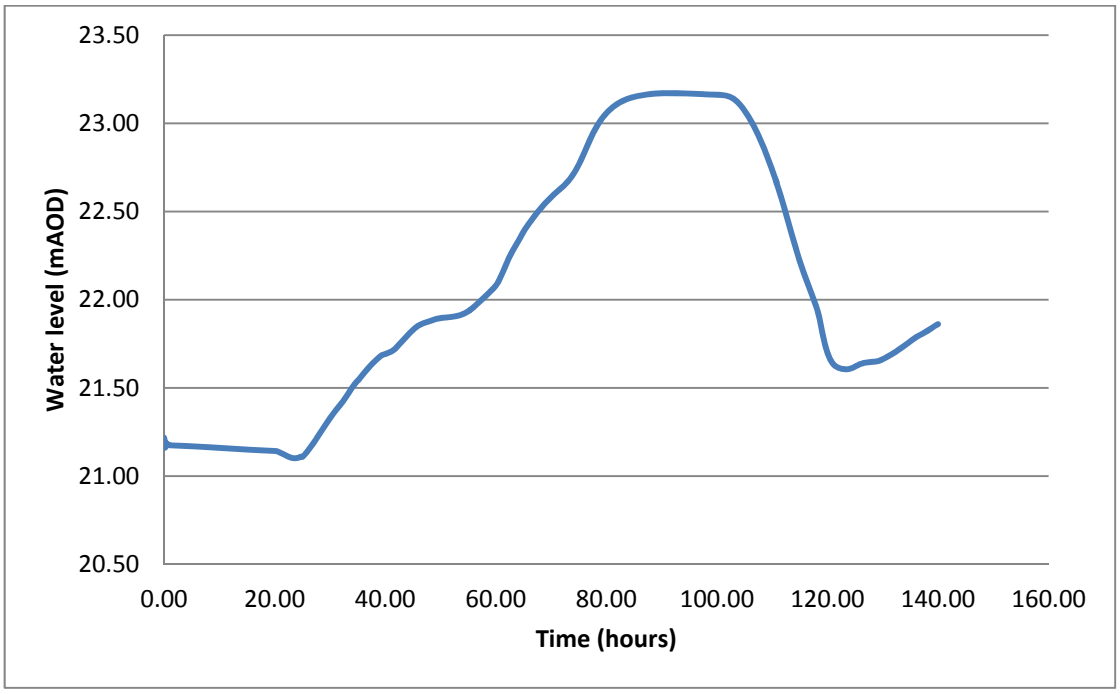

Figure 3: Undefended River Medway flood levels during a 1 in 100 + CC year event

4.2.2 *Hydrology*

From the continuous simulation (CS) hydrology, JBA Consulting were able to identify 1 in 5 year, 1 in 100 year and 1 in 1000 year hydrographs for:

- Outflows from the Leigh Flood Storage Area (FSA) on the Medway upstream of Tonbridge and Hildenborough;
- Hilden Brook; and
- Hawden Stream.

This gave nine design events (three focused on each watercourse – referred to as the subject watercourse). **At this stage, the hydrographs and outputs for the 100-year+CC events have not been supplied by JBA Consulting. Consequently, climate change is not included within the references to peak flows.**

Two options for CS events for a given return period were provided by JBA Consulting – one slightly larger and one slightly smaller than the return period event, referred to as ‘event 1’ and ‘event 2’. This was intended to show the variability within the simulation, which suggests that there could be significantly different flows on Hilden Brook/Hawden Stream for a given flow on the River Medway. This implies that there is not one set of flows on the Hawden Stream or Hilden Brook that corresponds with a 1 in 100 yr + CC event in the Medway. For this reason,

the more conservative ‘event 1’ results have been used for assessment of peak flows and flood volumes in Hilden borough, as identified in this report. The ‘event 1’ hydrological input will subsequently be used within the hydraulic model simulations.

The 1 in 100 year event peak flow results on each watercourse, corresponding to the given subject watercourse, are presented in Table 2. This shows that the largest peak flows are generally experienced when the River Medway is the subject watercourse.

	Peak Flows		
	River Medway	Hawden Stream	Hilden Brook
River Medway subject focus	172m^3/s	4.66m^3/s	26.8m^3/s
Hawden Stream subject focus	79.2m^3/s	4.11m^3/s	20.7m^3/s
Hilden Brook subject focus	62.2m^3/s	4.12m^3/s	17.1m^3/s

Table 2: 1 in 100 year peak flows within each watercourse, corresponding to the given subject watercourse

A separate hydrological assessment was undertaken by JBA Consulting in parallel with the CS assessment, which used the Revitalised Flood Hydrograph (ReFH) method for the Hilden Brook and Hawden Stream. The ReFH assessment results for the Hilden Brook and Hawden Stream as subject focused watercourses were: 16.1m^3/s and 2.9m^3/s respectively. Although the CS Hilden Brook subject focus peak flow of 17.1m^3/s (Table 2) is slightly higher than the ReFH result, the CS Hawden Stream subject focus peak flow of 4.11m^3/s suggests is significantly higher than that obtained by the CS method. However, the CS hydrological assessment is the preferred, more conservative, method based on the justification by JBA Consulting below:

- *The continuous simulation hydrological approach is suitable approach for predicted hydrological inputs for smaller watercourses such as Hilden Brook and Hawden Stream.*
- *The standard guidance on producing the hydrological inputs e.g. time to peak adjustments made for Hawden Stream based on Hilden Brook data are informed from FEH recommended adjustments have been followed.*
- *Without gauged information on Hawden Stream it is not possible to refine the hydrological inputs further.*

The CS hydrograph for the 1 in 100 year event, with the River Medway as the subject watercourse, is shown in Figure 4. From this it is apparent that the peak flows in the Hawden Stream and Hilden Brook occur noticeably before the peak flow on the River Medway.

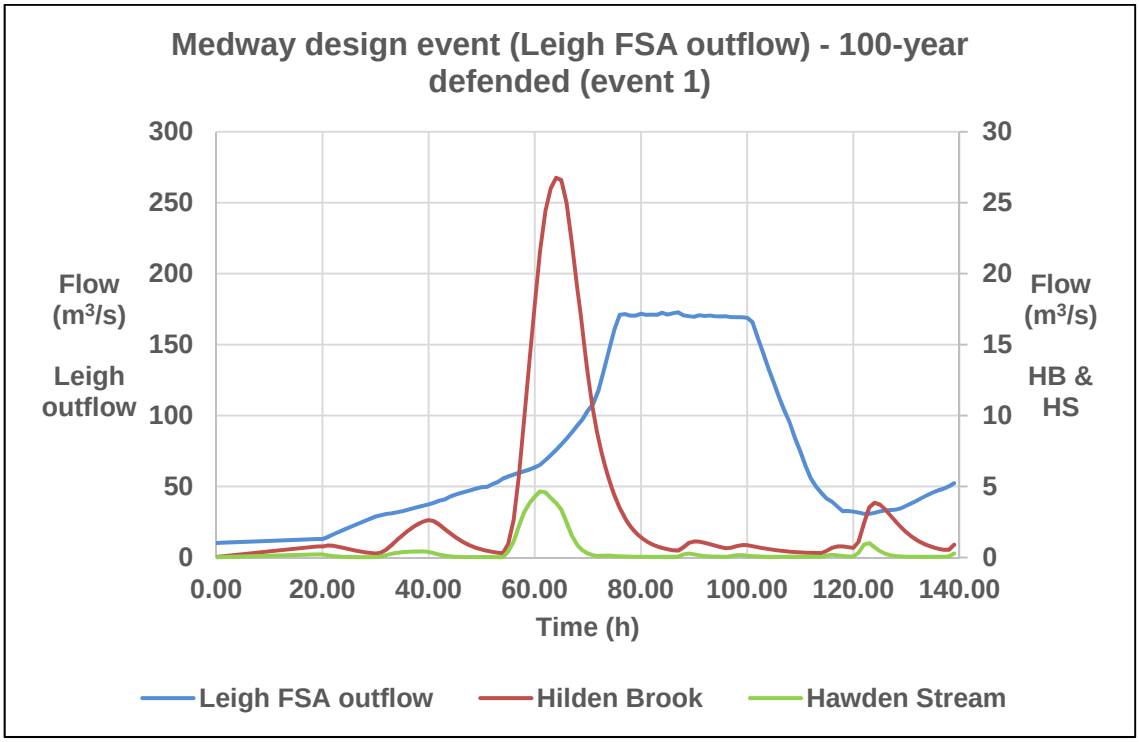

Figure 4: 1 in100 year hydrograph for a River Medway subject watercourse at Tonbridge School playing fields

4.3 Interpretation of the Hydrology

Without hydraulic model simulation results, an assessment of the hydrological data has been undertaken to inform the outline design. This is particularly relevant for the assessment of any over-pumping requirements on the Hawden Stream.

4.3.1 Interpretation of the Hawden Stream Hydrology

As shown in Figure 4, the peak flow of 4.66m^3/s for the Hawden Stream during a 1 in 100 year event occurs at approximately 61 hours. Given that the Hawden Stream is culverted through a 490m long 600mm diameter pipe upstream of the study area, it is reasonable to assume that overland flow would occur around the culvert. The impact of this overland flow on the surrounding properties is unknown but might be expected to cause internal flooding. The volume of water that corresponds to the period of high flows around the peak flow is approximately 149,000m^3 over 16 hours.

In order to protect the properties within Hildenborough from inundation during a 1 in 100 year flood event, which has a maximum flood level of 23.43mAOD on the River Medway, it is necessary for the flood defence to cross the Hawden Stream with the inclusion of a flow control structure with flap valves. The invert level of the stream at the proposed defence crossing point (based on the suggested flood defence alignment) is approximately 20.39mAOD, and the adjacent ground level is 21.8mAOD. When considering these levels in relation to flood levels of the River Medway and peak flows on the Hawden Stream (Figure 3 and Figure 4 respectively), it is reasonable to assume at 61 hours, when the peak flow from the Hawden Stream occurs, the flow control structure would be flood-locked. This implies that any flows upstream of the flow control would have to be either stored and/or over-pumped.

The available storage capacity on the Hawden Stream and adjacent ground upstream of the proposed flow control structure, up to the lowest threshold level of the properties, has been calculated to be approximately 37,000m^3. The extent of the storage area is shown by the red line in Figure 5, which uses the land between the flow control structure and the downstream end of the 490m long culvert to a maximum level of 22.9mAOD, which is the lowest property threshold level.

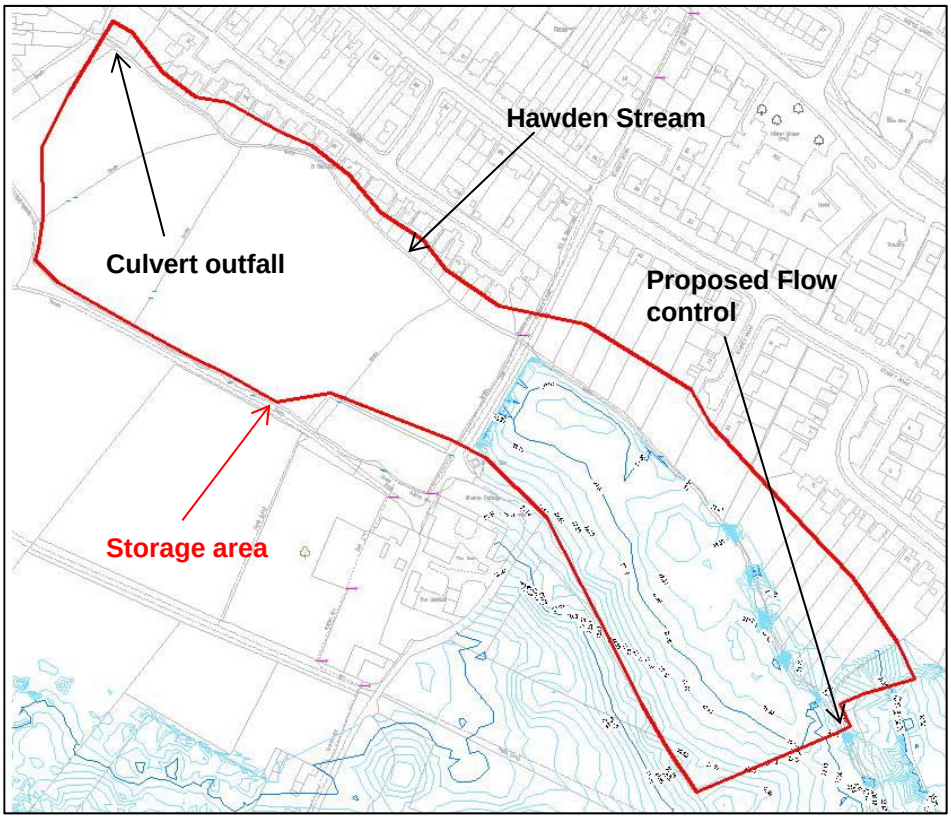

Figure 5: Potential Hawden Stream flood storage area to a maximum level of 22.9mAOD

A simple comparison of the volume of water that corresponds to the period of high flow against the available storage capacity of the Hawden Stream (149,000m^3 – 37,000m^3 = 112,000m^3 excess) suggests that there is insufficient capacity within the Hawden Stream to store all the floodwater during a 1 in 100 year flood event. Consequently, over-pumping of the Hawden Stream is required. For the purposes of this feasibility assessment, a high-level estimate of the pump size was deemed to be appropriate; this identified a pump capacity of 2m^3/s (112,000m^3/16 hours = 7000m^3/hr = 1.9m^3/s). However, whilst the proposed pump should be sufficient to ensure that flooding from the peak flows in the Hawden Stream was no worse than at present, it is not possible to determine whether the 2m^3/s pump would be able to keep flood water levels below property threshold levels throughout Hildenborough without further and more detailed hydraulic modelling.

4.3.2 Interpretation of the Hilden Brook Hydrology

It has not been possible to assess all implications of the Hilden Brook hydrological assessment. However, it is apparent from previous hydraulic modelling, coupled with the relatively close peak flows shown in Figure 4, that the Hilden Brook experiences back flows from the River

Medway. The extent of flooding from this occurrence is unknown and as such requires hydraulic modelling.

4.4 Hydrological and Hydraulic Model Design Parameters

The available hydraulic modelling data is limited to flood levels for a 1 in 100 year + climate change event of the River Medway and hydrological data for the River Medway, Hawden Stream and Hilden Brook. Consequently, all design parameters used in the development of options are reliant on interpretation of this data which is less accurate than hydraulic modelling.

The design parameters for this feasibility assessment for outline design, determined through interpretation of the available hydrological modelling data, is summarised in Table 3.

Parameter	Value	Comment
Flood defence level	23.8mAOD	(23.43mAOD for 1 in 100yr + CC event on the River Medway + 0.37m freeboard (the freeboard assessment has not been undertaken at present and is therefore assumed)
Available storage with Hawden Stream, upstream of defence	37,000m^3	Estimated available flood storage between the proposed flood defence and the upstream culverted section of the Hawden Stream. Maximum flood level taken as minimum threshold level for defended properties.
Peak flow on Hawden Stream	4.66m^3/s	JBA hydrograph – 100yr event (Q1) on the River Medway.
Volume of floodwater associated with peak flow on Hawden Stream	149,000m^3	Estimated from JBA hydrograph – 100yr event (Q1) on the River Medway during a period of 16 hours. It is reasonable to assume that the flow control structure would be flood-locked at this time.
Over-pumping requirement	2m^3/s	Estimated Hawden Stream over-pumping requirement (floodwater volume – available storage)/16 hours

Table 3: Hydraulic design parameters

5. Geotechnical Assessment

5.1 Desk Study and Ground Investigation

A geotechnical assessment for the proposed site has been undertaken in order to gain an understanding of the existing stratigraphy and what bearing it might have on any design options for a flood defence. As such, a geotechnical desk study for the Tonbridge School playing fields and the neighbouring farmland was undertaken by Capita AECOM in June 2015. This was subsequently used to inform the specification for a ground investigation (GI), to a level of detail appropriate for outline design. The findings of the GI are presented in Hildenborough FAS Geotechnical Interpretive Report, prepared by Capita AECOM, in November 2015.

5.1.1 Geotechnical Desk Study Summary

The desk study was focussed on the proposed alignment of the embankment, which identified that the site geology comprises superficial deposits of alluvium, possibly head deposits (periglacial reworked soils) and river terrace deposits. The solid geology comprises sandstone, mudstone and limestone of the Tonbridge Sand Formation. Existing ground investigation in the area around the site suggests the conditions immediately beneath the embankment may comprise a layer of clay of approximately 2.5 to 3m in thickness over sand and gravel. However, none of the existing ground investigation locations are on the proposed alignment.

The preliminary ground model suggested that the proposed embankment will be founded on Alluvium or River Terrace Deposits and it is likely that over the length of the proposed alignment, both of these materials will be encountered as the founding strata. The rate of seepage of impounded flood water beneath the flood defence will be dependent upon which of these strata it is founded; on alluvium it is likely that seepage could be limited to an acceptable level, whilst on sections founded on river terrace deposits additional measures such as cut-offs may be required or, if sufficient confidence in the ground model can be achieved, the defence could be relocated to avoid River Terrace Deposits. Consideration may be needed in addressing stability and settlement of the embankment and other structures founded on soft alluvial soils. Some sections of the alignment may present space constraints on the installation of a flood embankment and another flood defence option. For example a flood wall or sheet piling, may need to be considered locally.

5.1.2 Geotechnical Interpretive Report Summary

A preliminary GI to provide geotechnical information to the outline design was completed by AECOM in September of 2015. This GI comprised the excavation of six trial pits to a maximum depth of 2.0m, two using a mechanical excavator, four using hand tools and the drilling of three dynamic (windowless) samples with adjacent dynamic probes to 6m depth. A suite of laboratory geotechnical classification tests and geo-environmental tests were carried out on samples recovered from the exploratory holes.

The ground investigation broadly confirmed the anticipated superficial geology of the site comprising soft to firm silty sandy clayey Alluvium over clayey, silty sand and gravel River Terrace Deposits. The results of the ground investigation have been interpreted and used to provide guidance to the options appraisal and outline design. The engineering considerations identified include the potential for seepage beneath a flood embankment which is anticipated to be minimal where Alluvium forms the foundation but may be problematic, depending upon the maximum design flood level and acceptable seepage, where the River Terrace Deposits form

the foundation as a result of their higher permeability. Also of consideration is the potential for compaction difficulties of the initial layers of fill in an embankment where Alluvium forms the foundation as the result of its soft consistency.

The results of the ground investigation indicate that where required, it will be possible to drive sheet piles within the strata encountered (although this should be confirmed locally in the western part of the site). Given the strength properties of the ground, sheet piles may need to be significantly embedded to retain the anticipated flood water and prevent seepage.

It is likely that imported fill will be required to complete construction of an earth embankment and this material will require control to ensure its geotechnical properties are suitable. Laboratory testing data indicates that the stockpile of material at Tonbridge School, estimated to be approximately 3,600m^3, will make an acceptable fill material for use in an earthwork embankment, the fines content would be likely to produce a material of low permeability provided compaction and the moisture content can be adequately controlled on site. As there is insufficient material in the stockpile to construct an embankment over the full length of the site, consideration could be given to mixing the material with imported fill.

Continued discussion with Southern Water is required in respect of the construction implications arising from the presence of a foul rising main indicated to pass beneath and close to the site. Initial communications with Southern Water have resulted in the advice that construction of an earthworks embankment over the alignment of the pipeline would not be acceptable. Continued liaison with Network Rail is required in respect of any influence that the scheme may have on their embankment.

5.2 Geotechnical Design Parameters and Constraints

Interpretation of the ground investigation suggests that the geology beneath the proposed flood defence alignment is largely Alluvium. However, there are greater volumes of River Terrace Deposits near the Hilden Brook watercourse. The Alluvium has a low permeability and as such would provide a suitable foundation for construction of an earth embankment; whereas the River Terrace Deposits have a higher permeability and would require the installation of a cut-off, such as sheet piles, to avoid seepage under the defence. The likely extents of flood defence construction types are presented in Table 4. Further design considerations and recommendations are provided in the Hildenborough FAS Geotechnical Interpretive Report, November 2015.

Flood Defence Type	Length	Location	Comments
Earth embankment	970m	Waterfield Lane – Hawden Cottage	Spec for Highway Works Class 2 cohesive fill with 1m deep ‘key’ required
Sheet piles	280m	Surrounding “all-weather” sports pitches, adjacent to Hilden Brook	5.5m embedment required.

Table 4: Extents of flood defence construction types

It is understood that maintenance of any flood embankment in the sports field area will be undertaken by the Tonbridge School grounds maintenance team. It is therefore necessary that any embankment can be mown by a hand-held lawn-mower. For this reason, the slopes on either side of the earth embankment shall not be steeper than 1 in 3.

6. Environmental Assessment

6.1 Environmental Impact Assessment (EIA)

Assessment of environmental impacts is an integral part of the design process for Hildenborough FAS. An overview of potential key issues or environmental impacts which may result from the Proposed Development and potential mitigation measures are presented within the Hildenborough Flood Alleviation Scheme EIA Filenote, prepared by Captia AECOM. The EIA Filenote highlights existing environmental baseline conditions and requirements for additional surveys, along with any relevant assumptions and limitations.

An 'EIA Screening and Scoping' exercise was undertaken to identify the key issues that need to be addressed, in liaison with Environment Agency technical specialists, for the construction of the proposed flood defence. The principal topics considered as part of this screening and scoping exercise are listed below:

- Ecology;
- Water environment;
- Archaeology and cultural heritage;
- Landscape and visual amenity;
- Ground conditions;
- Traffic and transport;
- Noise and vibration;
- Community;
- Air quality and climate.

6.2 Ecology

The following potential impacts to fauna and flora have been identified relating to the Proposed Development (refer to Hildenborough Flood Alleviation Scheme EIA Filenote for further details and mitigation):

- Construction works could potentially result in killing or injury of individual great crested newts and/or damage/destruction of great crested newt terrestrial habitat;
- Potential for habitat severance of Hawden Stream where the embankment intersects with the stream;
- Potential for water pollution incident from construction works into the watercourses;
- Crossing of waterbodies by the Hildenborough FAS may result in impacts to aquatic invertebrates;
- Potential noise and vibration effects from construction activity to aquatic species;
- Loss of terrestrial habitats, including dense scrub, scattered scrub, tall ruderal and improved grassland within the location of the embankment, hardstand area and access track;
- Potential impact on trees which support bats;
- Removal of vegetation may result in disturbance to reptile species;
- Potential for works to lead to loss of breeding and foraging habitat for birds;
- Potential spreading of non-native invasive signal crayfish (Pacifastacus leniusculus), Japanese knotweed and Indian balsam.

6.3 Water Environment

The following potential impacts to the water environment have been identified relating to the Proposed Development (refer to Hildenborough Flood Alleviation Scheme EIA Filenote for further details and mitigation):

- Removal and exposure of bare ground, earth movement, stockpiling, mobilising of sediment into surface water receptors through runoff from the site;
- Vehicle wheel washing run-off, or muddy run-off from construction access tracks within the site;
- Pollution due to vandalism of construction plant;
- Poor/inappropriate storage of materials and chemicals/fuels and wastes such as on permeable surfaces, adjacent to watercourses or without sufficient bunding capacity;
- Accidental spillages of fuels, oils, hydraulic fluid and polluting materials; and
- Creation of preferential pathways via piling operations.

Preliminary Water Framework Directive Assessment:

- Kent Weald Western - Medway (Groundwater) waterbody is the most likely to be affected by the Proposed Development given its proximity.
- The proposed works, a flood embankment to defend local development, is small in scale relative to the size of the adjacent waterbodies. The nature of the works is not anticipated to directly impact the aquatic environment.
- Two areas of concern are bank habitats and the effects of piling on groundwater pollution.
    - Deterioration of existing bank habitats. Natural banks could be degraded, which could have a non-temporary impact on habitat and WFD objectives. If sheet piling is used, it may be difficult to directly mitigate loss of bank habitat with like-for-like replacement or enhancement of banks elsewhere, but some equivalent form of compensation habitat should be provided to ensure that there is no overall deterioration. Existing bank conditions, the scale of deterioration, and mitigation measures will need to be investigated further once preferred options are confirmed.
    - Impacts of piling on pollutant pathways to groundwater. Piling could open flow and contaminant pathways from surface water to groundwater, which could compromise improvement to the existing poor status groundwater body. The local groundwater body is currently under pressure from a range of sources including Pesticides, DrWPA, and Chlorinated Solvents. The scheme is within a Source Protection Zone and impacts on particularly sensitive groundwater are therefore likely, the effects of piling on groundwater will need be mitigated, therefore reducing any risk.

6.4 Archaeology and Cultural Heritage

The potential for the Proposed Development to contain previously unrecorded heritage assets has been assessed as **low**, including the potential for encountering sub-surface remains associated with the former brickworks. It is assumed that the Proposed Development will comprise of importing material to the site to create the embankment resulting in minimal impacts to sub-surface deposits. In addition, the height of the proposed embankment is unlikely to affect the setting of heritage assets in the study area.

Due to the low potential for the Proposed Development to contain heritage assets and the low level of impact arising from the Proposed Development, it is assessed that further archaeological evaluation is not required at this stage.

Refer to Hildenborough Flood Alleviation Scheme EIA Filenote for further details and mitigation.

6.5 Landscape and Visual Amenity

The following potential impacts to landscape and visual amenity have been identified relating to the Proposed Development (refer to Hildenborough Flood Alleviation Scheme EIA Filenote for further details and mitigation):

- Temporary, short-term changes to the landscape character and visual amenity during construction due to movement of construction plant and general construction activity;
- Potential disturbance to users of recreational facilities, public footpaths, the school and to nearby residents;
- Temporary loss of terrestrial habitats, including dense scrub, scattered scrub, tall ruderal and improved grassland within the location of the embankment, hard stand area and access track; and
- On completion of works, the appearance of the new grassed embankment will be different to existing views and replanted vegetation may take some time to establish. In addition, there will be permanent infrastructure including Hawden Stream flow control structure, the concrete hardstand area and the grasscrete access track, which will be visible.

6.6 Ground Conditions

As identified within the Geotechnical desk study, the following potential impacts have been identified for ground conditions relating to the Proposed Development:

- The risks to these human and controlled water receptors were classified as low since it is assumed that appropriate site control measures will be adopted and validation testing of imported soils will be undertaken.
    - Potential for human health pathway – particulate from ingestion, inhalation, dermal contact, with soil particulates. This is considered to apply to direct contact with the imported/stockpiled soils rather than existing soils since only limited below ground excavations are envisaged;
    - Migration pathways have the potential to cause pollution of sensitive controlled waters receptors, including: Leaching – that is, migration of chemicals of potential concern from imported/stockpiled soils into shallow and deep groundwater; and migration of chemicals of potential concern from imported/stockpiled soils surface water via surface water run-off.
- Both alluvium or river terrace deposits are likely to be encountered when constructing the embankment. The rate of seepage of flood water beneath the embankment will be dependent upon which of these strata are encountered. If on alluvium, it is likely that seepage could be limited to an acceptable level. However, if it is on river terrace deposits, which is more permeable, additional measures, such as cut offs (i.e. sheet piling), may be required or the embankment realigned to avoid these areas. At this stage, they have been identified near the Tonbridge School sports pitches.
- There is also potential for compaction difficulties of the initial layers of fill in an embankment where Alluvium forms the foundation as the result of its soft consistency.

6.7 Traffic and Transport

The following potential impacts have been identified for traffic and transport relating to the Proposed Development (refer to Hildenborough Flood Alleviation Scheme EIA Filenote for further details and mitigation):

- Potential diversion/closure of PRoW Numbers MU22, MU23 and MT43. Discussions will be required with the Local Planning Authority;
- Temporary disturbance along the B245 from construction plant entering/exiting the site;
- Potential tracking of mud/dirt onto local road network.

6.8 Noise and Vibration

The following potential impacts have been identified for noise and vibration relating to the Proposed Development (refer to Hildenborough Flood Alleviation Scheme EIA Filenote for further details and mitigation):

- There may be potential noise impact from construction activity experienced by nearby residents;
- There may be potential noise disturbance to people utilising the recreational fields, public footpaths and Tonbridge School. Receptors further away from construction activities may also experience disturbance during works but to a lesser extent;
- Vibration impacts may be experienced during piling operations of sheet piles. These may cause disturbance to people and nearby buildings; and
- The increased movement of construction plant on/off London Road may cause additional noise and vibration disturbance to nearby residents.

6.9 Community

The potential impacts to the community are similar to those already identified within Sections 6.5 (landscape and visual amenity) 6.7 (traffic and transport) and 6.8 (noise and vibration). Refer to Hildenborough Flood Alleviation Scheme EIA Filenote for further details and mitigation.

7. Option Identification and Appraisal

7.1 Design Options Identified

As discussed in Section 4.1, the available hydraulic modelling data is limited to flood levels for a 1 in 100 year + climate change event of the River Medway and hydrological data for the River Medway, Hawden Stream and Hilden Brook. Consequently, the design options identified are based on assumed flood levels and flows only. The key design parameters for identifying and appraising options are presented in Table 5.

Parameter	Value	Comment
Flood defence level	23.8mAOD	23.43mAOD for 1 in 100yr + CC event on the River Medway + 0.37m freeboard (the freeboard assessment has not been undertaken at present and is therefore assumed)
Minimum threshold level for defended properties	22.9mAOD	17 Hawden Close, Hildenborough, TN11 9BP. Approximate level, excluding air brick levels.
Available storage with Hawden Stream, upstream of defence	37,000m^3	Estimated available flood storage between the proposed flood defence and the upstream culverted section of the Hawden Stream. Maximum flood level taken as minimum threshold level for defended properties.
Peak flow on Hawden Stream	4.66m^3/s	JBA hydrograph – 100yr event (Q1) on the River Medway.
Volume of floodwater associated with peak flow on Hawden Stream	149,000m^3	Estimated from JBA hydrograph – 100yr event (Q1) on the River Medway during a period of 16 hours. It is reasonable to assume that the flow control structure would be flood locked at this time.
Overpumping requirement	2m^3/s	Estimated Hawden Stream overpumping requirement (floodwater volume – available storage)/16 hours
Earth embankment length	970m	Embankment slopes to be no steeper than 1 in 3.
Sheet pile length	280m	Sheet piles required around the “all weather” sports pitches with 5.5m embedment.

Table 5: Key design parameters

7.1.1 Option 1 – 1.25km Flood defence with provision for overpumping

The Capita AECOM proposal document for this project stated that the 950m long flood defence suggested by the Environment Agency would be included within this report as “Option 1”. However, in light of the flood levels from a 1 in 100yr inc. climate change (CC) event on the River Medway and a better understanding of the topography, it is apparent that a 950m long embankment would leave the Hawden Oast property susceptible to flooding. As a consequence, the flood embankment has been extended to approximately 1.25km long. The raised defences tie into high ground at either end, makes use of higher ground along the line of the proposed defence in order to minimise the amount of additional material required, and accommodates existing property boundaries.

To enable construction of the flood defences, tree clearance in several locations would be necessary. It would also be necessary to divert or modify the existing Southern Water rising main that runs beneath the playing fields due to restrictions imposed by Southern Water which prohibit works above existing mains.

The general alignment of the flood defence is shown in Figure 6. The flood defence design includes:

- An earth embankment, typically with a 1m wide crest and 1 in 3 slopes either side;
- The earth embankment would cross existing ditches in 2No. locations. 600mm diameter pipes with flap valves at the downstream ends would be incorporated into the embankment at the crossings to allow the ditches to function appropriately.
- Plastic sheet piles surrounding Tonbridge School's "all weather" sports pitches, which have a lower carbon footprint than steel sheet piles;
- 2No. flood gates will be required where the proposed raised flood defences cross existing access routes within the Tonbridge School playing fields.
- A flow control structure where the defence crosses the Hawden Stream. The flow control structure would consist of 2No. 2.5m (W) x 1.5m (H) flap valves, positioned top and bottom, with the bottom flap being fish friendly.

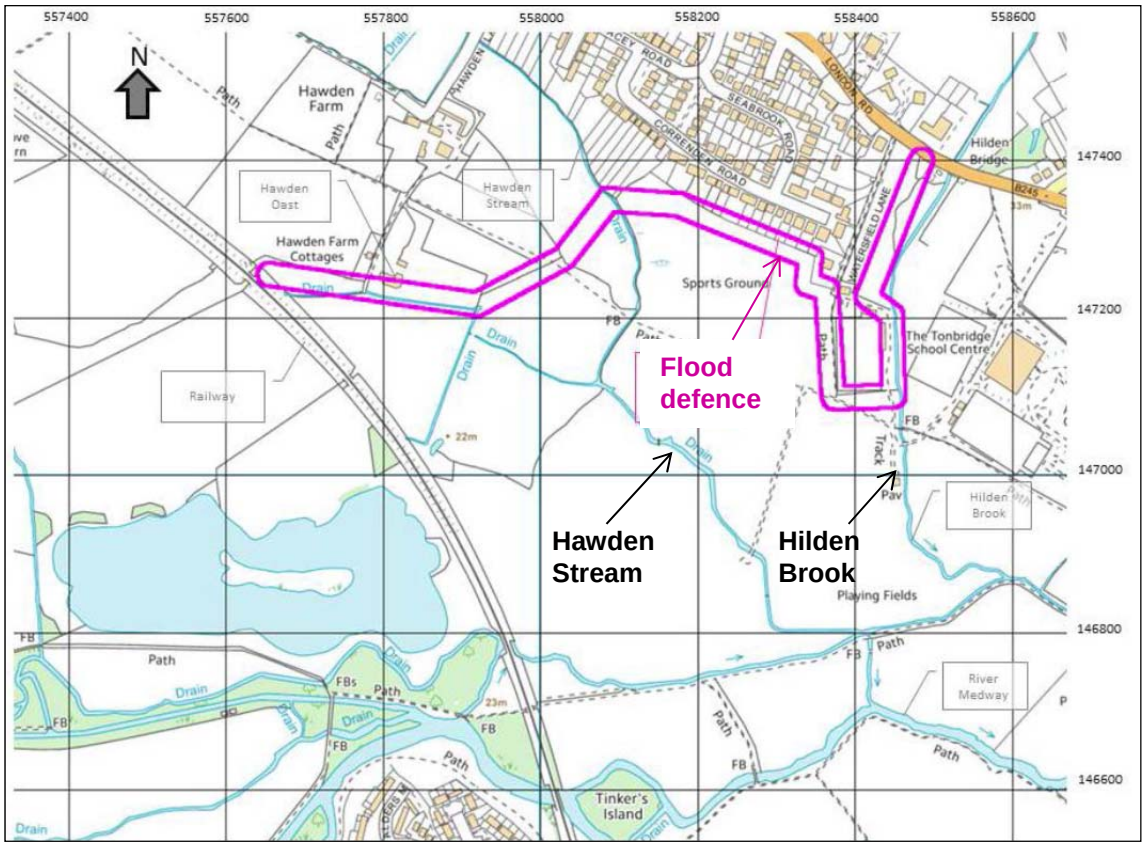

Figure 6: Proposed flood defence alignment

To facilitate over-pumping, the feasibility assessment for outline design includes:

- A Grasscrete access track between Waterfield Lane and the flow control structure with a concrete hardstanding immediately adjacent to the flow control structure. The access track would be a minimum of 4m wide;
- The access track and hardstanding would be positioned on the defended side of the embankment at existing ground level;

- Several relatively small temporary pumps (approximately 0.5m^3/s total capacity) would be delivered to the hardstanding by Hiab lorries in the event of imminent flooding. The basis for using pumps of this size is on the assumption that the Environment Agency generally have 6" pumps available locally, which have a capacity of approximately 100l/s.

7.1.2 Option 2 – 1.25km Flood defence with provision for mobile 1m^3/s pumps

The design of this option is very similar to Option 1, with the following exceptions:

- The Grasscrete access track and concrete hardstanding would be at the embankment crest level (23.8mAOD) to enable delivery and installation of 2No. 1m^3/s pumps at the top of the embankment, immediately adjacent to the flow control structure;
- The 1m^3/s pumps are part of the form part of a national stock of assets owned by the Environment Agency (10No. 1m^3/s pumps total). The storage location of the pumps is unknown but it is estimated that deployment can be a minimum of 1 day from request;
- 1No 5m (W) x 10m (L) x 2.5m (D) sump would be constructed in the left bank of the Hawden Stream, immediately upstream of the flood defence;
- The section of flood embankment between Waterfield Lane and the flow control structure would have a minimum crest width of 4m to accommodate vehicle movements on top of the embankment. Vehicular restraint barriers would be required on top of the embankment, and a ramp between Waterfield Lane and the embankment.

7.1.3 Option 3 – 1.25km Flood defence with provision for mobile 2m^3/s Archimedes screw pump

The design of this option is very similar to Option 1, with the following exceptions:

- Installation of 1No. 2m^3/s Archimedes screw pump, and associated controls, as part of the flow control structure. This pump design is in-keeping with an Archimedes screw pump used within Leigh FSA Pumping Station.
- The grasscrete access track and concrete hardstanding would be at the embankment crest level (23.8mAOD) to enable operation of the pump at the top of the embankment, immediately adjacent to the flow control structure;
- 1No 5m (W) x 10m (L) x 2.5m (D) sump would be constructed in the left bank of the Hawden Stream, immediately upstream of the flood defence;
- The section of embankment between Waterfield Lane and the flow control structure would have a minimum crest width of 4m to accommodate vehicle movements on top of the embankment. Vehicular restraint barriers would be required on top of the embankment, and a ramp between Waterfield Lane and embankment.

7.2 Option Costs

The construction costs for each option are presented in Table 6. The construction costs were developed using construction cost schedules, quotations from suppliers and experience from similar construction projects. The cost estimates are contained within Appendix D.

A number of assumptions were made when developing the costs, which are as follows:

- Option 3 – 2m^3/s archimedes screw pump costs have been scaled from smaller pumps costs, with an allowance for extensive civil and MEICA works;
- Southern Water (SW) mains diversion – SW have advised that it is not acceptable to construct over its asset. A nominal fee of £100k has been allowed;
- Option 1 assumes the use of mobile pumps <0.5m^3/s;

- A haul road is required along the full extent of the defence to accommodate vehicle movements, allowing for winter working;
- No allowance has been made for procurement, supply, delivery, installation, maintenance and operation of mobile pumps;
- Options 2 & 3 – the scale of the embankment has been increased locally around the flow control structure to accommodate vehicular movements. No allowance for safety barriers has been made.

When preparing the costs, an allowance of 35% was made for prelims, which would include development in subsequent project stages and enabling works, and design. A 60% optimism bias has also been included to account for uncertainties within the costing, which is deemed to be appropriate at this early stage of the project.

		Option 1	Option 2	Option 3
A	Construction Cost	£1.23m	£1.40m	£2.06m
B	Prelims and design cost (Item A x 35%)	£0.429m	£0.491m	£0.721m
C	Optimism Bias [(Items A + B) x 60%]	£0.993m	£1.14m	£1.67m
D	**Total cost** (Items A + B + C)	**£2.65m**	**£3.03m**	**£4.45m**

Table 6: Estimated construction costs for each option

7.3 Project Risks

There are a significant number of risks associated with each of the design options, some of which are due to the lack of available hydraulic modelling. The more significant risks identified are presented in Table 7 and a full risk table has been included in Appendix E.

Risk Description & Consequence	Initial Risk	Mitigation	Residual Risk
Non-availability of mobile pumping plant at time of flooding – increased flood damage (applicable to Options 1 & 2)	VH	Buy mobile pumps (Option 1). Designate a minimum of 2No. pumps to the River Medway (Option 2)	H
High flows in the Hawden Stream – flooding behind defences (applicable to all options)	VH	Maximise size of outfall and provide suitable pumping arrangements	H
Delay in starting pumping at outfall due to inability to deliver mobile pumps to outfall – flooding and possibly adverse publicity to the Environment Agency (applicable to Options 1 & 2)	VH	Keep mobile pumps as close to the outfall as possible and provide dry access or provide fixed pump - unlikely to be possible for Option 2	H
Diversion of Southern Water rising main – delay and additional cost (applicable to all options)	VH	Negotiate options to locally modify or protect rising main	H

Table 7: Significant project risks

7.4 Option Appraisal

7.4.1 Assessment of Option 1 – 1.25km Flood defence with provision for over-pumping

This option would require some local area planning to mobilise the pumps. However, the peak flow of 4.66m^3/s and associated net 112,000m^3 (149,000m^3 – 37,000m^3) volume of water (see Table 5) to be discharged over the flood defence from the residential area presents a significant concern to the implementation of this option. Based on the information that is currently available, this option is suitable to prevent flooding of the Hildenborough properties from the River Medway, but not the Hawden Stream during a 1 in 100 year flood event. Therefore, this option does not appear to be able to provide a standard of protection that is appropriate for a 1 in 100 year including an allowance for climate change.

The influence of the Hilden Brook is unknown at present. Consequently, it is not possible to determine if and where flooding from the Hilden Brook may occur.

7.4.2 Assessment of Option 2 – 1.25km Flood defence with provision for mobile 1m^3/s pumps

This option would require significant planning to mobilise the 1m^3/s pumps to ensure effective use. There are also safety concerns associated with operation of vehicles on top on an embankment, particularly during flood periods. However, this option appears to enable the flows and stored water from the Hawden Stream to be discharged over the embankment, albeit with suitable erosion protection. Based on the information that is currently available, this option is suitable to prevent flooding of the Hildenborough properties from the River Medway. However, whilst the proposed pumps should be sufficient to ensure that flooding from the peak flows in the Hawden Stream was no worse than at present, it is not possible to determine whether the pumped 2m^3/s would be able to keep flood water levels below property threshold levels throughout Hildenborough without further and more detailed hydraulic modelling.

The influence of the Hilden Brook is unknown at present. Consequently, it is not possible to determine if and where flooding from the Hilden Brook may occur.

7.4.3 Assessment of Option 3 – 1.25km Flood defence with provision for mobile 2m^3/s Archimedes screw pump

This option would require regular maintenance, but appears to be able to provide a permanent solution for discharging high flows from the Hawden Stream during a flood event. This pump design is also in-keeping with an Archimedes screw pump used within Leigh FSA Pumping Station. However, there are also safety concerns associated with operation of vehicles on top on an embankment, although it is unlikely to be as frequently required as Option 2.

Based on the information that is currently available, this option is suitable to prevent flooding of the Hildenborough properties from the River Medway. However, whilst the proposed pumps should be sufficient to ensure that flooding from the peak flows in the Hawden Stream was no worse than at present, it is not possible to determine whether the pumped 2m^3/s would be able to keep flood water levels below property threshold levels throughout Hildenborough without further and more detailed hydraulic modelling.

The influence of the Hilden Brook is unknown at present. Consequently, it is not possible to determine if and where flooding from the Hilden Brook may occur.

7.4.4 *Option Appraisal Matrix*

The options presented in Section 7.1 have been considered in detail and by means of an RAYG option appraisal matrix, the merits and de-merits of each option were compared. The criteria and appraisal of each option are presented in Table 8.

Appraisal Criteria	**Option 1** 1.25km defence and over-pumping provision	**Option 2** 1.25km defence and 1m^3/s pumps	**Option 3** 1.25km defence and 2m^3/s Archimedes screw
Flood Risk Alleviation Effectiveness	Would not prevent flooding from Hawden Stream	Unlikely to prevent flooding to all properties but unconfirmed as yet	Unlikely to prevent flooding to all properties but unconfirmed as yet
Hydraulic Capacity	Cannot suitably discharge flood waters from Hawden Stream	Can suitably discharge flood waters from Hawden Stream	Can suitably discharge flood waters from Hawden Stream
Reliability	Requires mobilisation of pumps	Requires mobilisation of pumps with a significant notice period to mobilise and set-up	Permanent and reliable option – appropriate operation and maintenance required
Buildability	Manageable by a competent contractor	Manageable by a competent contractor	Substantial civil & MEICA works
Estimated Cost	Reasonable for scheme size	Reasonable for scheme size	Significantly higher than Options 1 & 2
Environmental	Mitigation for GCN required. Piling may adversely effect bank habitats adjacent to Hilden Brook	Mitigation for GCN required. Piling may adversely effect bank habitats adjacent to Hilden Brook	Mitigation for GCN required. Piling may adversely effect bank habitats adjacent to Hilden Brook
Health & Safety	No significant issues	Vehicles accessing pumps across the top of an embankment and maintenance of sump	Vehicles accessing pumps across the top of an embankment and maintenance of sump
Services	Likely to require diversion of Southern Water rising main	Likely to require diversion of Southern Water rising main	Likely to require diversion of Southern Water rising main
Third parties	Large embankment near Hawden Oast – possibly unpleasing aesthetics	Large embankment near Hawden Oast and visible vehicle restraints in playing fields – possibly unpleasing aesthetics and objections to scale	Large embankment near Hawden Oast, visible vehicle restraints in playing fields and large pump station – possibly unpleasing aesthetics and objections to scale
Legal	Planning compliance	Planning compliance	Planning compliance
Decision	**Not acceptable**	**Acceptable with some issues**	**Acceptable with some issues**
Key			
	No issues		High issues
	Medium issues		Unacceptable issues

Table 8: Option appraisal matrix

The option appraisal identified a number of issues associated with the each of the options. Option 1 has been discarded, whereas Options 2 and 3 are recommended to be taken forward to the next stage of the project for further consideration.

Before one single option can be identified as the preferred option, further hydraulic modelling and detailed consideration of the project risks are required. At this feasibility assessment for outline design stage of the project, irrespective of the flood risk alleviation effectiveness of each solution, the balance of reliability versus estimated cost has a significant bearing on whether Option 2 or 3 is preferred. It is considered that the option that would most closely meet the project objectives is Option 3, which would require a substantial capital investment.

Designs for Options 2 and 3 and included within Appendix F.

8. Conclusion and Recommendations

8.1 Summary and Conclusion

As part of the feasibility assessment for outline design, the following assessments were undertaken and data obtained:

- Topographical survey in the vicinity of the proposed flood defence;
- Hydraulic model flood levels for the River Medway, and hydrological assessments of the Hilden Brook and Hawden Stream;
- Geotechnical assessment for the study area; and
- Environmental assessment of the study area.

The assessments and data listed above were used to identify options that would provide a 1 in 100 year, including allowance for climate change, standard of protection against fluvial flooding from the River Medway, Hilden Brook and Hawden Stream. These options were based on the Environment's Agency's suggested 950m long flood defence within Tonbridge School playing fields and the neighbouring farmland.

The flood levels determined as part of the River Medway hydraulic model compared with the topography made it apparent that a 950m long embankment would leave the Hawden Oast property susceptible to flooding. As a consequence, the flood embankment has been extended to approximately 1.25km long. The raised defences tie into high ground at either end.

The flood defence would consist primarily of an earth embankment (approximately 1km), with a section of sheet piles (0.25km) to restrict seepage, and a flow control structure. The defence would also require the inclusion of large pumps (total capacity of $2m^3/s$) to discharge flood waters from the Hawden Stream, as identified in Options 2 and 3 in Sections 7.1.2 and 7.1.3.

With limited hydraulic modelling data available during the design process, feasibility assessments for outline design have been based largely on hydrological data and flood levels on the River Medway. Consequently, it has not been possible to determine the effectiveness of the flood defence options. Options 2 and 3 appear to be suitable at preventing flooding of the Hildenborough properties from the River Medway. However, whilst the proposed pumps should be sufficient to ensure that flooding from the peak flows in the Hawden Stream was no worse than at present, it is not possible to determine whether the pumped $2m^3/s$ would be able to keep flood water levels below property threshold levels throughout Hildenborough without further and more detailed hydraulic modelling. Also, the impact of flooding from the Hilden Brook is not known at present.

8.2 Recommendations

To ensure an appropriate flood alleviation solution is identified, which meets the objective of creating a standard of protection suitable to defend properties within Hildenborough from a 1 in 100 year + CC flood event, the following are recommended:

- Complete the hydraulic modelling for this feasibility assessment for outline design, as per the scope in Section 4.1.1;
- Investigate the potential for upstream storage;
- Investigate the potential benefits of de-culverting the Hawden Stream;
- Investigate the potential for improvements to surface water drainage;
- Investigate areas that may benefit from property level protection.

Appendix A – Topographical Survey Extent

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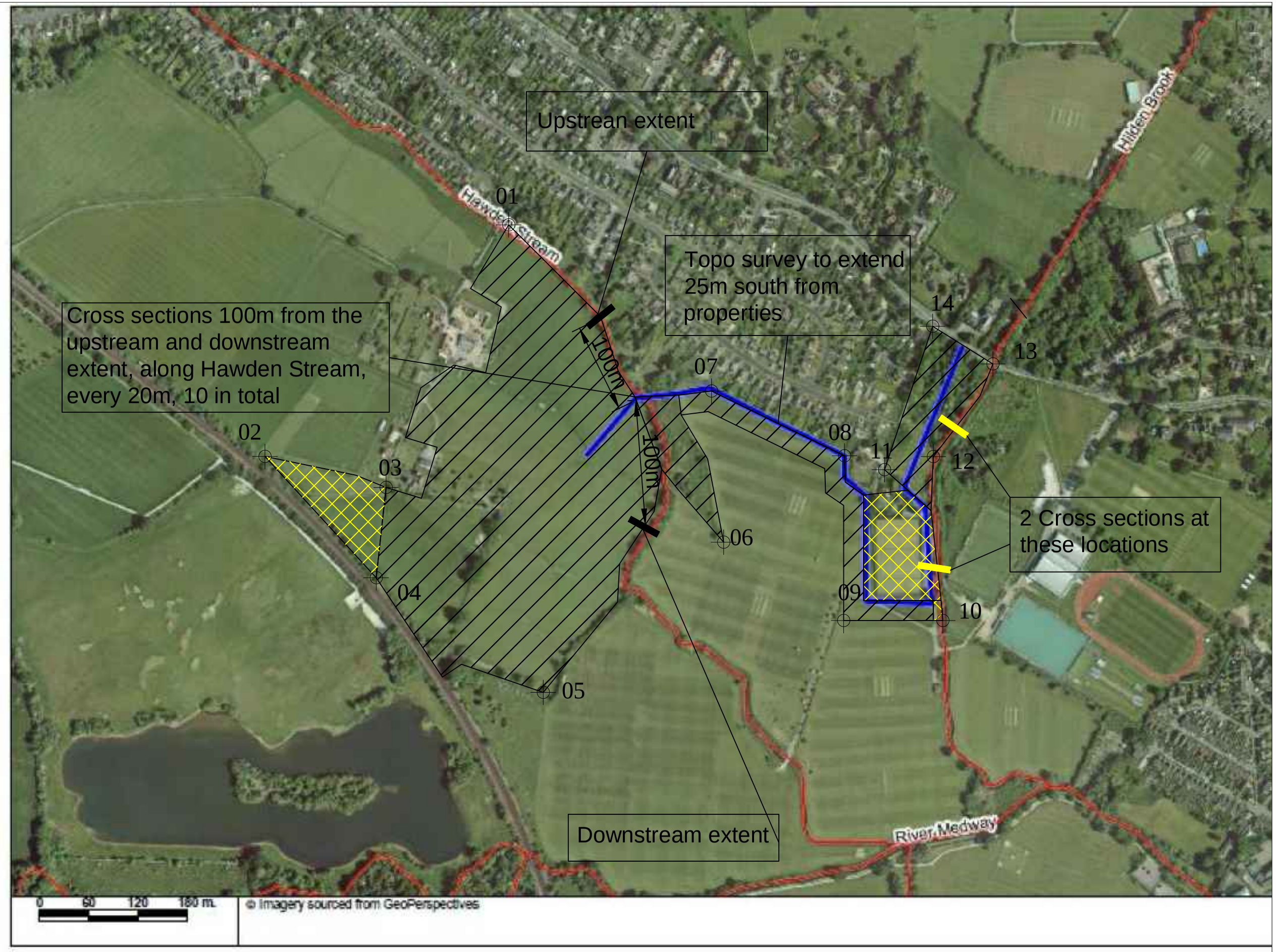
Upstrean extent
Topo survey to extend 25m south from properties
Cross sections 100m from the upstream and downstream extent, along Hawden Stream, every 20m, 10 in total
2 Cross sections at these locations
Downstream extent
Hawden Stream
Hilden Brook
River Medway
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02
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04
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06
07
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Appendix B – Email Correspondence with Southern Water

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Walsh, James P (Basingstoke)

From: Brown, Richard
Sent: 05 January 2016 16:40
To: Walsh, James P (Basingstoke)
Subject: FW: Rising Mains at Hildenborough in Kent

James,

See below for a further e-mail from Southern Water that arrived just before Christmas. I'm still not 100% clear from mark's e-mail, but I read it to confirm that there are indeed rising mains beneath the proposed alignment, which is what I asked him to clarify.

Richard.

From: Macey, Mark [mailto:Mark.Macey@southernwater.co.uk]
Sent: 22 December 2015 15:55
To: Brown, Richard
Cc: Ward, Stuart
Subject: RE: Rising Mains at Hildenborough in Kent

Rising Mains at Hildenborough in Kent
Richard
Rising Main (pumped sewerage main) Pipe material is indicated as spun iron, outer diameter is 225mm, depth unknown, these are there are only general indicators, I suggest that if any excavation is undertaken, first notify Southern Water to ensure appropriate Health & Safety concerns have been met accordingly.
Any excavation should be conducted on trial holes basis.
As for the availability of drawings, they can be purchased, through Southern Water Land Searches Department, to suit your needs accordingly.
Regards

Mark Macey
County Sewerage Engineer (Kent)

Southern Water | **T.** 01634 824138
www.southernwater.co.uk

From: Brown, Richard [mailto:richard.brown@aecom.com]
Sent: 07 December 2015 16:47
To: Macey, Mark
Subject: RE: Rising Mains at Hildenborough in Kent

Mark,

Thanks for the reply, we'll pass your comments on to our client.

One of the things we've struggled with is identifying the pipes and consequently being sure that there is indeed an issue at the site. We purchased a services search report from Landmark who provided us with a plan of the Southern Water plant in the area of our site but it isn't the easiest plan to understand and the resolution of the one we have isn't very good (even after we asked Landmark to provide a better one). I had a conversation with one of your colleagues a few months ago and he tried to identify the pipes I was interested in on your GIS system but

struggled to do so. He suggested I send a plan of the area we were interested in to developer services, which was attached to my original e-mail (and re-attached here).

I'd be grateful if you could put me in contact with the right person to enable to me to confirm the presence of the pipes that are shown on the plan so we can be sure there is a potential issue.

Many thanks for your help,
Richard.

Richard Brown, BSc MSc ARSM FGS
Senior Engineering Geologist, Ground Engineering, EMIA
D +44 1256 310304
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From: Macey, Mark [mailto:Mark.Macey@southernwater.co.uk]
Sent: 30 November 2015 14:46
To: Brown, Richard; Tidy, Bob; Nelson, Chris; Whitcher, Daniel
Cc: Collet, Jean-Paul; Rudland, Cliff; White, Sam
Subject: RE: Rising Mains at Hildenborough in Kent

Richard
For clarification, I would not offered any advice reference to any potable water mains in the vicinity of Hildenborough, as Southern Water are not the responsible Water Undertaker for this area.

However Southern Water are the Sewerage Undertaker for the rising mains within the the vicinity, to answer your question we would not normally allow any build over or within 3m distance of any strategic main (rising mains fall under this category) as Southern Water would have to be able to carry out maintenance, or an emergency repair.
Your current proposal of 1m earth bank over Southern Water assets (rising main) does not meet the criteria under strategic mains, therefore would not be considered as acceptable.
Alternatively you may wish to consider the cost funding of a diversion of the rising main which may, enable you to build in your desired location, subject to approval from the relevant parties.
Any further proposals would have be made in greater detail, including location details, so that any decision can be given full consideration.
Regards
Mark Macey
County Sewerage Engineer (Kent)

Southern Water
T. 01634 824138
www.southernwater.co.uk

From: Brown, Richard [mailto:richard.brown@aecom.com]
Sent: 25 November 2015 09:24

To: Macey, Mark
Subject: RE: Rising Mains at Hildenborough in Kent

Mark,

Thanks for the reply and the information.

You've addressed the procedure for the positive identification of the water mains by digging some inspection pits, but I was also looking for some longer term guidance on the feasibility of building a flood defence scheme, specifically an earth embankment of about 1m height that would cross the route of the rising main. Is there president for this kind of works and how has it been dealt with in the past?

The project is at an early stage and I'm just after some preliminary guidance to help identify the constraints the scheme might face at it develops.

Thanks,
Richard.

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From: Macey, Mark [mailto:Mark.Macey@southernwater.co.uk]
Sent: 25 November 2015 07:46
To: Brown, Richard; Pring, Scott
Cc: Whitcher, Daniel; Collet, Jean-Paul; Rudland, Cliff
Subject: FW: Rising Mains at Hildenborough in Kent

Richard
H&S 460 & RAMS will have to be completed before any work is allowed to commence. Once received further discussion will need to take place with all parties.
Regards
Mark Macey
County Sewerage Engineer (Kent)

Southern Water | **T.** 01634 824138
www.southernwater.co.uk

From: Developer Services
Sent: 24 November 2015 15:53
To: Macey, Mark
Subject: FW: Rising Mains at Hildenborough in Kent

Mark, can you respond to the customer please.

I know nothing about rising mains.

Bob Tidy
Developer Services
Southern Water
0330 303 0119, option 5
www.southernwater.co.uk

From: Whitcher, Daniel
Sent: 24 November 2015 15:35
To: Developer Services
Subject: RE: Rising Mains at Hildenborough in Kent

Hi,

This enquiry will ultimately need to go to Mark Macey in Operations. However, he will want to see a proposed risk assessment and method statement for the works.

They will also need to attach the following form: H&S 460

Cheers Dan.

Daniel Whitcher
Project Manager

Southern Water | **T.** 01962 716275 | **M.** 07798 856269
www.southernwater.co.uk

Southern Water, Sparrowgrove House, Sparrowgrove, Otterbourne, SO21 2SW

From: Developer Services
Sent: 24 November 2015 15:10
To: Whitcher, Daniel
Subject: FW: Rising Mains at Hildenborough in Kent

Dan, FYA (original email was forwarded to you on Pat's advice):

From: Brown, Richard [mailto:richard.brown@aecom.com]
Sent: 24 November 2015 14:48
To: Developer Services
Subject: FW: Rising Mains at Hildenborough in Kent

Dear sirs,

Please see below for an e-mail sent in September requesting further information regarding the presence of a rising mail located beneath the playing fields of Tonbridge School in Kent. I would appreciate a response to the items raised.

Thank you,
Richard.

Richard Brown, BSc MSc ARSM FGS
Senior Engineering Geologist, Ground Engineering, EMIA
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From: Brown, Richard
Sent: 15 September 2015 12:07
To: 'developerservices@southernwater.co.uk'
Subject: Rising Mains at Hildenborough in Kent [Filed 09 Oct 2015 13:19]

Sirs,

Further to a conversation with one of your colleagues I am e-mailing to seek advice on the procedure for physical exposure of two of your rising mains that pass through a site in Kent. We are working for the Environment Agency on a study to investigate the feasibility of a flood defence scheme to protect Hildenborough from flooding from the River Medway.

To inform the outline design of the scheme, we have prepared a ground investigation plan and had requested service location plans from Landmark to ensure our proposed exploratory holes were not located on or near to services. The return of these plans has revealed two rising mains shown on the attached scan of your plans that pass beneath the proposed alignment of the flood defence.

Although we can locate our ground investigation holes to avoid the locations of the pipelines, they may have an impact on design, construction and operation of the flood defence scheme and we would like to seek advice on what these impacts might be. We would also like advice on the depth of cover to these pipes and if they are within hand digging depth, the procedure and permissions required to physically expose them i.e. dig inspection pits at their locations and take coordinates for future reference. I have marked on the plan the locations where we would like to excavate inspection pits to the pipes based upon our flood defence alignment, but these locations are flexible. I've also marked national grid references for the locations and postcodes on nearby roads to help location of the site.

I look forward to hearing from you.

Best regards,
Richard Brown

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Senior Engineering Geologist
Environment and Ground Engineering, EMEA
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Appendix C – Flood levels during a 1 in 100 year + CC flood event on the River Medway

C.1 1 in 100 year + CC flood event on the River Medway – flood extent within Hildenborough

C.2 1 in 100 year + CC flood event on the River Medway – flood extent and flood levels along proposed defence

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2015s3163 - Hildenborough FAS study:
Peak modelled flood extents in the 1% AEP + climate change (+20% on flows) event
(Medway Catchment Mapping and Modelling study)

N

Stocks Green Primary School
Hilden Park
Football Ground
Car Pa
Pav
Recn Gd
B2027
LEIGH ROA
AIRFIELD WAY
MEADWAY
HILL VIEW ROAD
PARK AVE
WEALDEN CLOSE
WOODVIEW CRESCENT
ELM GROVE
ELM GROVE
ASHLEY ROAD
BYRNESIDE
COPSE ROAD
BRAMBLE CLOSE
HILDEN AVENUE
OAKLANDS WAY
PO
BIRCH C
GREENVIEW CRESCENT
BROOKMEAD
LEYBANK
HILDEN PARK ROAD
FARM LANE
OAST LANE
HIGH HILDEN CLOSE
Hilden High
Recreation Ground
HAWDEN CLOSE
Hotel
Selby's Farm
HAWDEN LANE
STACEY ROAD
SEABROOK ROAD
LONDON RD
CORRENDEN ROAD
Hawden Farm
Grove Barn
Hilden Bridge
B245
Hawden Farm Cottages
Recreation Ground
WATERSFIELD LANE
The Tonbridge School Centre
The F
Recn Gd
Pav

Legend
- Modelled watercourses
- Flood_Defence_Alignment_LN
- Peak modelled flood extent - 1% AEP + climate change (+20% flows)

0 100 200 400 m

2015s3163 - Hildenborough FAS study:
Peak modelled water levels (m AOD) in the 1% AEP + climate change (+20% on flows) event (Medway Catchment Mapping and Modelling study)
Note: values of 0.00 denote no flooding is predicted at this point

N

HW1.005
HW1.006
HW1.007
HW1.008
HW1.009
HL1.003-BD
HL1.005
HL1.006-BJU
HL1.006-BJD
HL1.007-BJU
HL1.007-BJD

Hawden Farm
Hawden Farm Cottages
Recreation Ground
HAWDEN
SEABROOK ROAD
LONDON RD
CORRENDEN ROAD

Legend
- Modelled watercourses
- Flood_Defence_Alignment_LN
- 1D model node (channel)
- Peak modelled flood extent - 1% AEP + climate change (+20% flows)

Location of water level extraction
- Upstream of proposed embankment
- Along proposed embankment location
- Downstream of proposed embankment

Appendix D – Option Costs

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Sheet (i)

Job Title	Hildenborough Flood Alleviation Scheme							Date	Job no. 47074464-A002
	Introduction								Project no. 60472771
Originator	Checked	Revision	Suffix	Orig	A	B			
MP	JW		Date	Check	28/01/2016	01/02/2015			

Scope

Develop Hildenborough FAS construction cost estimates for the following options:
1 Flood defence and flow control structure – assumes use of smaller pumps
2 Flood defence, flow control structure and moveable 1m3/s pumps
3 Flood defence, flow control structure and permanent 2m3/s Archimedes screw pump

References

SPONS 2014
Quotations from suppliers: Grass Concreet Ltd, Aquatic Engineering Control Ltd, Defence Doors Ltd
Construction estimates based on understanding of previous schemes

Drawings used

HILD_AEC_XX_XX_DR_CE00001 & 00002

Assumptions

- Option 3 - 2m^3/s archimedes screw pump costs have been scaled from smaller pumps costs, with an allowance for extensive civils works
- Southern Water (SW) mains diversion - SW have advised that it is not acceptable to construct over their asset. A nominal fee of £100k, based on scale of works, has been allowed
- Option 1 assumes the use of mobile pumps <0.5m^3/s
- A haul road is required along the full extent of the defence to accommodate vehicle movements, allowing for winter working
- No allowance has been made for procurement, supply, delivery, installation, maintenance and operation of mobile pumps
- Options 2 & 3 - the scale of the embankment has been increased locally around flow control structure to accommodate vehilcular movements. No allowance for safety barriers have been made
- Preliminaries (inc. consultation, meeting delivery gateways, enabling works) design, and supervision is assumed to an additional 35% of the construction cost
- 60% Optimism bias has been allowed

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Calculations

Job Title	Hildenborough Flood Alleviation Scheme	Date	Job no.	47074464-A002
	Defence and flow control only		Project no.	60472771

Originator	Checked	Revision	Suffix	Orig	A
MP	JW		Date	Check	28/01/2016

Summary of key features

Construction of a 1.25km flood defence comprising: approx 1km earth embankment, 0.25km plastic sheet piles, 1No. Flow control structure, 0.3km grasscrete and hardstanding, 2No. flood gates, diversion works to water mains. This options assumes use of relatively small pumps (<0.5m^3/s)

No.	Activity	Reference	No.	Unit	Rate (£/unit)	Cost £
1	Mobilisation / welfare / demobilisation	Assumed / experience	24	Weeks	6000	£ 144,000.00
2	Construction / removal of temporary haul road	Spons	8400	m^2	7.59	£ 63,756.00
3	Site / vegetation clearance and tree removal	Spons	0.5	ha	2792.56	£ 1,396.28
4	Diversion of rising main	Assumed / experience	1	sum	100000	£ 100,000.00
5	Excavation for embankment key	Spons	7022	m^3	3.41	£ 23,945.02
6	Placement of geotextile	Spons	10032	m^2	3.91	£ 39,225.12
7	Construction of embankment (clay and topsoil)	Spons	6600	m^3	22.8	£ 150,480.00
8	Embankment seeding	Spons	7736	m^2	5.5	£ 42,548.00
9	Supply of plastic piles	Quotation	2009	m^2	45	£ 98,297.00
10	Installation of plastic piles	Spons - SSP rate	2009.0	1500m^2	152	£ 313,260.00
11	Construction of concrete flood gate piers and hardstanding	Assumed / experience	20	m	1200	£ 24,000.00
12	Timber cladding for piles and flood gate piers	Assumed / experience	746.2	m^2	50	£ 37,310.00
13	Installation of 6m and 4m flood gate	Quotation	1	sum	21100	£ 22,100.00
14	Flood gate installation labour	Assumed / experience	1	sum	1000	
15	Installation of pipework on existing ditches inc. concrete surround and temp works	Spons / Assumed	37.5	m	120	£ 4,500.00
16	Installation of flap valves on existing ditches	Assumed / experience	2	sum	1000	£ 2,000.00
17	Installation of retrospective flap valve - 225m diam	Spons / Assumed	3	sum	500	£ 1,500.00
18	Installation of retrospective flap valve - 375m diam	Spons / Assumed	1	sum	800	£ 800.00
19	Installation of retrospective flap valve - 450m diam	Spons / Assumed	2	sum	1000	£ 2,000.00
20	Construction of grasscrete access track	Quotation	2896	m^2	37.42	£ 108,368.32
21	Construction of RC hardstanding for Hiab	Spons / Assumed	225	m^2	50	£ 11,250.00
22	Construction of RC flow control structure	Assumed / experience	1	sum	15000	£ 15,000.00
23	Foundations for flow control stucture	Spons / Assumed	10	m^3	200	£ 2,000.00
24	Supply and installation of fish-friendly flap valves	Quotation	1	sum	18600	£ 18,600.00
A	Sub-total		Sum items Nos. 1-24			£ 1,226,335.74
B	35% for prelims, design, supervision, scale of works		Item A x 0.35			£ 429,217.51
C	60% Optimism bias		Items (A + B) x 0.6			£ 993,331.95
D	**Total**		**Items A + B + C**			**£ 2,648,885.20**

Calculations

Job Title	Hildenborough Flood Alleviation Scheme	Date	Job no. 47074464-A002
	Defence and use of mobile 1m^3/s pumps		Project no. 60472771

Originator	Checked	Revision	Suffix	Orig	A	B
MP	JW		Date	Check	28/01/2016	01/02/2015

Summary of key features

Construction of a 1.25km flood defence comprising: approx 1km earth embankment (0.3km capable of accommodating lorry movements), 0.25km plastic sheet piles, 1No. Flow control structure, 0.3km grasscrete and hardstanding, 2No. flood gates, diversion works to water mains, 75m^3 sump. This options assumes use of 2 - 3No. 1m^3/s mobile pumps on the embankment/hardstanding.

No.	Activity	Reference	No.	Unit	Rate (£/unit)	Cost £
1	Mobilisation / welfare / demobilisation	Assumed / experience	24	Weeks	6000	£ 144,000.00
2	Construction / removal of temporary haul road	Spons	8400	m^2	7.59	£ 63,756.00
3	Site / vegetation clearance and tree removal	Spons	0.5	ha	2792.56	£ 1,396.28
4	Diversion of rising main	Assumed / experience	1	sum	100000	£ 100,000.00
5	Excavation for embankment key	Spons	7022	m^3	3.41	£ 23,945.02
6	Placement of geotextile	Spons	10032	m^2	3.91	£ 39,225.12
7	Construction of embankment (clay and topsoil)	Spons	10654	m^3	22.8	£ 242,911.20
8	Embankment seeding	Spons	7736	m^2	5.5	£ 42,548.00
9	Supply of plastic piles	Quotation	2009	m^2	45	£ 98,297.00
10	Installation of plastic piles	Spons - SSP rate	2009.0	1500m^2	152	£ 313,260.00
11	Construction of concrete flood gate piers and hardstanding	Assumed / experience	20	m	1200	£ 24,000.00
12	Timber cladding for piles and flood gate piers	Assumed / experience	746.2	m^2	50	£ 37,310.00
13	Installation of 6m and 4m flood gate	Quotation	1	sum	21100	£ 22,100.00
14	Flood gate installation labour	experience	1	sum	1000	
15	Installation of pipework on existing ditches inc. concrete surround and temp works	Spons / Assumed	37.5	m	120	£ 4,500.00
16	Installation of flap valves on existing ditches	Assumed / experience	2	sum	1000	£ 2,000.00
17	Installation of retrospective flap valve - 225m diam	Spons / Assumed	3	sum	500	£ 1,500.00
18	Installation of retrospective flap valve - 375m diam	Spons / Assumed	1	sum	800	£ 800.00
19	Installation of retrospective flap valve - 450m diam	Spons / Assumed	2	sum	1000	£ 2,000.00
20	Construction of grasscrete access track	Quotation	2896	m^2	37.42	£ 108,368.32
21	Construction of RC hardstanding for Hiab	Spons / Assumed	225	m^2	60	£ 13,500.00
22	Construction of RC flow control structure	Assumed / experience	1	sum	15000	£ 15,000.00
23	Foundations for flow control stucture	Spons / Assumed	10	m^3	200	£ 2,000.00
24	Supply and installation of fish-friendly flap valves	Quotation	1	sum	18600	£ 18,600.00
25	Piling for hiab slab	Spons	1	sum	24960	£ 24,960.00
26	Sump excavation	Spons	216	m^3	3.41	£ 736.56
27	Sump walls SSPs	Spons / Assumed	300	m^2	148	£ 52,050.00
28	Sump base	Spons / Assumed	25	m^3	210	£ 5,250.00
A	Sub-total		Sum items Nos. 1-28			£ 1,404,013.50
B	35% for prelims, design, supervision, scale of works		Item A x 0.35			£ 491,404.73
C	60% Optimism bias		Items (A + B) x 0.6			£ 1,137,250.94
D	**Total**		**Items A + B + C**			**£ 3,032,669.16**

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Calculations

Job Title	Hildenborough Flood Alleviation Scheme Defence and use of a permanent pump		Date	Job no. 47074464-A002 Project no. 60472771

Originator	Checked	Revision	Suffix	Orig	A	B
MP	JW		Date	Check	28/01/2016	01/02/2015

Summary of key features

Construction of a 1.25km flood defence comprising: approx 1km earth embankment (0.3km capable of accommodating lorry movements), 0.25km plastic sheet piles, 1No. Flow control structure, 0.3km grasscrete and hardstanding, 2No. flood gates, diversion works to water mains, 75m^3 sump. This options assumes use of 2m^3/s archimedes screw pump.

No.	Activity	Reference	No.	Unit	Rate (£/unit)	Cost £
1	Mobilisation / welfare / demobilisation	Assumed / experience	24	Weeks	6000	£ 144,000.00
2	Construction / removal of temporary haul road	Spons	8400	m^2	7.59	£ 63,756.00
3	Site / vegetation clearance and tree removal	Spons	0.5	ha	2792.56	£ 1,396.28
4	Diversion of rising main	Assumed / experience	1	sum	100000	£ 100,000.00
5	Excavation for embankment key	Spons	7022	m^3	3.41	£ 23,945.02
6	Placement of geotextile	Spons	10032	m^2	3.91	£ 39,225.12
7	Construction of embankment (clay and topsoil)	Spons	10654	m^3	22.8	£ 242,911.20
8	Embankment seeding	Spons	7736	m^2	5.5	£ 42,548.00
9	Supply of plastic piles	Quotation	2009	m^2	45	£ 98,297.00
10	Installation of plastic piles	Spons - SSP rate	2009.0	1500m^2	152	£ 313,260.00
11	Construction of concrete flood gate piers and hardstanding	Assumed / experience	20	m	1200	£ 24,000.00
12	Timber cladding for piles and flood gate piers	Assumed / experience	746.2	m^2	50	£ 37,310.00
13	Installation of 6m and 4m flood gate	Quotation	1	sum	21100	£ 22,100.00
14	Flood gate installation labour	experience	1	sum	1000	
15	Installation of pipework on existing ditches inc. concrete surround and temp works	Spons / Assumed	37.5	m	120	£ 4,500.00
16	Installation of flap valves on existing ditches	Assumed / experience	2	sum	1000	£ 2,000.00
17	Installation of retrospective flap valve - 225m diam	Spons / Assumed	3	sum	500	£ 1,500.00
18	Installation of retrospective flap valve - 375m diam	Spons / Assumed	1	sum	800	£ 800.00
19	Installation of retrospective flap valve - 450m diam	Spons / Assumed	2	sum	1000	£ 2,000.00
20	Construction of grasscrete access track	Quotation	2896	m^2	37.42	£ 108,368.32
21	Construction of RC hardstanding for Hiab	Spons / Assumed	225	m^2	60	£ 13,500.00
22	Construction of RC flow control structure	Assumed / experience	1	sum	15000	£ 15,000.00
23	Foundations for flow control stucture	Spons / Assumed	10	m^3	200	£ 2,000.00
24	Supply and installation of fish-friendly flap valves	Quotation	1	sum	18600	£ 18,600.00
25	Sump excavation	Spons	216	m^3	3.41	£ 736.56
26	Sump walls SSPs	Spons	300	m^2	148	£ 52,050.00
27	Sump base	Spons / Assumed	25	m^3	210	£ 5,250.00
28	Permanent 2m^3/s archimedes screw pump	Assumed	1	sum	650000	£ 650,000.00
29	Electrical substation	Assumed / experience	1	sum	6200	£ 6,200.00
30	Piling for hiab slab	Spons	1	sum	24960	£ 24,960.00
						£ -
A	Sub-total		Sum items Nos. 1-30			£ 2,060,213.50
B	35% for prelims, design, supervision, scale of works		Item A x 0.35			£ 721,074.73
C	60% Optimism bias		Items (A + B) x 0.6			£ 1,668,772.94
D	**Total**		**Items A + B + C**			**£ 4,450,061.16**

Appendix E – Project Risks

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Project Risks

Nr	Risk	Possible Consequence	Initial Risk	Mitigation	Residual Risk	Applicable to / Comment
1.	Difficulty in agreeing permanent vehicular access route to outfall	Delay & additional cost	M	Consider options early and liaise accordingly	L	All options
2.	Difficulty in gaining agreement for land-take from landowners and stakeholders	Delay & additional cost	H	Early and regular contact with all stakeholders	L	All options
3.	Requirement for fish and eel-friendly pumping arrangements at the outfall	Delay in gaining Fisheries approval & additional cost	H	Early liaison with Fisheries officer	M	All options, but particularly options 1 & 2
4.	Difficulty in getting permanent power supply for the pump at the outfall	Delay & additional cost	H	Make early enquiries with power provider	M	Option 3
5.	Non-availability of mobile pumping plant at time of flooding	Increased flood damage	VH	Buy mobile pumps (Option 1). Designate a minimum of 2No. pumps to the River Medway (Option 2)	H	Options 1 & 2
6.	Not used	-	-	-	-	-
7.	Excessive seepage beneath flood embankment	Localised flooding behind defences	H	Suitable and timely ground investigations appropriate for detailed design. Appropriate cut-off required	L	All options
8.	Blockage of outfall due to debris in Hawden Stream	Localised flooding behind defences	H	Provide suitable trash screen on outfall	L	All options
9.	Higher flood levels on the River Medway floodplain	Overtopping of the flood defences with possible risk of collapse and major flooding	VH	Allow for a suitable emergency overspill to reduce risk of failure of the embankment	M	All options
10.	High flows in the Hawden Stream	Flooding behind defences	VH	Maximise size of outfall and provide suitable pumping arrangements	H	All options
Nr	**Risk**	**Possible Consequence**	**Initial Risk**	**Mitigation**	**Residual Risk**	**Applicable to / Comment**

11.	Unexpected ground conditions	Delay & additional cost; possibility of embankment failure	M	Suitable and timely ground investigations appropriate for detailed design. Install geotextile	L	All options
12.	Unexpected public utility services	Delay & additional cost; possibility of strike during construction	M	Detailed services searches (GPR)	VL	All options
13.	Unexpected UXOs	Delay & additional cost	L	Conduct further searches	VL	All options
14.	Unexpected environmental/ecological concerns	Delay & additional cost	M	Conduct further environmental assessments	L	All options
15.	Flood damage to Chestnut Lodge in the event of a 100yr event in the Medway or Hilden Brook	Unexpected flood damage and bad publicity	M	Ensure adequate hydraulic modelling is carried out	VL	All options
16.	Flooding from the Medway to residential area in Hildenborough due to overland flooding to the north of Hawden Cottages	Unexpected flood damage and bad publicity	M	Ensure adequate topographical surveys and hydraulic modelling are carried out	VL	All options
17.	Delay in starting pumping at outfall, hence flooding and possibly adverse publicity to the Environment Agency					
(a)	Due to being unaware of the onset of critical flood conditions in the Hawden Stream		H	Provide contact probes to provide warning of rising flood levels and, if appropriate, to automatically start pumping	M	Options 1 & 2
(b)	Due to inability to obtain suitable mobile pumps		H	Early contact with pump supplier and reservations	M	Options 1 & 2
(c)	Due to inability to deliver mobile pumps to outfall		VH	Keep mobile pump as close to the outfall as possible and provide dry access or provide fixed pump	H	Options 1 & 2 – unlikely to be possible to keep pumps close to outfall
(d)	Due to inability to start pump(s)		H	Regular maintenance and operation of pump. Setting up emergency plan to supply back-up pumping	L	All options
Nr	**Risk**	**Possible Consequence**	**Initial Risk**	**Mitigation**	**Residual Risk**	**Applicable to / Comment**

(e)	Due to mobile pump failure during an event		H	Ensure personnel are on site during pumping or provide for sensing device with automatic remote alarm to advise of failure. Provide standby pumps	M	Options 1 & 2
(f)	Due to fixed pump failure during an event		H	Provide for sensing device with automatic remote alarm to advise of failure. Ensure regular maintenance and operation of pump.	L	Option 3
18	FAS does not provide adequate flood protection against flooding from the Hawden Stream	Flooding, adverse publicity & additional cost	H	Provide suitably sized flow control structure and pumps	H	All options – further modelling required. Pumping may not be effective. Upstream storage to be investigated
19	Diversion of Southern Water rising main	Delay & additional cost	VH	Negotiate options to locally modify or protect rising main	H	All options
20	Damage to railway embankment during flooding	Delay & additional cost	H	Avoid tying into railway embankment with flood defence. Early liaison with Network Rail	L	All options
21	Inability to achieve suitable compaction on embankment	Inadequate construction & additional cost	M	Excavate to suitable strata and install geotextile	L	All options

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Appendix F – Options 2 and 3 Scheme Drawings

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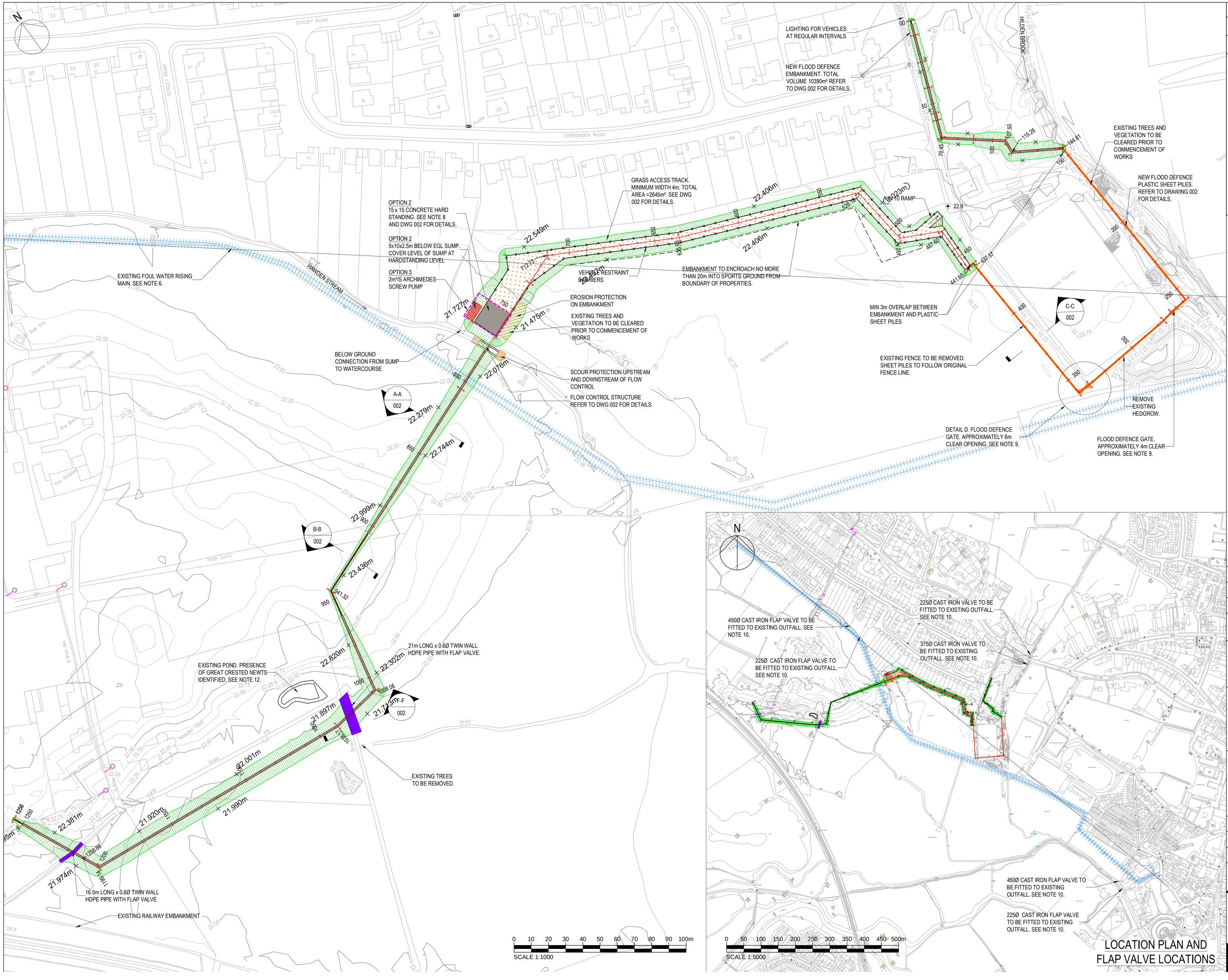

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

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CONSTRUCTION

STRIKING EXISTING SERVICES - POTENTIAL FOR INJURY/DEATH

ENCOUNTERING GCN - POTENTIAL FOR CAUSING HARM TO GREAT CRESTED NEWTS

UNSTABLE GROUND - POTENTIAL FOR COLLAPSE AND INJURY

OPERATION

DEEP WATER DURING FLOOD - POTENTIAL FOR DROWNING

OPERATING LARGE PUMPS DURING FLOOD - POTENTIAL FOR INJURY/DEATH

WORKING AT HEIGHT/ BY DEEP EXCAVATION - POTENTIAL FOR INJURY/DEATH WHEN WORKING WITH THE SUMP

DEMOLITION/DECOMMISSIONING

STRIKING EXISTING SERVICES - POTENTIAL FOR INJURY/DEATH

UNSTABLE GROUND - POTENTIAL FOR COLLAPSE AND INJURY

NOTES

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3. ALL DIMENSIONS IN MILLIMETRES, ALL CHAINAGES, LEVELS AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. ALL LEVELS ARE TO ORDNANCE DATUM (NEWLYN).
5. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWING 4464-XXX-XX-XX-DR-CE-00002.
6. EXISTING FOUL WATER RISING MAIN TO BE DIVERTED. ENVIRONMENT AGENCY TO ARRANGE DIVERSION AND ANY OTHER WORKS TO COMPLY WITH SOUTHERN WATER'S REQUIREMENTS AS PART OF NECESSARY ENABLING WORKS, PRIOR TO COMMENCEMENT OF THE MAIN WORKS.
7. ALL EXISTING TREES AND VEGETATION ON THE NEW FLOOD DEFENCE ALIGNMENT TO BE REMOVED AS PART OF NECESSARY ENABLING WORKS, PRIOR TO COMMENCEMENT OF THE MAIN WORKS.
8. CONCRETE HARDSTANDING SUITABLE FOR HIAB LORRY OR SIMILAR TO ENABLE TRANSPORTATION AND INSTALLATION OF PUMPING EQUIPMENT.
9. FLOOD GATE SUITABLE TO ACCOMMODATE HYDROSTATIC LOADING TO 1% AEP + CLIMATE CHANGE EVENT. DEFENCE DOORS PRODUCT OR SIMILAR ACCEPTED.
10. FLAP VALVES TO BE RETROSPECTIVELY FITTED TO EXISTING OUTFALLS FOLLOWING RECEIPT OF PRIOR AGREEMENT FROM SOUTHERN WATER. ENVIRONMENT AGENCY TO FACILITATE AGREEMENTS.
11. DESIGN FLOOD DEFENCE LEVEL = 23.8m AOD
12. A LICENCE FROM ENGLISH NATURE UNDERTAKING MITIGATION WORKS FOR GREAT CRESTED NEWTS MAY BE REQUIRED. ENVIRONMENT AGENCY TO LEAD ON LICENSING REQUIREMENTS.

Revision Details	By / Check	Date	Suffix
LEVELS ADDED AT TOE OF EMBANKMENT	MRM / JW	23/03/16	B
FOR COMMENT	MRM / JW	04/02/16	A

Purpose of issue

FEASIBLITY ASSESSMENT FOR OUTLINE DESIGN

Client

Environment Agency

Project Title

HILDENBOROUGH FLOOD ALLEVIATION SCHEME

Drawing Title

FLOOD DEFENCE GENERAL ARRANGEMENT

Designed	Drawn	Checked	Approved	Date
JW	MRM	JW	JHR	04/02/16

AECOM Internal Project No.	Suitability
60472771	
Scale @ A1	Zone
1:1000, 1:5000	

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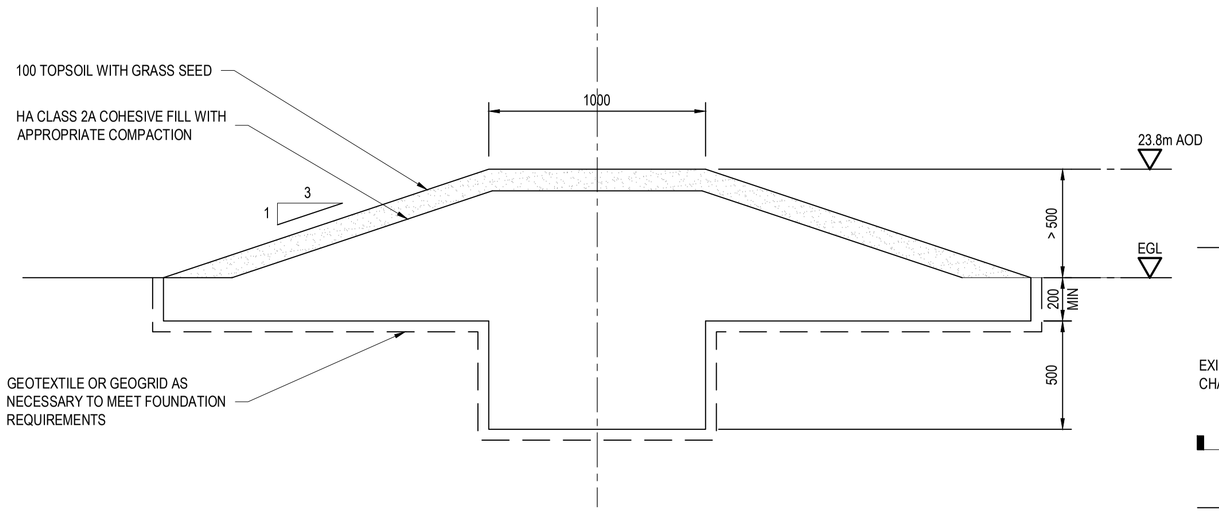
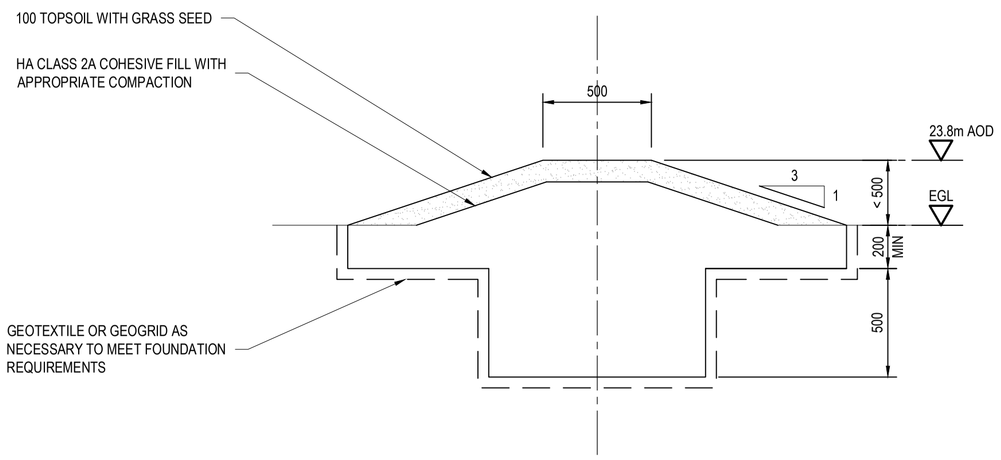
AECOM

Drawing Number	Rev
4464-XXX-XX-XX-DR-CE-00001	B



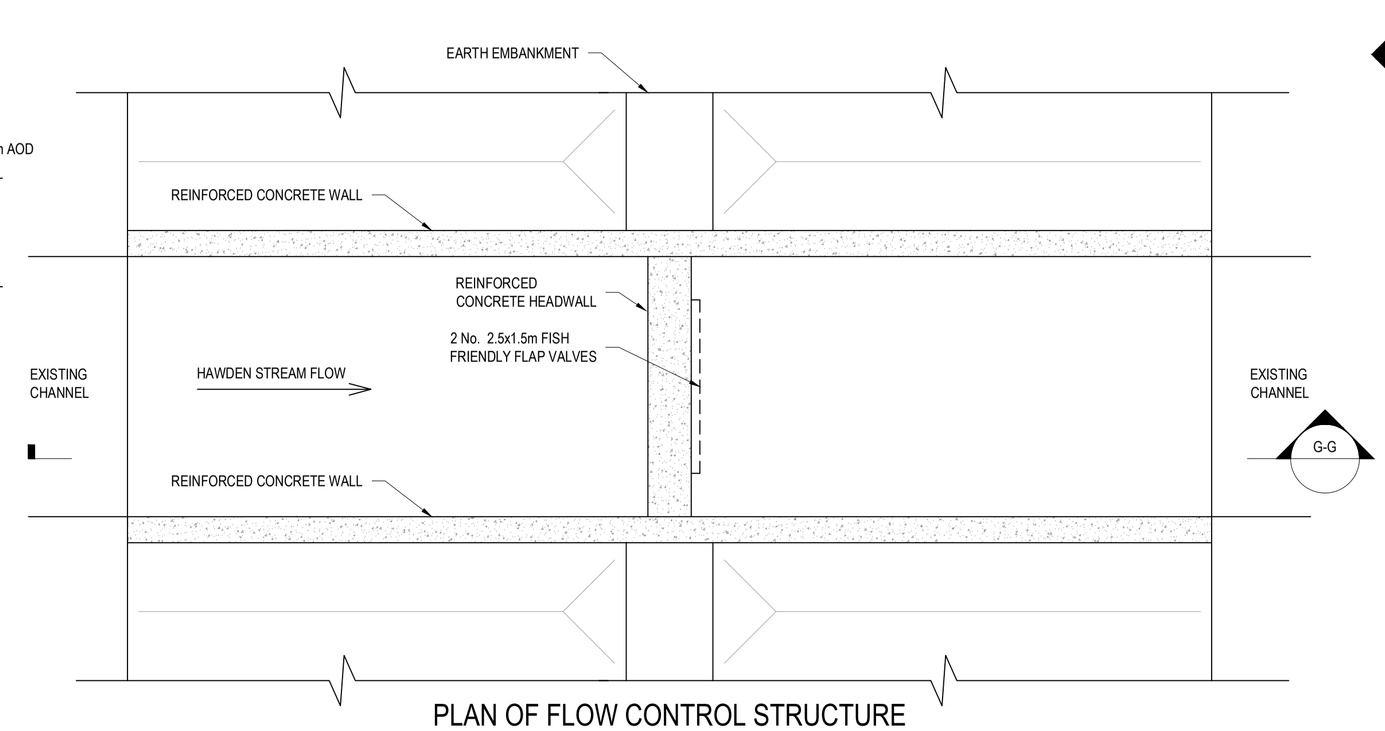
SECTION A-A
TYPICAL EMBANKMENT FOR HEIGHT > 500mm

SCALE 1:20



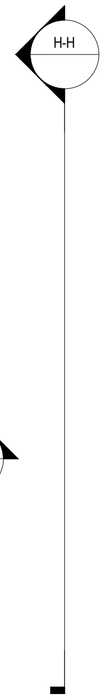
SECTION B-B
TYPICAL EMBANKMENT FOR HEIGHT ≤ 500mm

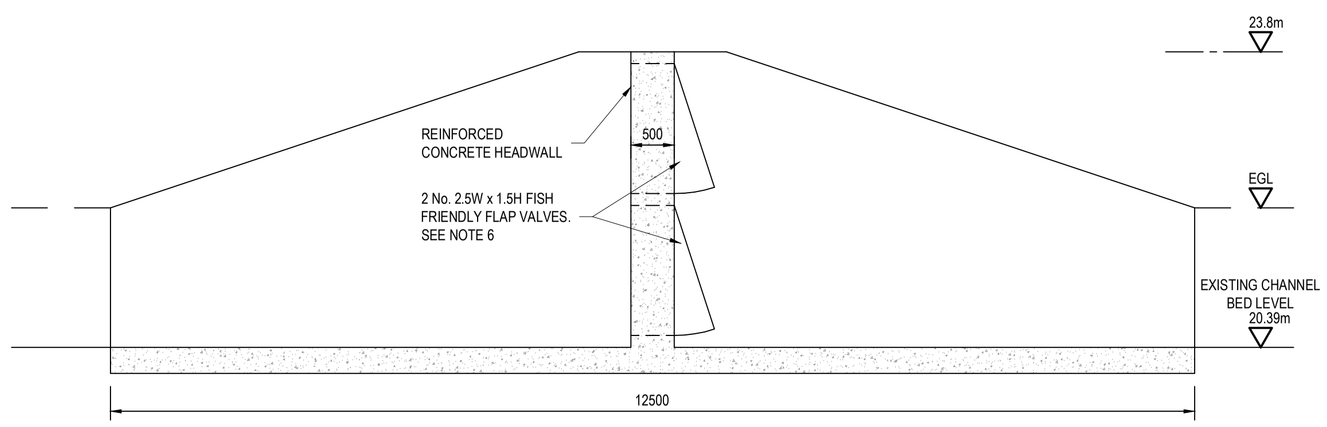
SCALE 1:20



PLAN OF FLOW CONTROL STRUCTURE

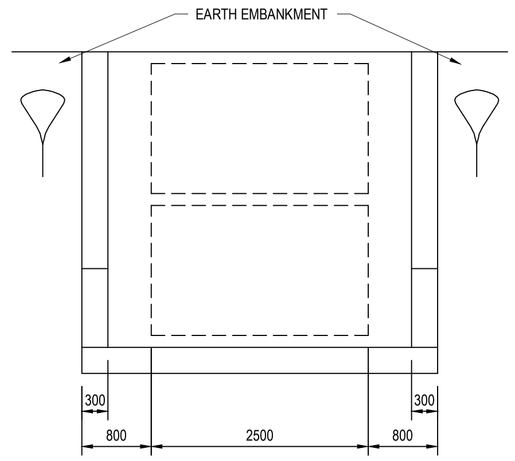
SCALE 1:50





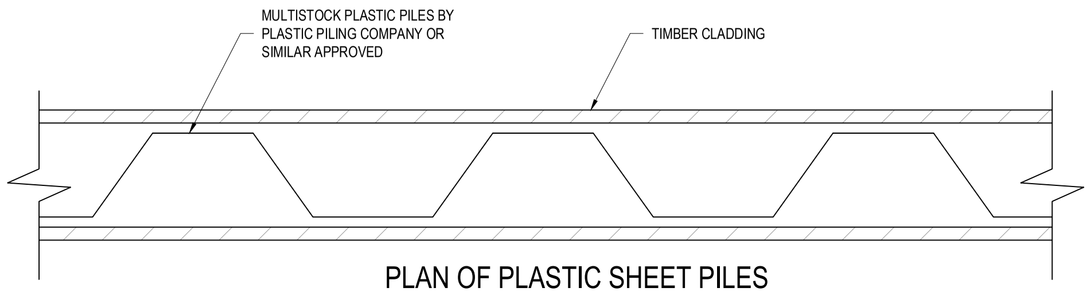
SECTION G-G THROUGH FLOW CONTROL

SCALE 1:50



ELEVATION H-H

SCALE 1:50



PLAN OF PLASTIC SHEET PILES

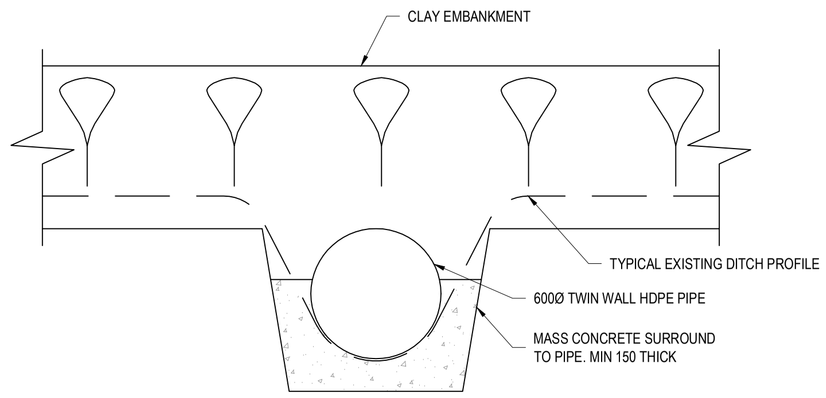
SCALE 1:10

0 400 800 1200 1600 2000mm

SCALE 1:20

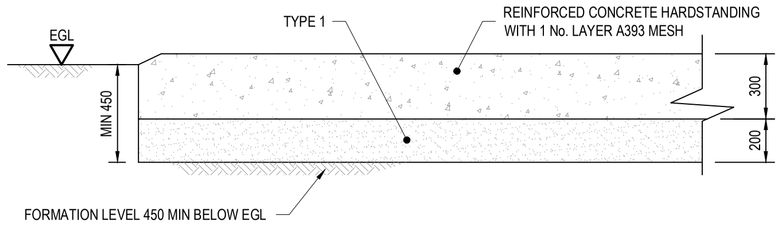
0 200 400 600 800 1000mm

SCALE 1:10



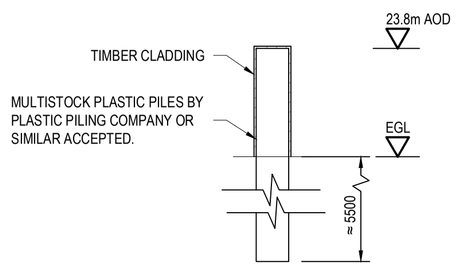
SECTION F-F
TYPICAL DRAINAGE PIPE DETAIL

SCALE 1:20



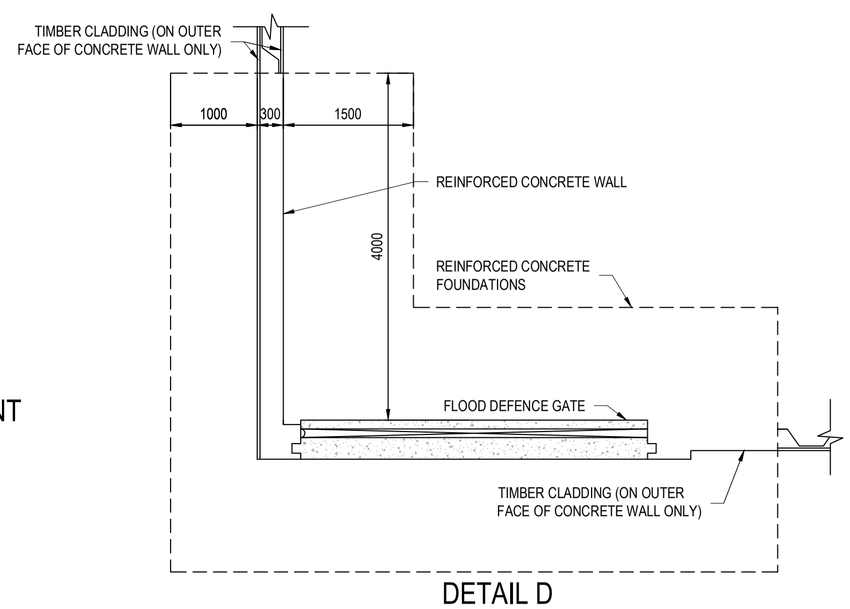
TYPICAL SECTION THROUGH HARDSTANDING

SCALE 1:20



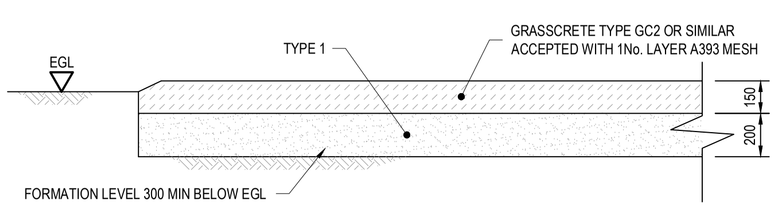
SECTION C-C
TYPICAL SHEET PILE ARRANGMENT

SCALE 1:20



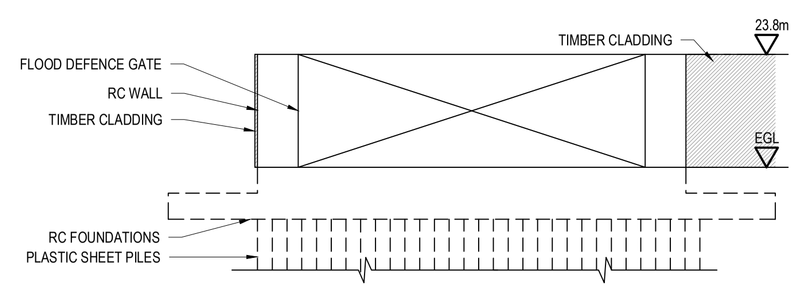
DETAIL D
TYPICAL PLAN OF FLOOD DEFENCE GATE

SCALE 1:50



TYPICAL SECTION THROUGH GRASSCRETE

SCALE 1:20



ELEVATION E-E

SCALE 1:50

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PURPOSE OF ISSUE UPDATED	MRM / JW	23/03/16	B
FOR COMMENT	MRM / JW	04/02/16	A

Purpose of issue

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Drawing Title

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JW	MRM	JW	JHR	04/02/16

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