Frogmead Meadow Natural Flood Management Project

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Location

The Site is located within the grounds of the National Trust estate at Sissinghurst, adjacent and to the south of the Hammer Stream. Grid reference: TQ81372 38672.

It lies just outside the High Weald Area of Outstanding Natural Beauty in a landscape with similar characteristics, transitional between the High and Low Weald and in the Parish of Cranbrook.

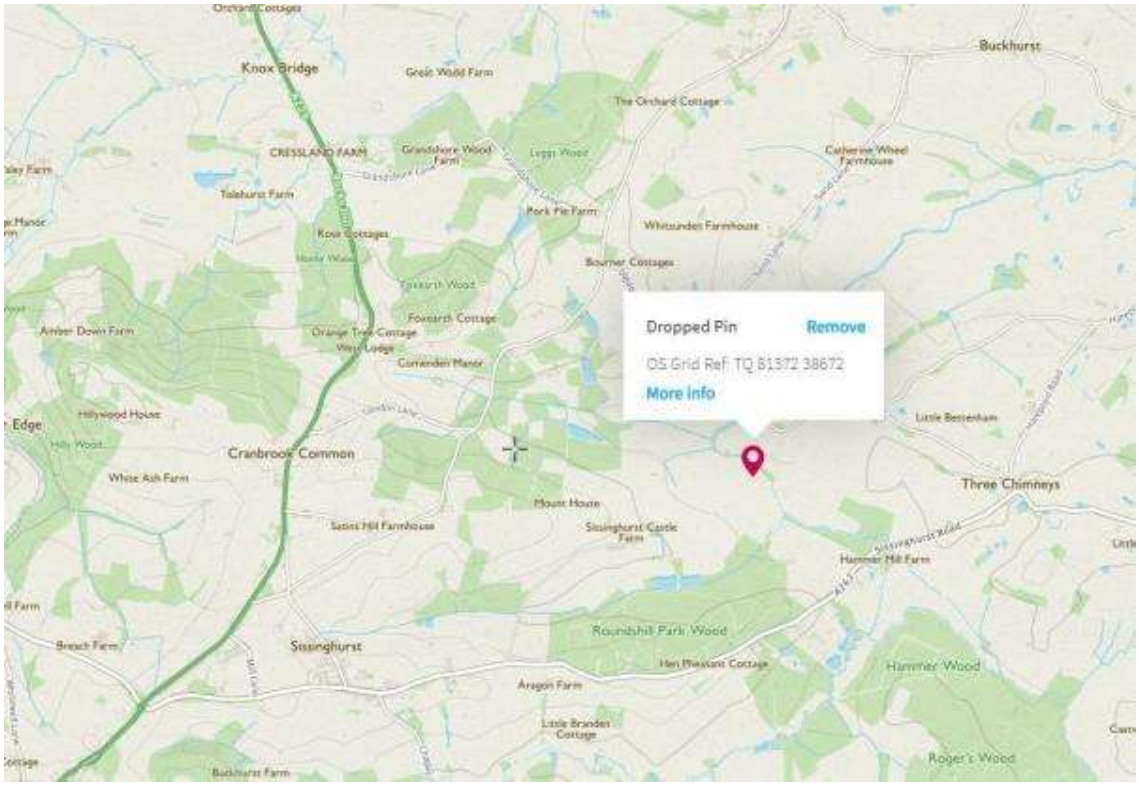

Fig 1 General location

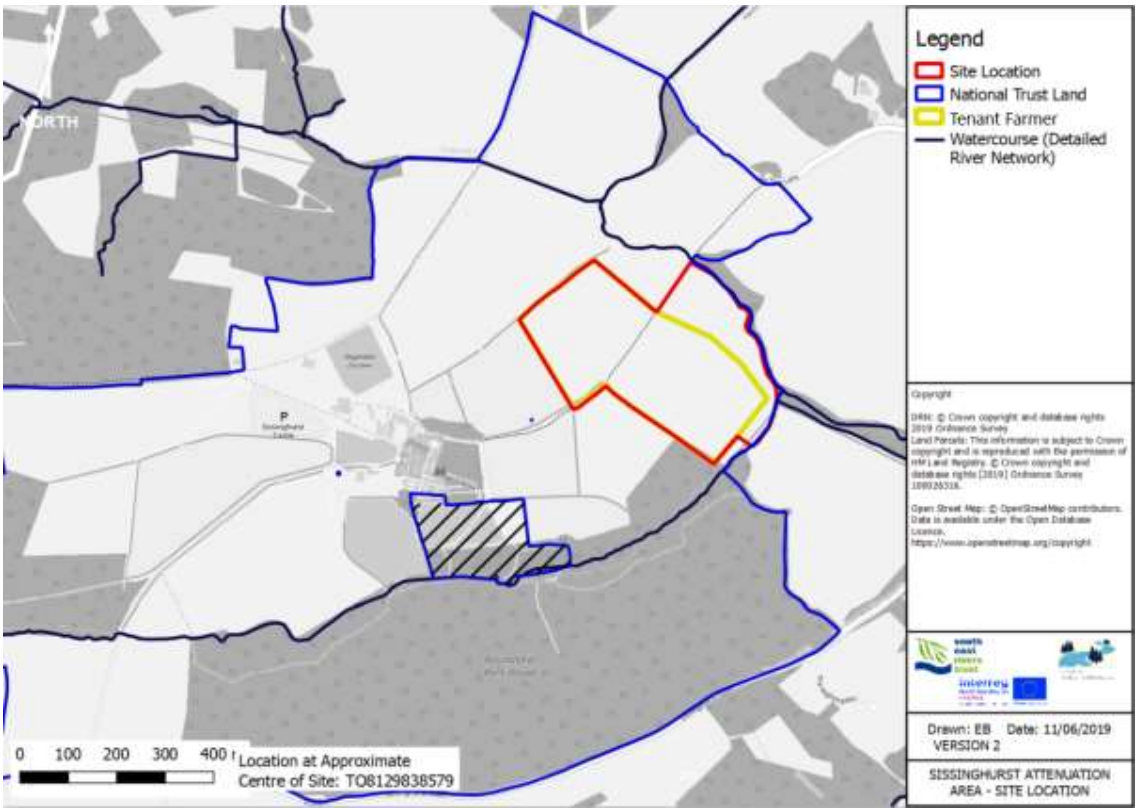

Fig 2 Site boundaries **– full extent red line – soil reception areas yellow line**

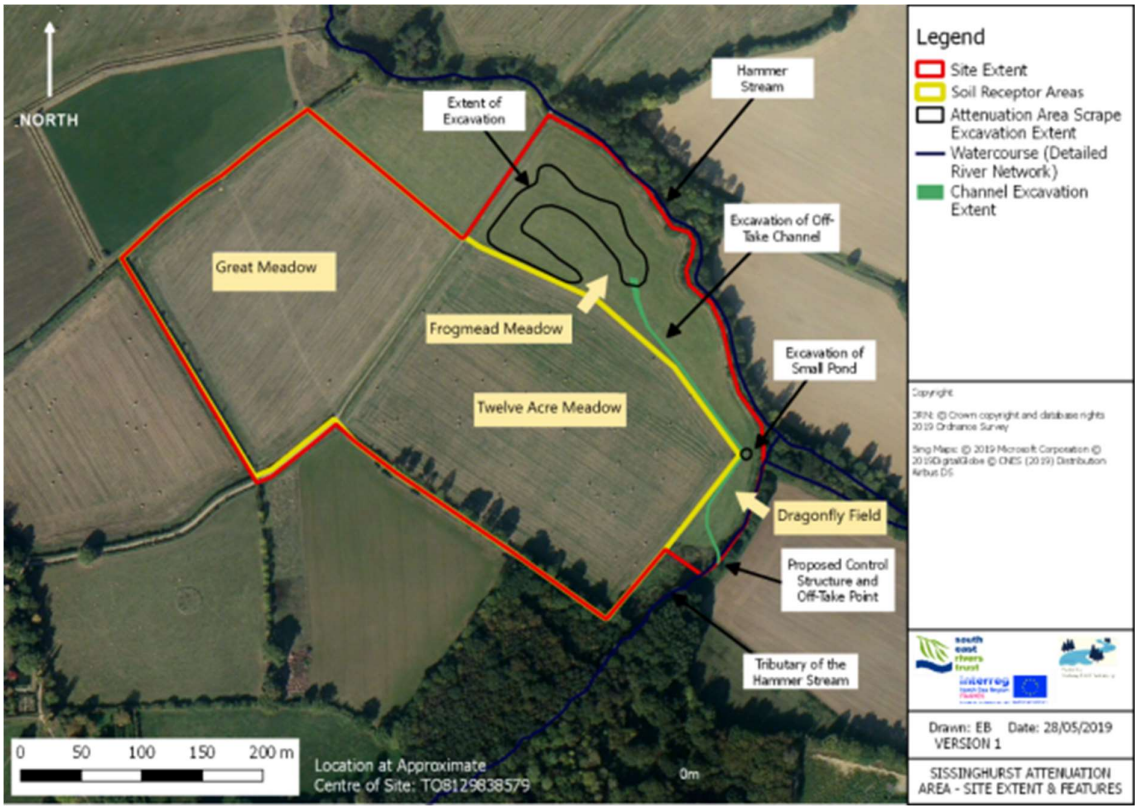

Fig 3 Field names and location of features

Description of the proposal

Background to the project partners and roles

This project proposal is the fruit of a partnership between the South East Rivers Trust (SERT) and National Trust to improve biodiversity at the Sissinghurst Castle Estate and to trial nature-based solutions to flood mitigation. SERT works closely with the Environment Agency and is part of both the :Medway Flood Action Partnership (MFAP)[1]; and the European FRAMES Partnership[2]; who wish to reduce flood risk in the Medway catchment and to pilot novel approaches to increasing environmental resilience to flooding and climate change . After extensive consultation with a wide range of stakeholders this Natural Flood Management proposal at Frogmead Meadow has been developed which offers multiple biodiversity, flood and agricultural benefits; at the same time respecting the landscape, heritage, archaeological and ecological integrity of the site.

The South East Rivers Trust is leading on the delivery of the project with funding from DEFRA via the MFAP and the European Union via FRAMES. The National Trust who own and manage the site have been intimately involved in the development of this proposal and will continue their long term management and custodianship of it following project delivery.

The topsoil reception fields belong to the National Trust and are managed under an agricultural tenancy – we have the agreement of the tenant farmer to the proposal.

The eastern bank of the minor tributary belongs to a neighbouring landowner whose agreement we have for access to the site and installation of the water control structure.

Aims of the project

The project aims to:

- Improve biodiversity at Frogmead Meadow by: creating a wider range of wet/dry conditions throughout the seasons: reducing soil fertility by stripping topsoil; to create better conditions for the establishment of wildflowers; and creating new pond habitats.
- Contribute to flood mitigation in the Medway catchment through the temporary storage of flood waters in the floodplain, potentially reducing flood peaks downstream.
- Contribute to drought resilience through the storage and slow release of water stored in the floodplain by raising the water table within it.
- Contribute to other increases in Natural Capital, through for example carbon storage on the site, and improvements to water quality through the creation of a natural filtration system.
- Provide benefits to agriculture through improvements to topsoil depth on neighbouring arable fields
- Contribute to the overall national evidence base for Natural Flood Management in the UK, thought pre and post project monitoring.

Provide a model and exemplar demonstration site for the multiple benefits of NFM in Southeast EnglandProject Design Summary

The aims of the project will be achieved by the diversion of peak flows from a minor tributary of the Hammer stream into a former arable field that lies alongside the Hammer Stream itself. The flood

[1] https://www.gov.uk/government/publications/the-river-medway-partnership-objectives-members-and-action-plan/the-river-medway-partnership-objectives-members-and-action-plan
[2] https://northsearegion.eu/frames/

waters will temporarily be stored in a large shallow scrape in Frogmead Meadow before infiltrating into the soil or slowly percolating into the Hammer Stream.

The project consists of the following elements:

- A small control structure constructed in the tributary to divert peak flood flows, whilst allowing base flows to continue uninterrupted.
- A shallow channel of approximately 260m to convey flood waters via the 'Dragonfly Field' to the scrape in Frogmead Meadow.
- A small hedge bund 30cm tall alongside part of the channel, to provide separation between the channel and the arable and the neighbouring arable field and for the creation of additional habitat.
- The creation of a large, shallow sloping scrape in Frogmead Meadow which follows existing contours and reflects what is thought to be the remains of a former river channel.
- The removal of the top 35cm of topsoil from the channel and scrapes for spreading at a depth of 5-6cm on neighbouring arable fields ('Twelve Acre Meadow' and the 'Great Meadow')
- Removal of residual subsoil down to 6ocm within the central part of the scrape and channel for spreading on parts of Frogmead meadow to an average depth of about 10cm. This to be reseeded with wildflower mixes of native provenance.
- The creation of three small ponds within the scrape and channel system to provide additional habitat.
  Continuing management of the site as a hay meadow, made possible by the very shallow 1 in 10 slopes of the scrape, and the expectation that the site will only be very wet on a rare and seasonal basis.

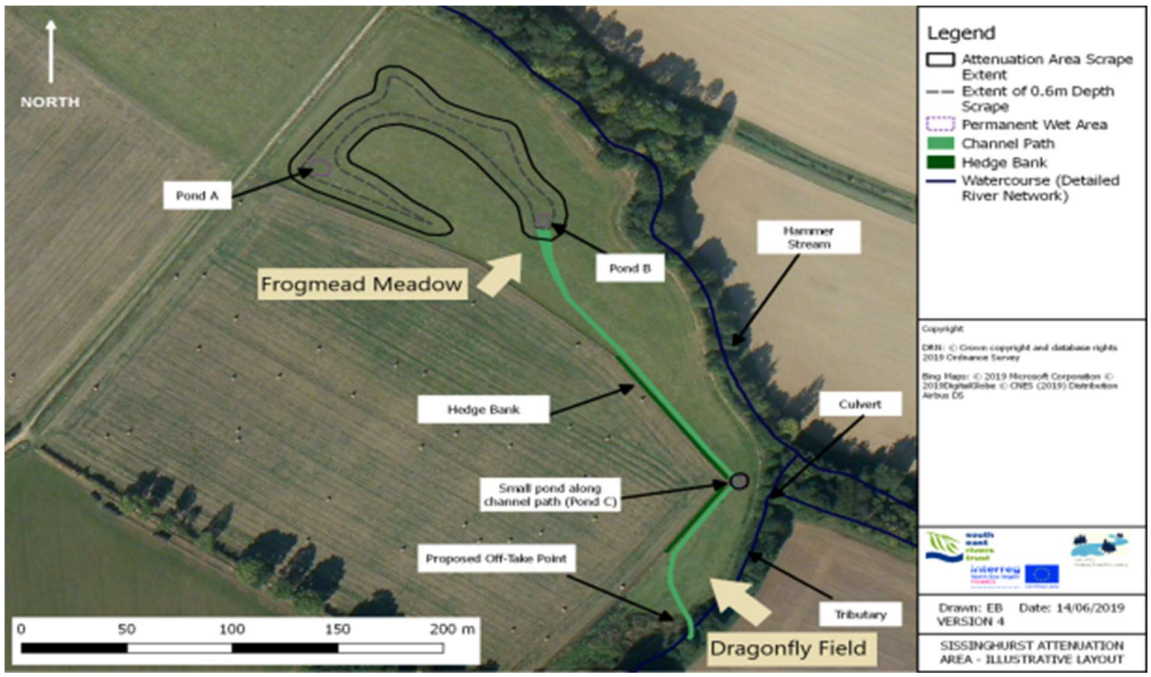

Fig 4. Sissinghurst Attenuation Area – Illustrative Layout

Visualisation

Fig 5 Frogmead Meadow - viewed from the track to the west, spring 2019

Fig 6 Artists impression of site when flooded in winter – ***note the areas of water are not entirely accurate***

Background to site, design consideration and constraints, consents and permissions

Heritage Context

The site is entirely owned by the National Trust as part of the historic Sissinghurst Castle Garden Estate.

In Saxon times the site was home to a pig farm called 'Saxenhurst' (a 'hurst' being a clearing in a wood, thus 'Saxon hurst' which evolved in to the present 'Sissinghurst'. At this time the farm would have been surrounded by the ancient woodland of the Weald, with the woodlands and watercourses little altered since at least Roman times.
The site was occupied by a moated manor house in the 12th century. This developed into a grand Tudor mansion in the 16th century, although this fell into serious decline as a consequence of the civil war. From 1756 to 1763 the house was leased to the government who used it as a military prison for French prisoners from the Seven Years War, causing considerable damage to the buildings. The title 'Castle' came about because the French prisoners referred to the grand house as the 'chateau' this then being mistranslated into English as 'Castle'. The site has never had any military function other than that of a POW camp. The buildings were later used as the parish poorhouse for around a 100 able bodied men. Both these uses provided an ample supply of labour for agricultural improvements and at the beginning of a great period of Victorian 'high farming' the Sissinghurst farm was deemed the best on the whole of the substantial Cornwallis estate[3].

Much of the later fame of the estate derives from its occupation between 1930 and 1962 by the famous novelist and gardener Vita-Sackville West and her husband Harold Nicholson. Most of the nearly quarter of a million annual visitors are attracted by the buildings and gardens at the core of the site, especially the internationally famous 'white garden'.

The core Sissinghurst site the boundaries of which are outside our proposal are described in the Character Area Assessment (7. Sissinghurst Wooded Farmlands[4]) as follows:

"*1) Sissinghurst Castle is a significant Grade I listed building which is the ruin of an Elizabethan courtyard house and moat dating from 1558. The tall red brick tower, with its distinctive dual turrets, rises majestically from the surrounding woodland and has a decidedly fairy-tale quality about it.*

2) Registered Parks and Gardens of Sissinghurst Castle (Grade I) and Hartridge House (Grade II). Sissinghurst is a mid-20th century formal garden created by Vita Sackville-West and her husband Sir Harold Nicolson with surviving built features of the 16th century and with adjacent land which formed part of a 16th century park. Hartridge House contains gardens laid out in 1907 by the respected horticulturalist and nursery owner Colonel Charles Grey, to provide the setting for his new house".

Frogmead meadow lies about a mile to the north of the core site, alongside a public bridleway. Despite the appellation 'Frog Mead' or 'Frog Meadow' map and survey evidence shows that it is likely that the site has been in some form of arable cultivation since at least the 1960's and possibly for long before that to the 1870's or before. It was probably subject to 'agricultural improvements' of land drainage from an early point in time using the abundant source of free labour from the POW

[3] https://www.nationaltrust.org.uk/sissinghurst-castle/features/the-history-of-sissinghurst-castle

camp and the poor house. The human modification of the Hammer Stream may go back even further to medieval times, as the whole area was the epicentre of the Tudor iron industry. Rivers were modified, and mill leats and hammer ponds were constructed to power the great forges and drop hammers using the locally abundant resources of charcoal and iron ore to produce the weaponry of the age. 'Hammer Mill Farm' about 500m upstream from the site show such activity – hence the Hammer Stream.

According to Heritage England's Conserving Historic Water Meadows [4]"*they are an important part of our cultural and agricultural heritage, painted by John Constable, described by Thomas H and vital to the economy of many river valleys for over four hundred years… working examples are extremely rare today… exceptions are a handful of examples which have been the subject of restorations schemes by individuals and trusts ... in addition to their importance for wildlife there is good evidence that water meadows provide wider benefits. They can contain flood water, trap silt and help reduce the nutrient load in water returned to rivers.*"

Frogmead Meadow today lies alongside a public right of way (bridleway) from which it can be seen by the public who walk and ride along it. It is also part of a National Trust self-guided trail. It has been managed under a Higher Level Stewardship scheme as a hay meadow for several years, and is becoming an attractive part of the landscape. This proposal fits within the National Trust's wider plans to restore the traditional management and landscape setting of Sissinghurst castle, and they will interpret the site to celebrate its natural heritage; and its evidential, historical, aesthetic and communal value.

Landscape

The site consists of an alluvial floodplain surrounded by the gentle slopes. The surrounding landscape consists of a mixture of woodland and fields in and arable rotation. Riparian woodland bounds Frogmead Meadow to the north-east along the Hammer stream. To the south east is the field we call 'The Dragonfly Field' a small area alongside the minor tributary that runs through the Sissinghurst estate, and in which the National Trust rangers have in recent years created a half-dozen 'dragonfly scrapes' to increase biodiversity. For the last seven years both these fields have been managed under a Higher Level Stewardship scheme through a regime of annual mowing and aftermath grazing. The two fields to the south the 'Twelve Acre Meadow' and 'Great Meadow' are tenanted and managed as part of an arable rotation. There is a small unnamed field to the northwest of Frogmead meadow on the other side of the PROW which lies outside this proposal. This is similar to Frogmead Meadow in its history and species composition, and management on this site will continue as before.

From the KCC KLIS maps the site is classified as 'Low Weald' in the Natural Character Areas classification, just outside the boundary with the High Weald and the Landscape Description Unit is 'River Valley'. The Landscape Character Assessment is 'Sissinghurst Wooded Farmlands'[5] summarised as:

"A rural agricultural landscape of pasture and arable farmland, mixed woodland and orchards punctuated by oast houses and sunken rural lanes, enclosed within undulating hills and with occasional extensive views of the Low Weald."

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[4] https://historicengland.org.uk/images-books/publications/conserving-historic-water-meadows/

[5] http://www.tunbridgewells.gov.uk/__data/assets/pdf_file/0016/215602/758340C0D0EF1457E0531401A8C041D3_Character_Area_7_Sissinghurst_Wooded_Farmland_pages_81-88.pdf

The "HIGH WEALD AONB KENT PARISHES KENT HISTORIC LANDSCAPE CHARACTERISATION: REVISION OF PHASE 1 (2000) (revised 2015) (page 24)" [6] indicates that the site is a "modern field amalgamation" which is consistent with the 1960's aerial photographs in the Calumma Ecology Report. The area containing Frogmead Meadow (Map 5 of the cited report) is classed as an 'irregular informal fields' described as follows:
DESCRIPTION OF IRREGULAR INFORMAL FIELDS Irregular fields with straight boundaries intermixed with wavy ones creating fields which are irregular in shape and with no clearly defined field pattern. Their boundaries are formed either of hedgerows or ditches. The shape and pattern of these fields are probably strongly influenced by topography as they are most frequently found in the smaller stream and river valleys.

PERIOD Early Medieval AD 410 - AD 1065 / Medieval AD 1066 - AD 1539 The strong association with river valleys suggest that these are meadows, cultivated for hay and thus could have a medieval or earlier date. Fields in valleys had a higher value than those on the higher ground due to their greater fertility from the alluvial soils and from the importance of hay used to overwinter stock.

While Frogmead Meadow fits this description very well there is no evidence that it was managed as a classic 'water meadow' *sensu stricto.* There is no evidence of 'catchworks', 'bedworks' or water control structures in the vicinity, and no signs of such management from historic maps. However, the Frogmead Meadow proposal is informed by the history of this form of management, and will replicate many of the rich ecological and landscape functions of an almost vanished agricultural practice[4].

In earlier iterations of the design there was an idea to create a hedge boundary along the length of Frogmead meadow to enhance flood mitigation through the interception of cross-field run-off. This has been dropped from the current proposal in order to maintain the open aspect of the site and the vista from the core Sissinghurst site. A small 'hedge bund' 30cm tall will be created alongside part of the conveyance channel, but the National Trust are not now planning to plant this with woody species, but to allow it to colonise naturally with low growing herbaceous plants this is similar in nature to the 'Grass Balk' boundaries which typify this area of the estate (Map 5 Kent Historic Landscape Characterisation Revision... (page 27).

The proposal then does not involve any significant alteration to the landscape other than enhancing the wetland function of the former hay meadow. The proposal, in enhancing the riparian character and ecological function of the landscape and restoring the former use through management as a hay meadow is sympathetic to the existing landscape and consistent with the Landscape Strategy for the Local Character Area in ensuring the "the visual diversity and landscape pattern is maintained" and recognising the "*importance that the highly visited area around Sissinghurst Castle plays in the perception of the landscape of the Borough and the County*."

Archaeology

SERT has been working with the National Trust's archaeologist Nathalie Cohen, who has visited the site and conducted a desk study. Here is a summary of her response to project in an email dated 11th June 2019:

[6] http://www.tunbridgewells.gov.uk/__data/assets/pdf_file/0011/157898/5C46044EB8EC7188E0531401A8C0AA14_Revised_HLC_HWAONB_August_2015_V1.pdf

"With regard to the archaeological potential of the area, there has been no previous investigation (either excavation or geophysics) in the area to my knowledge. This part of the property is covered in Nicola Bannister's 2002 Historic Landscape Survey of the estate but no features are recorded in the area of impact. The nearest in the vicinity are:

140988: Brick built bridge / culvert (many thanks for the photos Dean)[7]

141023: Site of bomb crater (to the west in Moat Field)[8]

140976: Saw pit (to the south)[9]

Fig 7 – National Trust map of heritage features of interest

It is possible that evidence for previously unknown water management features (such as revetments or drainage channels), or artefacts such as fish traps of medieval or post-medieval date, could be exposed during the project and the following steps are suggested with regard to mitigation during construction:

1) Metal detecting survey undertaken over the area of impact. This could take place prior to works starting, and also during periods of deeper excavation during the construction phase. A volunteer metal detectorist is available to undertake this work.

2) Watching brief by NT Archaeologist / archaeological contractor from Historic Buildings Archaeology and Conservation. Dependent on capacity and work programme I should be able to undertake regular site visits but it would also be advisable to retain the services of a contractor as

[7] https://heritagerecords.nationaltrust.org.uk/HBSMR/MonRecord.aspx?uid=MNA128156
[8] https://heritagerecords.nationaltrust.org.uk/HBSMR/MonRecord.aspx?uid=MNA128194
[9] https://heritagerecords.nationaltrust.org.uk/HBSMR/MonRecord.aspx?uid=MNA128142

part of contingency planning. Unfortunately, I haven't been able to get hold of Diccon from HBAC this afternoon to confirm his day-rate but I will let you know when I do.

3) It would be good to make a record of the culvert as part of this project as it doesn't seem to have been recorded before, I can do this.

4) Finds / conservation contingency – would be worth bearing in mind that if anything is found it will need assessment / conservation. If we do find organic waterlogged material, there is also the potential for radiocarbon dating / dendrochronological dating of samples."

As a result of further discussions:

1) The brick built bridge/culvert 140998 has been identified and is incorrectly mapped on the National Trust system and in fact lies about 40m to the east of where marked, on the minor tributary. It therefore lies outside our planned area of operations and will be unaffected by the works
2) The 1944 WW2 bomb crater 140123 lies in the 'Great Meadow" (named 'Moat Field' on the record) where we plan to spread some topsoil in the arable field at a depth of 5-6cm. The location is known to the tenant farmer, and we plan to mark the site and avoid spreading topsoil within a 5m radius of it in order to help preserve this feature.
3) The saw pit 140976 lies in woodland to the north and is outside the area of, and unaffected by our operations.

We will engage Nathalie Cohen on a watching brief as described, and have made provision for contingency for a consultant archaeologist should she not be available. We will also take up the offer of the National Trust volunteer metal detectorist. Access to the works for both will be arranged with the site contractors once appointed.

We have made provision within the contract with site contractors to suspend operations should anything of interest be discovered.

Further inspection of the Kent Heritage Maps has not identified any further features of interest:

Fig 8 – KCC heritage mapping of features of interest at Sissinghurst

Geomorphology

In their natural condition before human intervention rivers tend to naturally 'wander' shallowly across flood plains, dropping sediment and altering course because of physical hydrological forces, and falling riparian trees. In ancient times the natural capacity of floodplains was enhanced by the activities of beavers as 'ecological engineers'. This created a rich variety and mosaic of wetland habitats and associated species, with the entire system working as a natural 'sponge' slowing and holding the flow of water. Remarkably, and despite centuries of river engineering for the iron industry, drainage for agricultural improvement and over a century of ploughing; evidence of what appears to be former river channels appears on LIDAR images of the site:

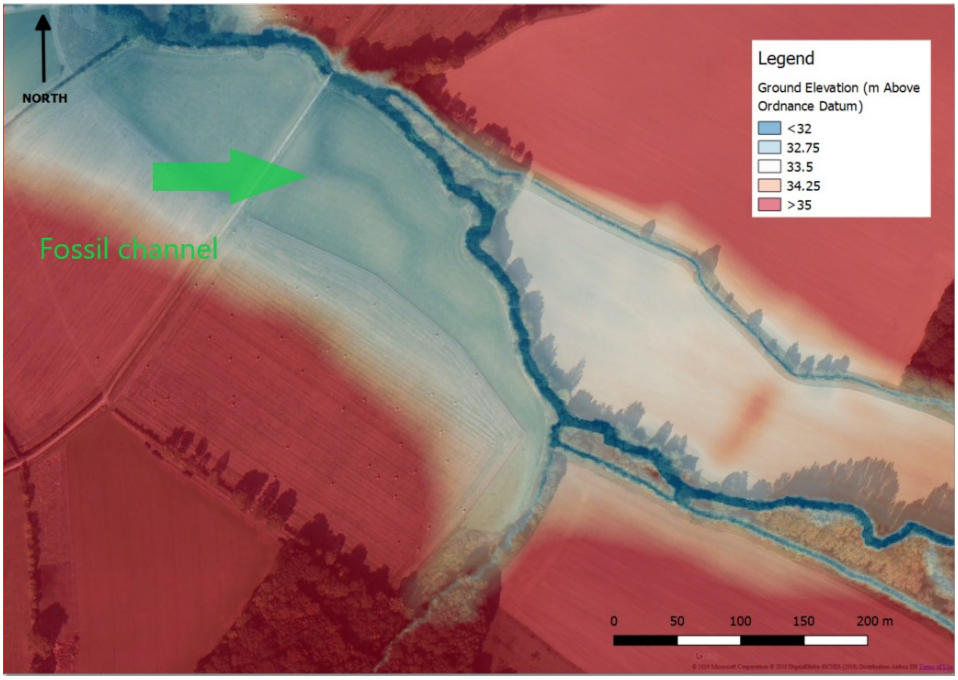

Fig 9 – LIDAR of Frogmead Meadow showing possible former river course

To an extent these can be seen on the ground through very subtle differences in vegetation (for example the presence of Hogweed *Heracleum sphondylium* on the higher and dryer areas).

The Hammer Stream channel is now much deepened and possibly straightened, and historic maps show that it has been fixed in this position since at least the 1870's. This may from a combination of direct works as part of the 19thC agricultural improvements, exacerbated by the upstream effects of a much straightened and deepened channel downstream from the site from Bettenham Manor to Buckhurst. The net effect of this is that the Hammer Stream is now much disconnected from its floodplain, with base flow about 2-3 metres below the meadow, rising only to flood the meadow on very rare occasions once every several years.

The Frogmead Meadow NFM proposal seeks to enhance these existing depressions by excavating topsoil along the length of these former channels to re-create the gently undulating former topography, and to restore some of the former ecological function by diverting flood waters from the minor tributary to recreate a wider range of wet/dry conditions, while retaining the ability to maintain the current hay meadow management regime. SERT have completed a topological survey of the site to confirm the difference in levels required to make the proposed system function.

Soils

Four trial soil pits were dug across Frogmead Meadow in spring 2019. Site inspection showed the soil to be mostly clay with a fine sand element ('Clay to Sandy Loam'), and alluvial in origin. This is consistent with what is shown on the British Geological Survey map for superficial deposits [10] and soils on this site: the bedrock geology of the surrounding fields is of the Tunbridge Wells Sand Formation. There were signs of disturbance of the topsoil down to a depth of 30-35cm as a result of a long history of ploughing. The soil was workable and relatively friable (see fig 10 of excavated

[10] http://mapapps.bgs.ac.uk/geologyofbritain/home.html

material being inspected by tenant farmer John Hickman and National Trust lead ranger Peter Dear). There were no signs of deeper excavation or soil contamination. Samples have been sent to a laboratory for testing.

Fig 10 Trial soil pit Frogmead Meadow inspected by tenant farmer and lead ranger

Fig 11 Trial soil pit cross-section showing horizons (note dry at bottom at time of survey in spring)

Ecology

Ecological rationale for the project:

Floodplain meadows are a much diminished and threatened habitat in the UK and pristine floodplain meadows are particularly rare in Kent (the Floodplains Meadows Association doesn't show any in its handbook). The Kent Nature Partnership Biodiversity Opportunity Area Statement for Medway and Low Weald Wetlands and Grasslands lists floodplain grasslands as a significant landscape and biodiversity feature. It recommends: catchment improvement work to create, restore and enhance wet grasslands; the pursuit of opportunities to create wide river floodplains around natural drainage channels: the creation of new species-rich grasslands in blocks of 2ha or more and the creation of ponds, particularly to establish networks to support great crested newt.[11]

As a former arable field which has been managed as a hay meadow by the National Trust since 2011 the sward of Frogmead Meadow shows signs of some improvement and improved floral diversity as one might expect. It is currently hard to fit within typical vegetation classifications as it is a transitional stage with elements of former cultivated species such as rye grasses, ruderal species, and semi-improved grasslands. It lacks species typical of more natural floodplain meadows in the Southeast. Although it could be expected to gradually improve over time, there are probably limiting factors to it achieving full ecological function as a floodplain meadow, and the establishment of the rich diversity of flora and invertebrate species associated with them.

[11] http://www.kentnature.org.uk/uploads/files/Opportunity_Area_Statement_-_Medway__Low_Weald_Wetlands__Grasslands_FINAL.pdf

These limiting factors are (*Floodplain Meadows Handbook especially chapter 10*[12])

- The overall dryness of the site and disconnection from the river as part of historical agricultural operations
- Residual high levels of soil fertility from many decades of use as arable (especially for phosphorus which binds to clay soils)
- Uniformity of conditions across the site because of many decades of ploughing
- Lack of seed sources for floodplain species nearby

Whilst a full restoration to a 'natural' condition is a too challenging objective for this project, nevertheless it remains possible to restore much of the natural ecosystem function of the site, enabling it to provide many of the same ecosystem benefits of a more natural system through a 'Working with natural processes' [13]approach.

Through: the introduction of peak flood waters; changing the range of wet/dry conditions of the field; stripping topsoil with remaining high levels of nutrients; spreading low fertility subsoil on some areas of the site; the introduction of 'missing' species unlikely to colonise for a long time because of a lack of donor seed sources upstream; seeding with yellow rattle to suppress competition from tall grasses; the overall range of base ecological conditions and biodiversity of the meadow should be much improved. The ecosystem services of flood peak reduction, groundwater storage and carbon should also benefit providing an overall net gain to 'Natural Capital[14]'.

Botanical Survey

A floral survey of Frogmead Meadow and the Dragonfly Field was conducted in May-June 2019 by Martin Allison of the Sylvan Consultancy (*Sissinghurst Frogmead Meadow Botanical Survey 2019 attached*). Although the meadow has clearly benefitted from management as a hay meadow by the National Trust since about 2011, and now supports 51 vascular species including a variety of grasses, most are commonplace and widespread. Species typical of wet floodplain meadows such as meadowsweet, ragged-robin, cuckooflower and marsh marigold, are mostly or completely absent. The site as a whole is very uniform as might be expected from a long history of arable cultivation and ploughing. The two instances of Common Spotted Orchid (itself a common and widespread species in England) have been identified and are outside our area of direct operations and will be unaffected by the excavations.

In conclusion Martin says: "*However, based on the findings of the current short survey, it is suggested that re-wetting the meadow, followed by sympathetic sward management, will improve its botanical status in the long term.*" He also recommends further annual monitoring post-completion until the sward is established.

Areas of the vegetation which has developed since 2011 will be retained in the proposal, along with the entire similar field to the other side of the PROW to the north (which will act as a control for study). This will ensure an element of existing interest and species composition will be retained, and then enhanced by the exposure of low-fertility subsoil and the introduction of wet meadow species of native provenance.

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[12] http://www.floodplainmeadows.org.uk/floodplain-meadow-technical-handbook
[13] https://www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk
[14] https://naturalcapitalcoalition.org/

Preliminary Ecological Appraisal

A full Preliminary Ecological Appraisal has been completed by Dr Lee Brady of Calumma Ecological Services in July 2019 *("Preliminary Ecological Appraisal – Land at Sissinghurst Castle…3rd July 2019 "*attached).

This is a comprehensive study based on site visits, desk study & literature review, KBRC records, the Martin Alison report and discussions with the National Trust and others. The SERT NFM officer Dean Morrison has fed in the results of other discussions with Tunbridge Wells ecologist David Scully, Natural England, The Environment Agency, The High Weald AONB unit and the Floodplain Meadows Association.

In short summary the report concludes: proposed works will result in an improvement to the meadow's botanical status; work will be beneficial for the local conservation status of water vole, dragonflies and other invertebrates; and further survey work for protected species is not required although for certain groups precautionary mitigation is advised.

The report makes a number of recommendations for precautionary mitigation and enhancement (e.g. buffer zones, phased habitat clearance, operations outside the bird nesting season etc. - section 7 of the report) which we accept in full, and will implement with the National Trust and site contractors once selected.

Flooding and water management

A significant aim of the project is to provide a demonstration of flood mitigation through 'natural flood management and 'working with natural processes'. There is also potential to make a contribution to drought resilience through groundwater recharge in the winter increasing summer flows, and to improve water quality through filtration and nutrient capture. This approach has potential to increase Natural Capital, improve ecosystem services and to increase overall environmental resilience.

The Hammer Stream which runs alongside the site is within the remit of the Medway Internal Drainage Board. The small tributary where we plan to locate the offtake structure is classed as an 'ordinary watercourse' for which Kent County Council have responsibility. Although there are no 'main' water courses within the proposal, the Environment Agency have some overarching responsibilities for water management in the project area.

After consultation with these agencies the licensing or consents required for elements of our operations as follows:

The Environment Agency

The Environment Agency is a supporter of the project, and will be providing funding from DEFRA for its execution through a partnership agreement with SERT. This forms part of the overall strategic objectives of the Medway Flood Action Partnership. The following permissions are required:

Flood Risk Assessment

We have been working closely with Spencer Smith, Flood and Coastal Risk Management Officer in the design of the project. A flood risk assessment of the proposal[15] has been completed by SERT NFM Officer Ed Byers, and submitted to the EA, the conclusion of which is as follows:

[15] "Sissinghurst Attenuation Area – Flood Risk Assessment – Ed Byers – June 2019

"Proposed works are designed to increase floodplain storage and to be inundated by flood waters. It is therefore considered to have a low vulnerability to flooding and is unlikely to be adversely impacted by flooding.

Overall flood storage will be increased by the proposed works, even when taking into account topsoil/subsoil spreading. Spreading of soil will influence local conveyance of flood water to a degree. However, the impact will be at the local scale and lack of nearby receptors means that the proposed works are unlikely to adversely impact flood risk."

We are awaiting the outcome of our application.

Impoundment License

We have been advised by the Environment Agency that the off-take structure may require an impoundment license. We have submitted a pre-application for this, and have been informed that if it is deemed low risk then a full planning application will not be required. The same process also covers water abstraction and transfer licenses, but current feedback form the Agency is that they will not be required for this proposal. The structure will be designed so as not to impede base flow, and once the appropriate level has been determined in construction, the drop boards will be fixed in place so they require no further adjustment.

Kent County Council

Ordinary Watercourse Land Drainage Consent

An 'Ordinary Watercourse Land Drainage Consent' is required for the proposal and has been applied for. Kent County Council's Land Drainage Engineer Emma Burdett has visited the site and advised on this.

Medway Internal Drainage Board

We have consulted Mike Watson of the Medway IDB on the project. He asked to be informed of any structures which were to be constructed on the Hammer Stream itself, and we have explained that there are no works proposed on or near (within at least 10 m) of the stream. He also asked about the potential for erosion as water from the NFM system re-enters the Hammer Stream.

We explained:

1. The system has been designed with a capacity and maximum flow entering the system are in almost all circumstances able to infiltrate into the ground water or otherwise leave by evapotranspiration,
2. Should this capacity ever be exceeded then the system is designed so the water can re-join the Hammer Stream on a broad front of nearly 300m, at many points, and through thick established riparian vegetation. This approach avoids the focus of water to a single erosion point.
3. Should such an extreme event ever occur, it almost certainly likely that the Hammer Stream itself would overtop its banks and flood into the field from the north.

Mike Watson accepted these assurances in a telephone call, and we have invited him to inspect the site.

Since no work is taking place on or near the Hammer Stream itself as we understand there is no requirement for a permit directly from the Medway IDB. However, as part of their licensing of the structure in the ordinary watercourse, KCC will consult the IDB as a matter of course.

Other:

Derogation from Higher Level Stewardship Scheme

Frogmead Meadow and the Dragonfly Field are currently managed under a Higher Level Stewardship scheme which involves assurance of a hay meadow management regime. The project design allows this management to continue as the shallow slopes permit access for mowing equipment in late summer when the meadow is expected to be dry. The exception is for the very small percentage of the site occupied by the conveyance channel and ponds for which a derogation from the scheme for which the National Trust will apply to Natural England and the Rural Payments Agency.

Waste

We have made preliminary enquiries to the Environment Agency whether the proposal would require a waste license for the topsoil transfer. We have a preliminary opinion that on the basis that we are moving clean, uncontaminated, useful soil within the site boundary, the material is not classified as waste and does not require permit or exemption. We are seeking to get this confirmed in writing.

Utilities

A utilities search has been conducted which has identified a 6.4 kV electricity cable running parallel to the public right of way at a distance of about 8m within Frogmead Meadow, but outside the area of direct operations and unaffected by it. This will be checked by our appointed contractors on site using electromagnetic detection equipment.

Detailed design:

Control Structure

Fig 12. Tributary of the Hammer Stream –proposed offtake structure location

NOTE: – since the following design was proposed, inspections with potential contractors have identified the issue of ground conditions making the site potentially unsuitable for the installation of the specified plastic piling. We now prefer the alternative material of conventional L8 steel sheet piles[16] to form the same structure.

The control structure and off-take channel arrangements are shown in Figures 13-15.

Figure 16 shows some applied examples of the piling as a control structure (photographs courtesy of The Plastic Piling Company). The D-Hex plastic piling sheets are produced in 0.5m sections. The piles will be driven approximately 0.9m into the banks of the existing channel to prevent flows within the tributary circumventing the control structure.

Dropboards will be slotted into the plastic piles to restrict flow. To create gaps between the stop boards to allow flow through, spacers will be placed within the piles and fixed into Each dropboard should be 0.1m in height to allow relatively small changes in the level that flow is backed up. The boards must be FSC accredited untreated oak. Wooden stakes will be driven approximately 1.5m

[16] https://safefence.co.uk/sheet-piles-l8.html

into the ground in the middle of the hexagon piles to reduce the depth to which the piling must be driven.

Immediately upstream and downstream of the control structure the existing channel hard bed will be excavated and filled with gabion stone (0.1-0.2m in depth) which will prevent scour within the channel. The gabion stone should extend for 2m downstream and 1m upstream of the control structure (15). Gabion stone will also be used on the banks near the control structure to reduce the risk of erosion.

The control structure arrangement shown in Figure 13 shows a 0.2m gap between channel bed and the bottom of the lower dropboard. The precise level to fix this at will be determined following construction so the system is fine-tuned as not to impede base flow, and to divert flood waters.

Contractors will be instructed to minimise disturbance to bank vegetation and to limit the area of operations during construction, in accordance with the mitigation strategy in the Preliminary Ecological Assessment.

The National Trust will clear any scrubby vegetation required for site access pre-construction, and use any material generated to create log piles and reptile and amphibian refugia.

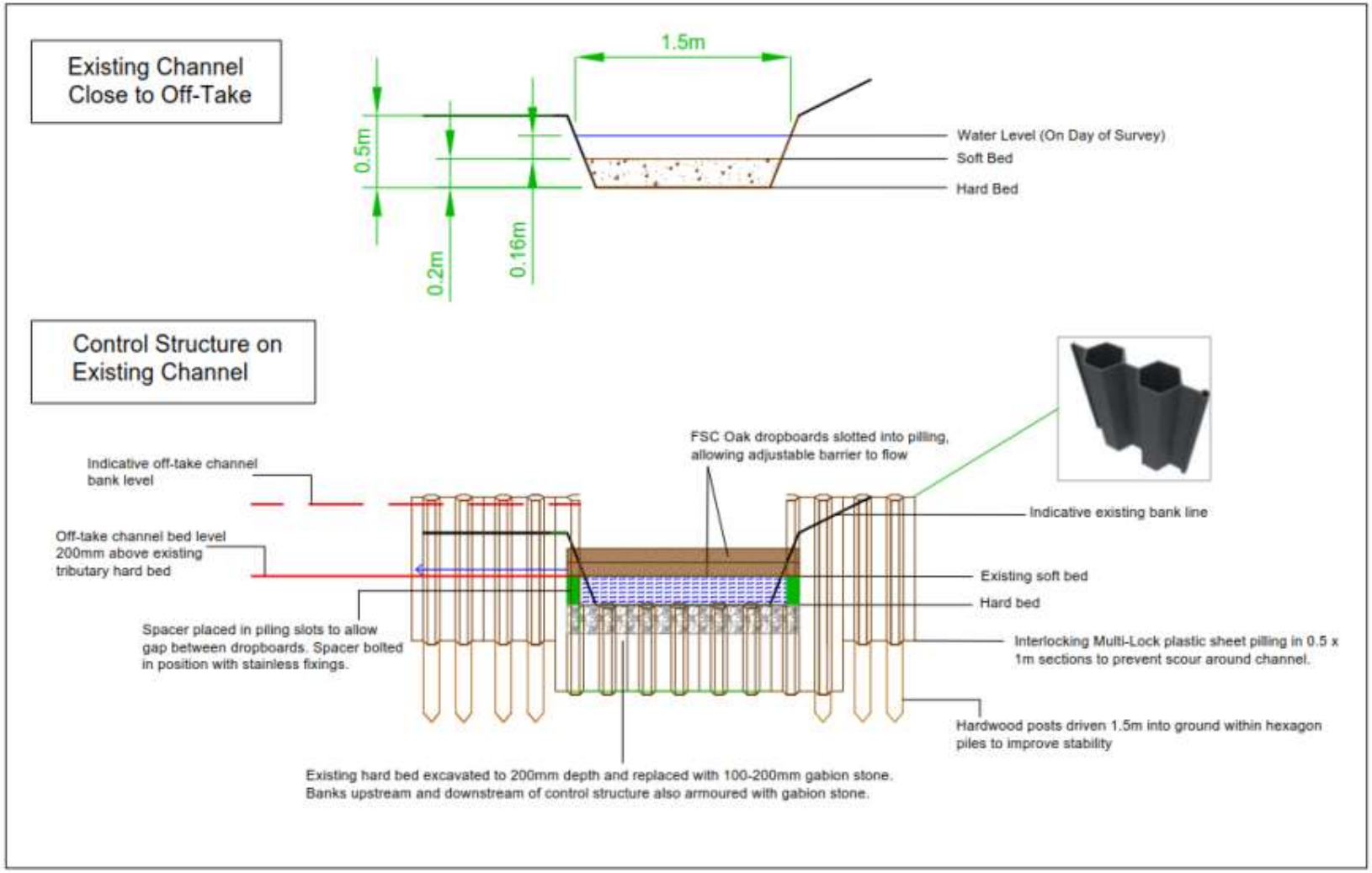

Figure 13. Control structure Cross-Section

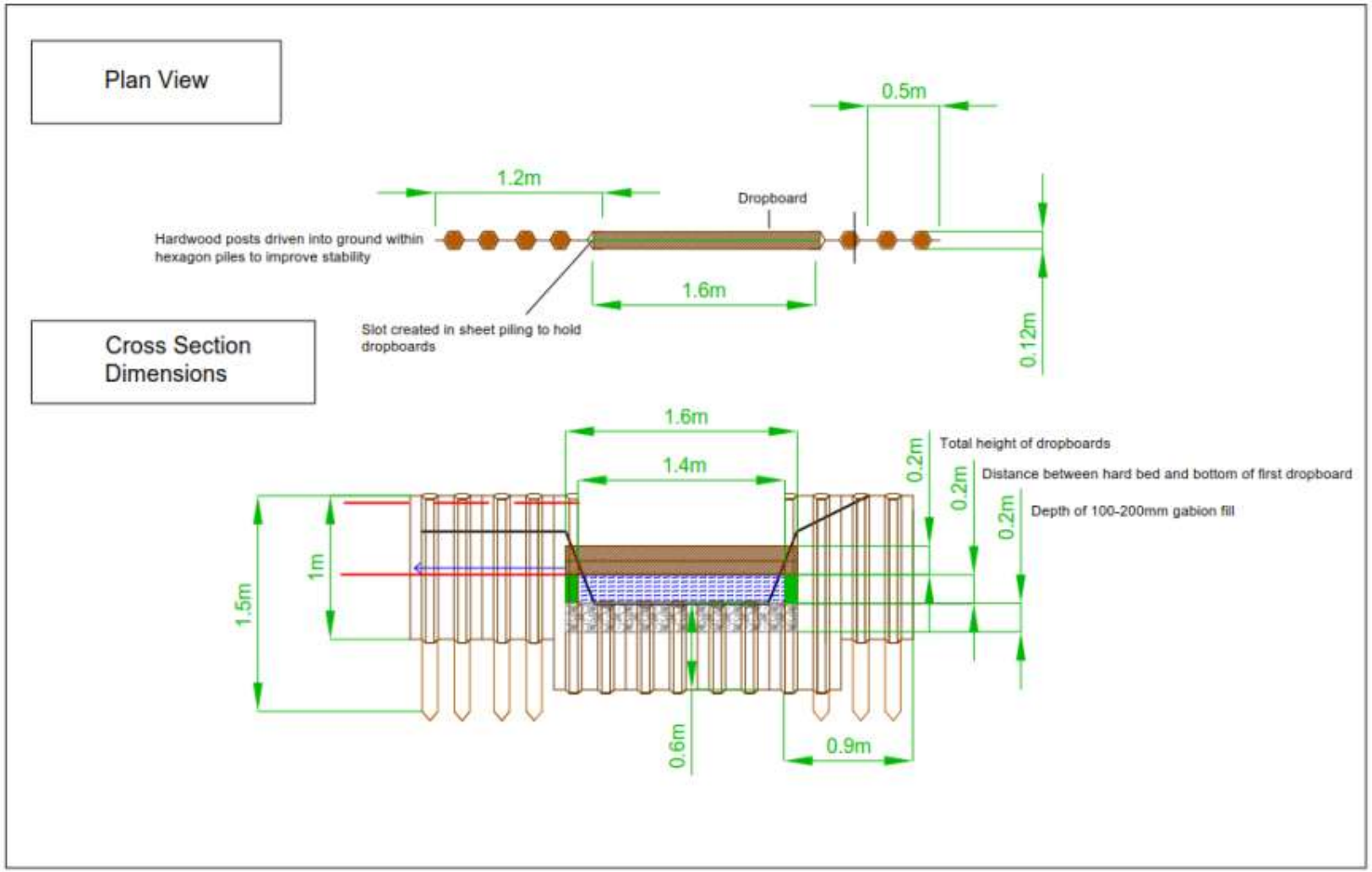

Figure 14. Control Structure Plan and Cross Section showing slotting of dropboards into piling.

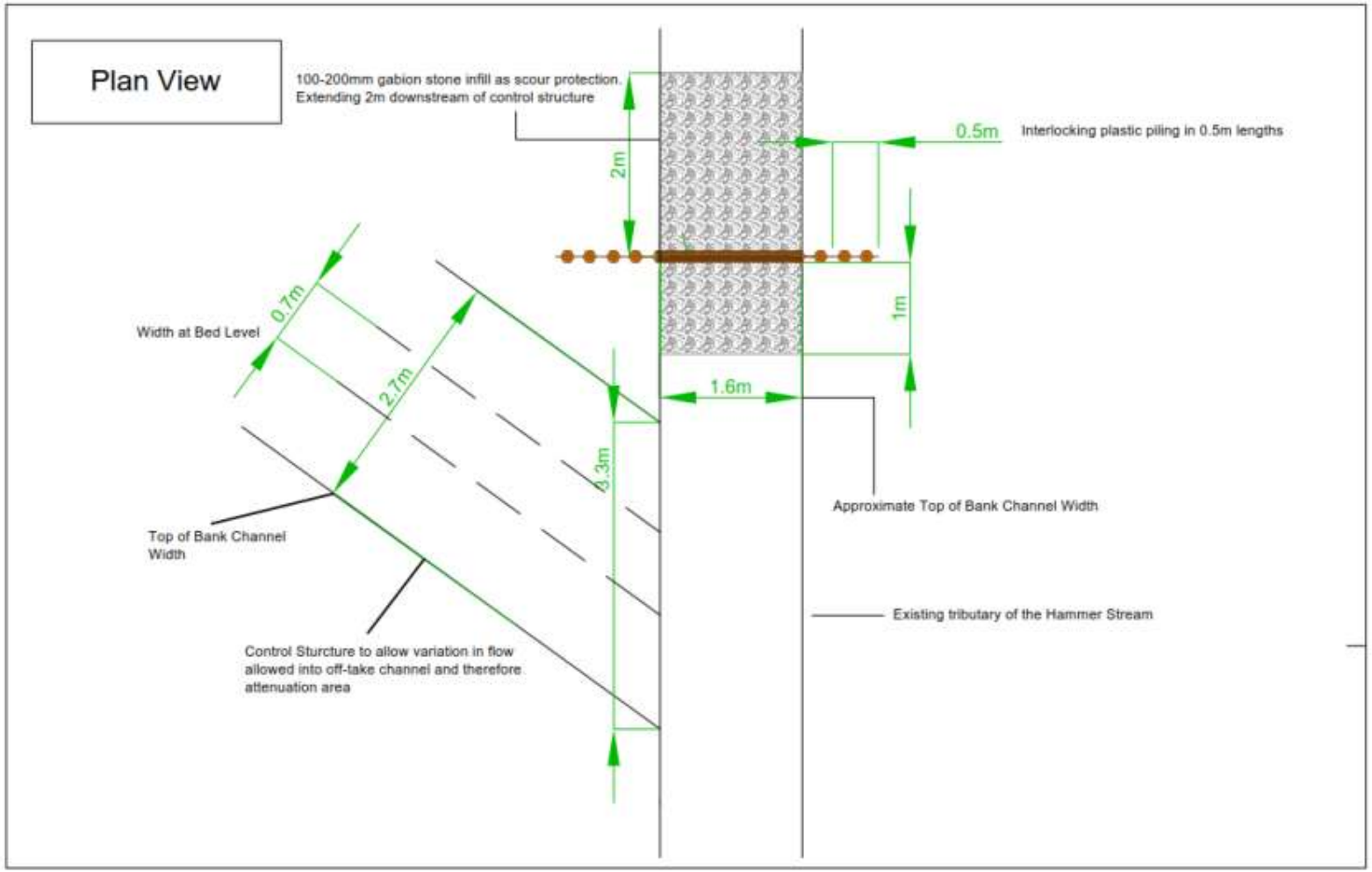

Figure 15. Plan view of off-take channel

(a)

(b)

(c)

Figure16. Applied examples of plastic piling as control structures. (a) A simple control structure using hexagon plastic piling. The bracket at the top of the structure used to strengthen the structure can be seen. (b) A simple dropboard solution. (c) An example of wooden posts driven into the ground inside the hexagon piling.

Off-Take Channel

The bed of the off-take channel will be set at the level of the soft bed in the existing channel, though the exact level should be confirmed by the contractor to ensure tie-in with the attenuation area. Figure 17 shows the existing and proposed levels along the Long Section shown in Figure 18. The proposed Long Section shows the bed of the off-take channel (in red), which will be set at a slope of approximately 1 in 250 (0.004 slope) (Figure 12 shows the approximate location of the off-take). As the existing ground level varies along the path of the proposed off-take channel, the level of the bed below existing adjacent ground level will vary. Figure 18 shows the approximate difference between proposed bed level and existing ground level at points along the Long Section, with values varying from approximately 0.3-0.6m.

The area of the proposed off-take channel is shown in Figure 15. The dimensions of the off-take are also shown in Figure 15. The channel would have a 0.7m wide base and 1 in 2 slopes. The slope of the channel will be set at approximately 1 in 250 (0.004). As outlined above, the depth of the channel will vary due to the expected variation in distance between the bed level and existing ground level. However, the channel requires a minimum depth of 0.5m. Where the distance between bed level and existing ground level is less than 0.5m, this will require building up of the banks using excavated material to maintain a regular flow capacity, as shown in **Error! Reference source not found.**. This is anticipated for approximately 130m of off-take channel, from approximately chainage 110m-240m along the Long Section presented in Figure 17 and Figure 18. Between approximately 120m and 200m along the Long Section the channel will be adjacent to the proposed hedge bank. Along this section, where the channel banks need to be built up, the hedge bank can form the left hand bank (looking downstream). A 0.5m deep channel would be able to convey approximately 0.75m^3/s based on a slope of 1 in 250This will be be able to convey all but the most extreme flood events, in which case a large area is likely to be experiencing flooding anyway.

Where the channel is 0.5m below existing ground level, the top of bank width will be 2.7m. The soil volume for this typical cross-section per 1m linear length of channel would be 0.85m^3. The channel will be approximately 270m and therefore assuming an average 0.5m depth channel, total soil for the off-take channel would be approximately 230m^3. Based on trial pits carried out on the site, the top 0.35m of excavation is topsoil and the bottom 0.15m subsoil. It is therefore anticipated that of the 230m^3 of total soil, approximately 189m^3 will be topsoil and 41m^3 will be subsoil (unbulked out).

To create a more natural appearance we will not excavate a conventional straight and uniform drainage ditch but rather allow for some sinuosity in the shallow sided channel.

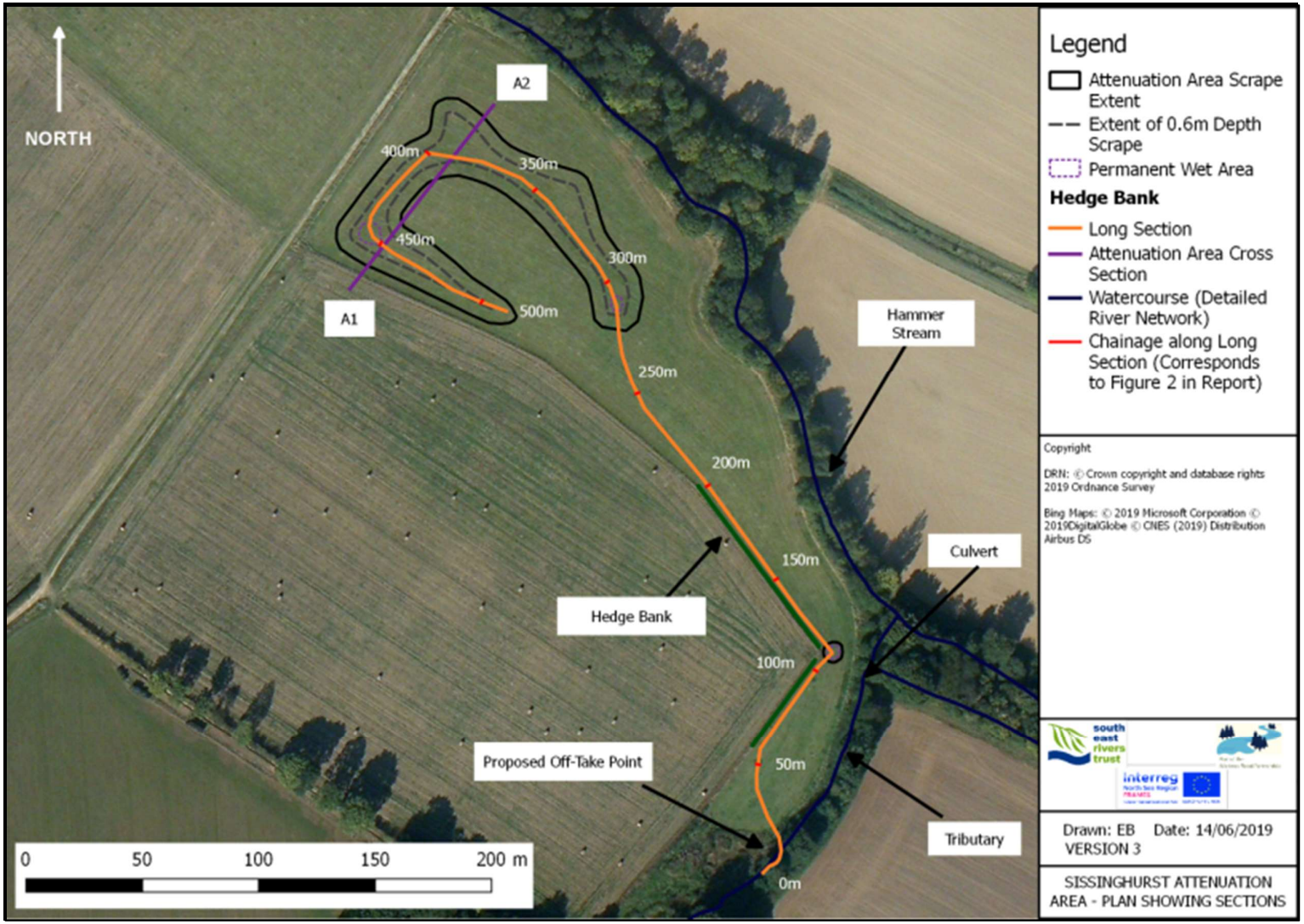

Figure 17. Plan View Showing Long and Cross Section

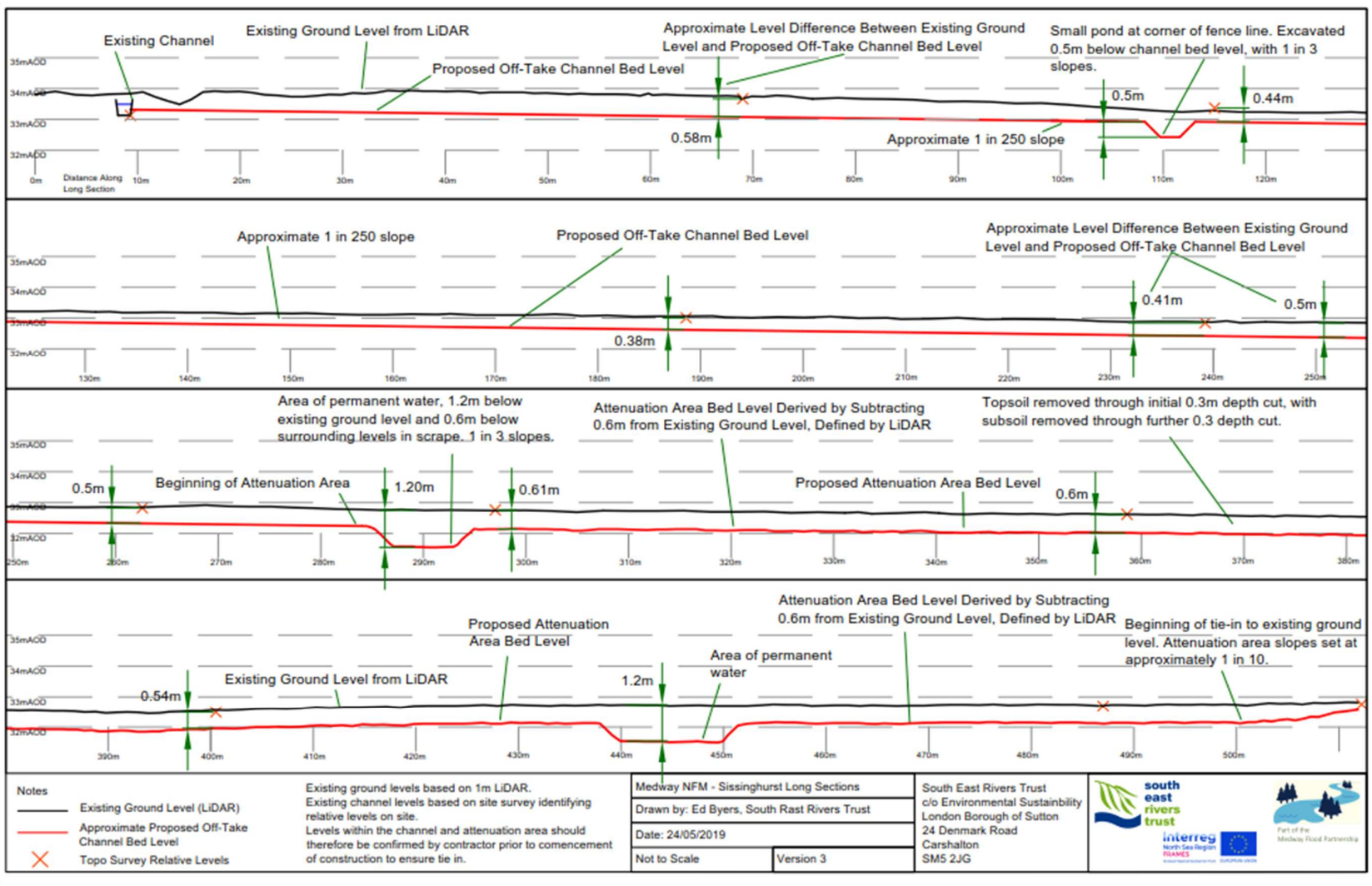

Figure 18. Off-Take Channel Long Section. Y-axis is stretched by a factor of 3 to highlight small changes in elevation along the long section.

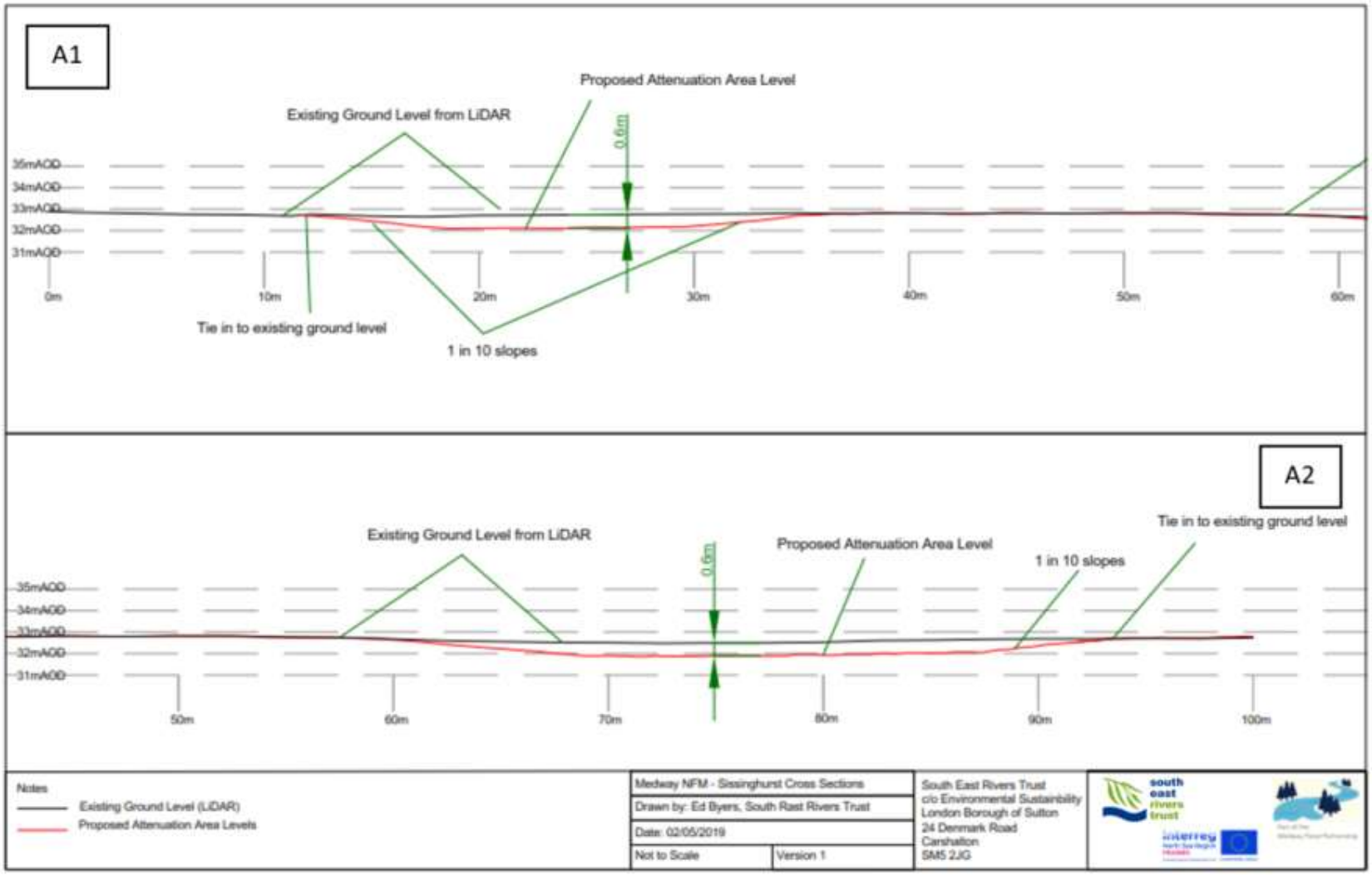

Figure 19. Attenuation Area Cross Section

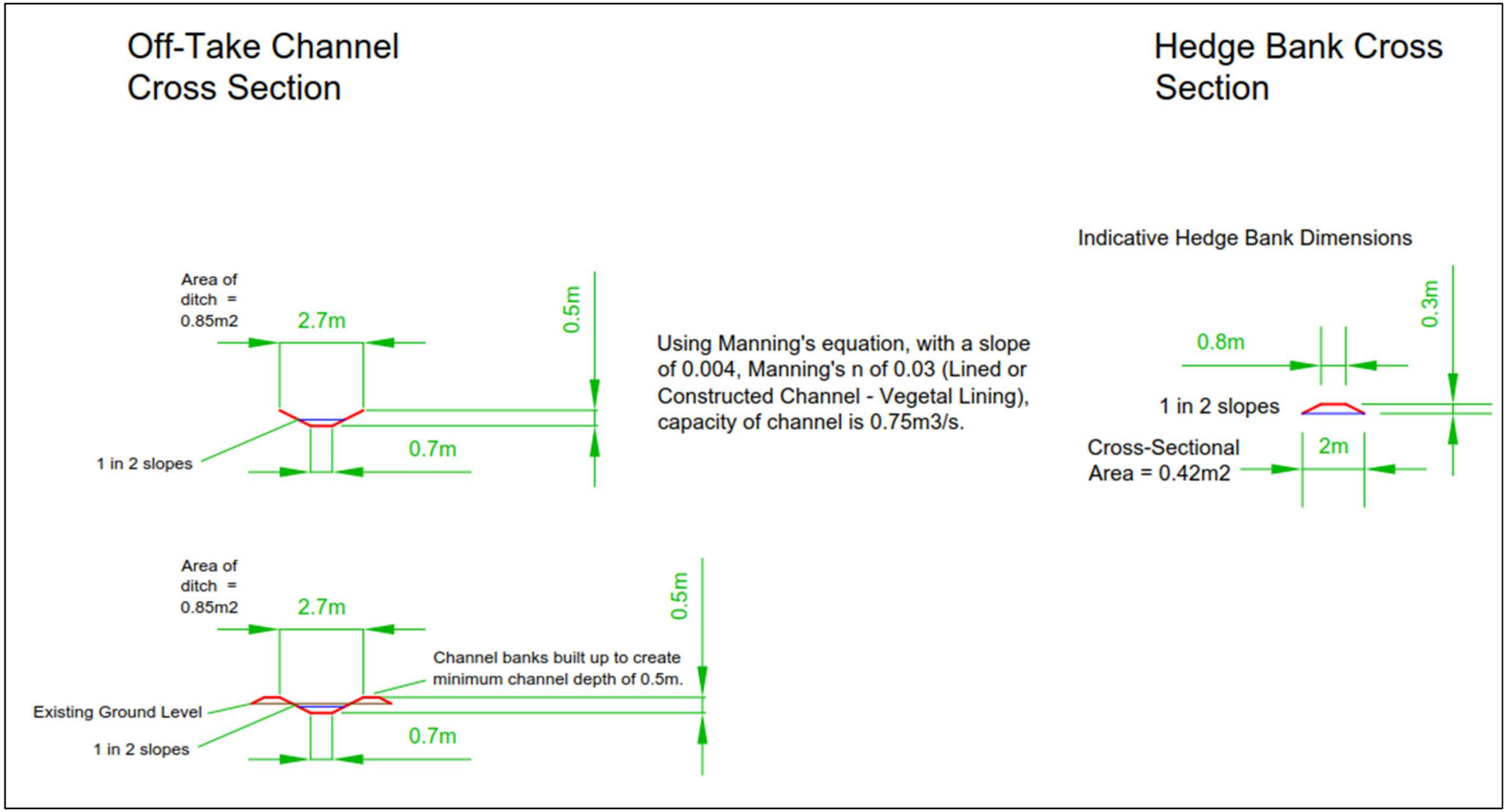

Figure 20. Off-Take Channel and Hedge Bank Dimensions (please note, drawings are purely schematic to demonstrate dimensions, the constructed channel will allow for a more sinuous and natural appearance. The channel 'hedge bank' will be constructed on one side only

‘Hedge Bank’

A ‘hedge bank’ is proposed along a 120m of a section of existing fence line, as shown in Figure 17. The hedge bank will provide additional habitat, and utilise some of the sub soil created by excavation of the off-take channel and attenuation area. Where the hedge bank runs parallel to the off-take channel, the subsoil excavated from the off-take channel will be deposited directly along the line of the proposed hedge bund. Care will be taken to prevent slumping of the material into the off-take channel and the bund should be formed into shape and firmed to avoid this happening over time.

Note that in order to maintain the open appearance of the site the bank will not now be planted with woody tree species, but allowed to recolonise naturally with herbaceous species to create an additional wildlife habitat. This will be similar then in function to the ‘grass balks’ which are a local feature of the local Sissinghurst landscape.

Scrape (or Attenuation Area)

The shallow scrape within the former water meadow will be on average 0.6m below existing ground level for the majority of its extent, with two deeper sections which will create more permanent standing water (ponds 'A' and 'B' in Fig 4), offering varied habitat. Trial pits carried out on the Site indicated a relatively consistent topsoil layer between 0m and 0.35m depth below ground level, with subsoil below. The scrape will be excavated to 0.35m depth to allow the topsoil to be separated out. The first stage of excavation will be to 0.35m depth below ground level, with the topsoil removed and spread across two adjacent arable fields. The second stage of excavation will remove down to 0.25m depth subsoil. In order to tie the bed of the attenuation area into the existing surrounding ground level, the edges of the scrape will be sloped at 1 in 10 slopes. Existing ground levels based on 1m LiDAR are shown in Figure 9, as well as proposed elevations in a number of points across the attenuation area.

Deeper sections will be located in the western corner of the attenuation area and in the south-eastern corner where the channel opens up into the attenuation area. The pond in the western corner of the attenuation area will measure approximately 12m x 12m. The pond in the eastern corner of the attenuation area will measure approximately 10m x 8m. The depths of both ponds will range between 0.6m and 1.2m below ground level and will have slopes no greater than 1 in 3. A sinuous 'natural' appearing shape is required.

Towards the northern corner of the attenuation area, existing ground levels are relatively low compared to the majority of the rest of the field, presenting a flow path towards the Hammer Stream once water levels build up within the attenuation area. In order to maximise the volume of water held within the attenuation area before it spills out into surrounding areas, subsoil from the excavated attenuation area will be used to fill this depression, raising ground levels by approximately 0-0.3m (see Figure 21). It will be designed to tie into adjacent existing ground levels. The maximum volume of soil required to create the bund is $50m^3$. The bund will have slopes of 1 in 4 and be 2m in width at its top.

A small pond (Pond 'C' in Fig 4) will also be constructed along the off-take channel, approximately 100m downstream of the off-take point and 150m south-east of the attenuation area The pond will measure approximately 8m x 8m and will be excavated to a maximum depth of 1m below ground level. The banks of the pond will have slopes no greater than 1 in 3.

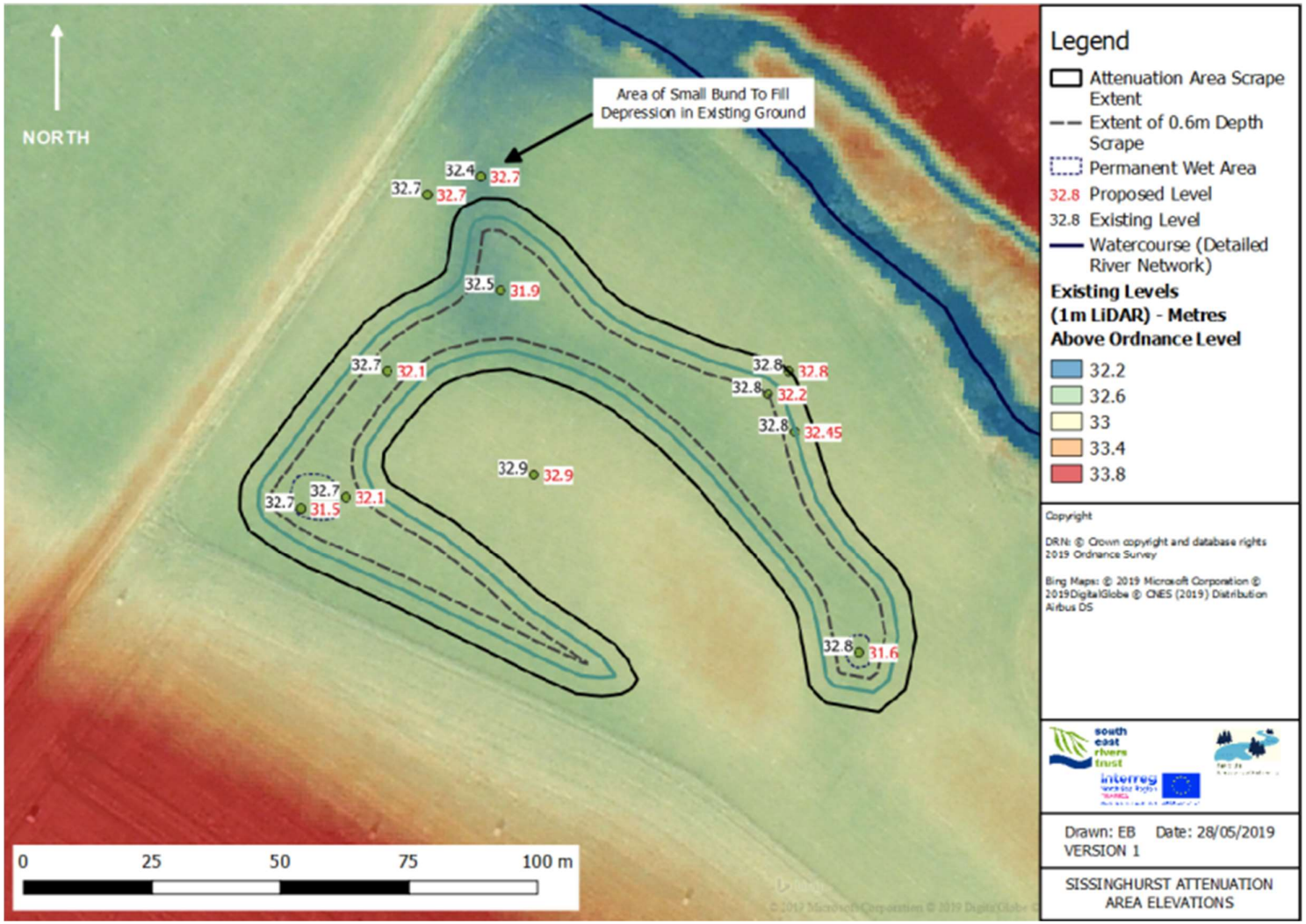

Figure 21. Attenuation Area Elevations

Estimated Soil Volumes

The area of the attenuation area will be approximately 5000m^2. Allowing for 1 in 10 slopes and an average depth of 0.6m for the majority of area, and two deeper sections to a maximum depth of 1.2m with 1 in 3 slopes, the total volume of soil from the attenuation area will be approximately 2,200m^3. Of this total soil, it is anticipated that 1450m^3 will be topsoil and 550m^3 will be subsoil. This assumes a topsoil layer at 0-0.35m below ground level.

The area of the pond south-east of the attenuation area will be approximately 60m^2. The total volume of soil from excavation will be approximately 30m^3, of which just under 15m^3 will be topsoil and just over 15m^3 will be subsoil. This assumes a topsoil depth of 0-0.35m below ground level.

Error! Reference source not found. provides a summary of approximate soil volumes from the attenuation area, off-take channel and small pond. In practice, excavated soil expands once excavated and then shrinks during spreading and compaction. Based on a number of sources, the bulk factor for clay is between 1.2 and 1.4[17] [18] [19], with a shrinkage factor following spreading and compaction of approximately 0.9[5]. Soil is found to have a bulking factor of 1.2 to 1.3. For this project a shrinkage factor has not been applied as the soil will not be compacted heavily once spread.

Table 1. Approximate Soil Volumes

Feature	Total Soil	Topsoil	Subsoil
Off-Take Channel	250	200	50
Attenuation Area	2200	1450	750
Small Pond	30	15	15
Total	**2480**	**1665**	**815**
Total Including Bulking Factors	**3470**	**2330**	**1140**

The subsoil will be spread across the remainder of the site at an average depth of approximately 0.10m. The approximate area of the field within which the attenuation area will be created, and which will not be occupied by the off-take channel or attenuation area is 10,000m^2. At a spreading depth of 0.10m this accounts for approximately 1,000m^3 of subsoil. Approximately 56m^3 of subsoil would be required to create 130m of hedge bank to a height of 0.3m (see Figure 20). Approximately 50m^3 will also be required to fill an area of low ground north of the attenuation area. This would leave approximately 40m^3 of subsoil to be transferred.

Soil Transfer

Topsoil will be spread across two adjacent fields at a depth of 5-6 cm for ploughing in and seeding by the tenant farmer John Hickman before then end of September.

Access for topsoil spreading is into a field directly adjacent, and another which is reached by use of 260m of Public Right of Way (Bridleway). The track is little used at this time of year, visibility is good,

[17] Barnes, G. (2010) Soil Mechanics: Principles and Practice. Palgrave Macmillan
[18] The Engineering Toolbox (Accessed Jan 2019) Soil and Rock – Bulk Factors. https://www.engineeringtoolbox.com/soil-rock-bulking-factor-d_1557.html
[19] Durham University Community (Accessed Jan 2019) Earthworks. https://community.dur.ac.uk/~des0www4/cal/roads/earthwk/earthwk.html

warning signs will be erected and operators will be properly instructed so as not to risk the safety of the public or cause undue inconvenience.

Subsoil will be spread within Frogmead Meadow itself and then sown with wild flowers. Steps will be taken to avoid soil compaction or rutting

See maps below for destination and routes for topsoil transfer, and for the maximum extent of subsoil spreading within Frogmead meadow (in practice the are used will be less than this).

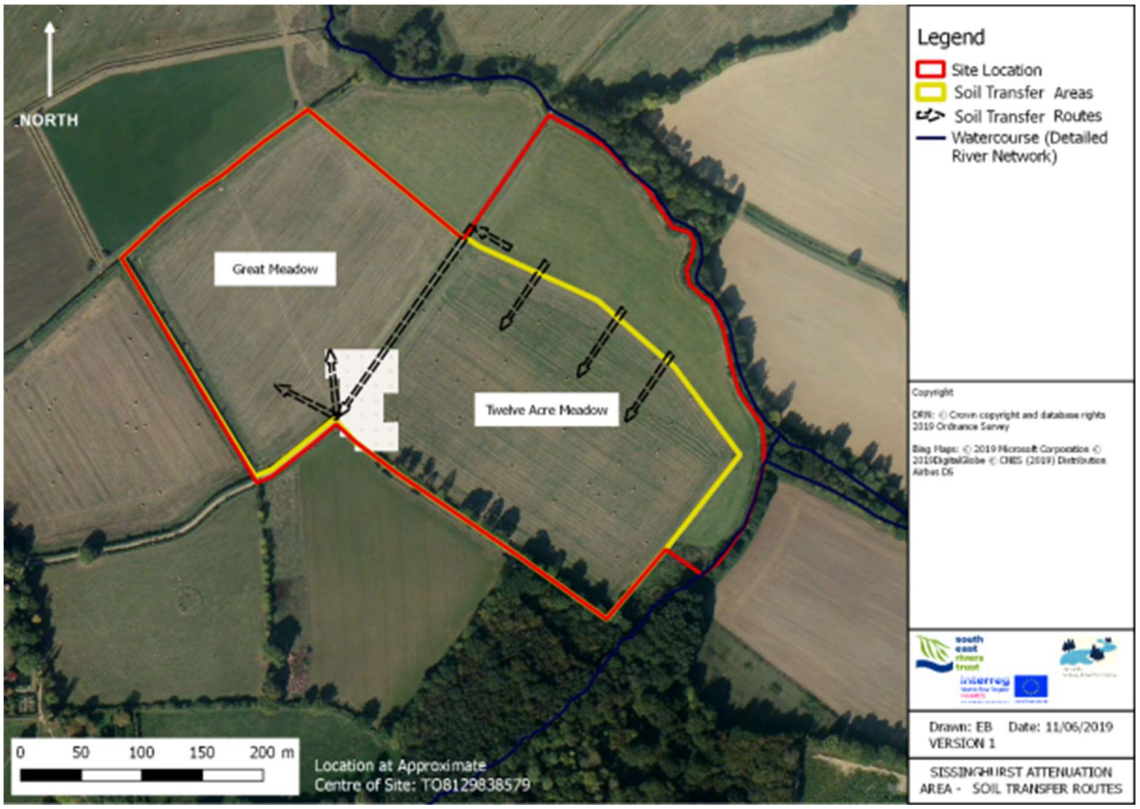

Fig 22 Topsoil transfer route and locations

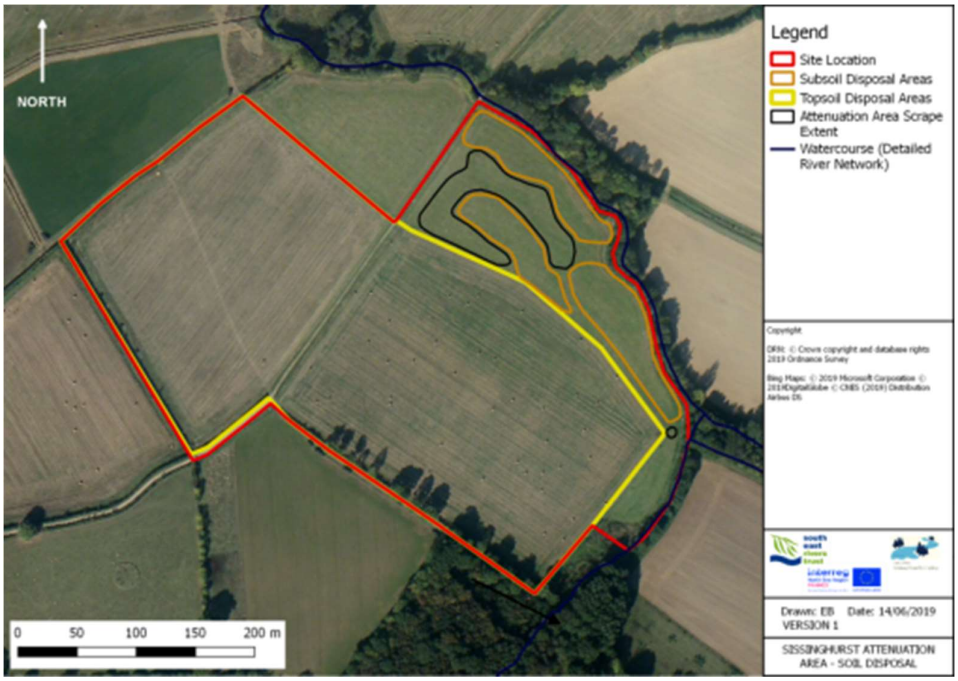

Fig 23 Subsoil transfer areas

Two fields: Twelve Acre Meadow and Great Meadow are available receive the topsoil excavated from the attenuation area and off-take channel. Twelve Acre meadow is approximately 45,000m^2 in area. With topsoil spread at a depth of 0.05m, potentially 2,250m^2 of topsoil could be spread across this field. Great Meadow is approximately 35,000m^2 in area and therefore there is potential to receive 1750m^3 of topsoil. This represents a total potential reception capacity of 4,000m^3, well in excess of the volume of 1665 m^3 topsoil which is projected to be generated.

Proposed timetable for construction

Excavation and transfer of topsoil from scrape and channel system	September 2019
Ploughing in of topsoil	before end Sept 2019
Excavation of and transfer of subsoil and creation of hedge bank	Sept-Oct 2019
Construction of off-take structure	Oct 2019
Connection of system and completion of engineering works	end Oct 2019
Re-sowing with wildflower mixes	Oct-Nov 2019

Post construction monitoring

Plans are being developed by SERT and the National Trust to monitor the long-term hydrological and ecological function of the proposal to contribute to the national evidence base for Natural Flood Management, and provide a case study for how similar projects can contribute to flood mitigation

and the creation of Natural Capital in the Medway Catchment and similar environments in Southeast England and North Sea Region.

Consultees

The following people have been consulted or have contributed advice to this application:

Name	Organisation	Summary
Peter Dear	Lead Ranger National Trust	Overall scheme concept and design
Peter Coles	Ranger National Trust	Practical aspects and natural history
John Hickman	Tenant farmer	Topsoil relocation
Nathalie Cohen	Archaeologist National Trust	Archaeology and heritage
Ross Wingfield	High Weald AONB	Landscape & local provenance wildflowers
Stewart Clarke	Freshwater Habitats Adviser, National Trust	Ecology and floodplain meadow restoration
Crispin Scott	Wildlife Adviser, National Trust	Strategic context of National Trust approach to biodiversity
Tom Cook	Biodiversity Technical Specialist, Environment Agency	Biodiversity, Natural Flood Management and licensing
Spencer Smith	Flood and Coastal Risk Management Officer, Environment Agency	Flood risk and mitigation
Emma Burdett	Land Drainage Engineer, KCC	KCC land drainage consent requirements on the ordinary watercourse
Ben Thompson	Land Management and Conservation Adviser, Natural England	Biodiversity, management and Higher Level Stewardship
Dan Tuson	Grassland restoration specialist, Natural England	Establishment of wildflower meadows
Mike Watson	Medway Internal Drainage Board	Flood risk, drainage and operations by the Hammer Stream
Toby Hull	Operations Manager, SERT	Construction, design and tendering
Ed Byers	Project Officer, SERT	Hydrology, design and drawings
Dean Morrison	NFM Project Officer, SERT	Ecology and overall design and implementation

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