Gatwick Airport Northern Runway Project

Environmental Statement
Appendix 11.9.1: Geomorphology Assessment

Book 5

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0 Executive Summary

0.1.1 The proposal to make best use of London Gatwick Airport's existing runways and infrastructure will require works that could affect the form and natural processes within the local watercourses.

0.1.2 This appendix provides the technical information that supports the assessment of impact on the geomorphology of those watercourses potentially affected by the Project reported in **Environmental Statement** (ES) **Chapter 11: Water Environment** (Doc Ref. 5.1).

0.1.3 The assessment finds that there would be minor adverse impacts during construction but these would be offset by their longer term significant benefits, such as the renaturalisation of the River Mole.

1 Introduction

1.1 General

1.1.1 This document forms **Appendix 11.9.1: Geomorphology Assessment** (Doc Ref. 5.3) of the Environmental Statement (ES) prepared on behalf of Gatwick Airport Limited (GAL) for the proposal to make best use of London Gatwick Airport's existing runways and infrastructure (referred to within this report as 'the Project').

1.1.2 This document provides the detail of the geomorphology assessment for the **ES Chapter 11: Water Environment** (Doc Ref. 5.1), including the baseline study and impact assessment.

2 Study area

2.1.1 There are four watercourses that have the potential to be directly or indirectly impacted by the Project and these have been defined as the fluvial geomorphological receptors. A study area has been defined for the desktop study that covers the catchments of the receptors. A smaller site study area has been defined for the site specific surveys and impact assessment which is based on the channels that will be directly impacted by the Project within the redline boundary. The catchments of the receptors cover a combined area of 237 km^2. The watercourses all sit within the River Mole management catchment of the Thames River Basin District. The watercourses identified as receptors are:

- River Mole;
- Gatwick Stream;
- Crawter's Brook;
- Burstow Stream Tributary; and
- Man's Brook

2.1.2 These watercourses are identified in **Figure 11.4.1** in the **ES Water Environment Figures** (Doc Ref. 5.2).

2.1.3 Design changes (including a reduction in the extent of flood mitigation measures) between the scoping, Preliminary Environmental Impact Report (PEIR) and ES stages of reporting mean that the following watercourses have been scoped out of the ES for geomorphological impacts, given that they are no longer considered to be impacted by the Project:

- Burstow Stream (where it is designated as "Main River"); and
- Withy Brook.

2.1.4 Potential scheme flood compensation measures at Withy Brook were reviewed during the Project development phases and were found to be insufficiently effective. The watercourse was then scoped out as not impacted by the Project. Burstow Stream was originally scoped into the assessment based on the extent of the highways works at the M23 spur (and consequently was included in the PEIR). Subsequently, following design development, Burstow Stream was scoped out due to the reduced extent of the highways works. A tributary to the Burstow Stream is affected by the embankment works to the M23 spur and is included within the scope of Project assessments. This watercourse is designated as an "ordinary watercourse".

2.1.5 Other watercourses scoped out of this assessment include Hookwood Common Brook and Spencer's Gill (tributaries of the River Mole), Dolby Brook (tributary of Man's Brook), and Crawter's Brook Tributary (tributary of Crawter's Brook). These watercourses are not considered to be impacted given their distance of over 1 km from the Project.

3 Methodology for baseline studies

3.1 Desktop Study

3.1.1 The baseline study included a fluvial geomorphology assessment undertaken at a catchment scale. The catchment extents of each watercourse have been used as the extent of a desk-based review of geomorphological conditions (**ES Appendix 11.9.2 Figure 4.1.1** (Doc Ref. 5.3)). This provides an overview of the catchments and how they currently function, and summary information on historical changes. This information then feeds into the more detailed baseline. The following are the key data sources used for this desk study:

- Thames River Basin District Management Plan (Department for Environment, Food and Rural Affairs (Defra), 2015);
- Geology maps (British Geological Survey, 2019);
- Historical maps (National Library of Scotland, 2019);
- Hydrological information (Centre of Ecology and Hydrology, 2019);
- Environment Agency Catchment Data Explorer (Environment Agency, 2022; and,
- Ordnance Survey (OS) mapping.

3.2 Site Specific Surveys

3.2.1 Geomorphological walkover surveys have been undertaken of the site study area within the Project boundary to develop a more detailed baseline of channel characteristics on the watercourses which are potentially impacted by the Project (**Figure 11.4.1** in the **ES Water Environment Figures** (Doc Ref. 5.2)). The first survey took place in September 2019 and water levels were above average following a prolonged period of heavy rainfall. As a result, the beds and part of the banks were not visible. However, some information on the banks, physical processes and existing pressures was recorded, and photographs were taken on site to supplement this. Two further site surveys were undertaken in March 2022 and April 2023 to collect additional detailed survey information at watercourses where there have been changes to the design since the PEIR stage. These include downstream parts of the River Mole and Man's Brook which are potentially impacted by surface access and highways works. During the surveys, water levels were average, and the bed and banks were visible. Additional photographs were captured along parts of the River Mole and Man's Brook to supplement existing baseline information. Therefore, sufficient information has been obtained to fully assess effects of relevance to this study.

3.3 Methodology for Impact Assessment

3.3.1 The baseline assessment was taken to be indicative of the current morphological condition of the watercourses. The potential geomorphological impacts of the Project and flood risk mitigation components were identified for each watercourse. Descriptions of the potential effects of construction and operational activities were outlined using expert judgment of fluvial geomorphological processes. The water body status, as provided by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (WFD), was used to infer importance to Project impacts where relevant (Table 3.3.1). For non-WFD designated water bodies, importance is assigned based on diversity of morphological features and processes, state of natural equilibrium, and extent of artificial modification or anthropogenic influence. A qualitative assessment of the magnitude of the impacts was established with reference to GIS information, baseline conditions (including existing morphological pressures) and the proposed design with embedded mitigation. The magnitude of the impact was determined in a matrix which combines the duration and scale of the impact into a qualitative descriptor (Table 3.3.2 and Table 3.3.3). The significance of the effect was then determined in a matrix which combines importance and magnitude into a qualitative descriptor (Table 3.3.4). Where a range of significance levels are presented in the matrix, the final assessment for each effect is based upon expert judgement. Effects that have moderate or greater significance are considered to be significant in EIA terms.

Table 3.3.1 Importance criteria for receptors

Importance	Criteria
Very High	Watercourses having a 'High' (or potential to achieve 'High') WFD Regulations classification for physico-chemical and biological elements status, 'pass' for specific pollutants and/or priority substances and shown in a RBMP. Watercourse part of a protected site/international designation related to wet features (e.g., a riverine Special Area of Conservation (SAC) or Special Protection Area (SPA)). Non WFD classified watercourses may be applicable if they demonstrate qualities such as: a channel in stable equilibrium and exhibiting a range of natural morphological features (such as pools, riffles and bars); diversity in morphological processes reflects unconstrained natural function; free from artificial modification or anthropogenic influence.
High	Watercourse having a 'Good' (or potential to achieve 'Good') WFD Regulations classification or having established RBMP objectives (for a later RBMP cycle) to achieve good physico-chemical and biological elements status (good potential for HMWBs), pass for specific pollutants and/or priority substances and shown in a RBMP. Watercourse contains species protected under EC or UK legislation for ecology and nature conservation but is not part of a protected site or national designation related to wet features (e.g. a riverine SSSI). Non WFD classified watercourses may be applicable if they demonstrate qualities such as: a channel achieving near-stable equilibrium and exhibiting a range of natural morphological features (such as pools, riffles and bars); diversity in morphological processes reflects relatively unconstrained natural function, with minor artificial modification or anthropogenic influence.
Medium	Watercourse having a less than 'Good' (or potential to achieve less than 'Good') WFD Regulations classification shown in a RBMP and/or local designation related to wet features (e.g. a riverine Local Nature Reserve (LNR)). Non WFD classified watercourses may be applicable if they include channels currently showing signs of historical or existing modification and artificial constraints, and/or attempting to recover to a natural equilibrium and exhibiting a limited range of natural morphological features (such as pools, riffles and bars).
Low	Minor local watercourses not having a WFD Regulations classification shown in a RBMP and no designated features. Water body not having a WFD Regulations classification shown in a RBMP. A channel currently showing signs of extensive historical or existing modification and artificial constraints. There is no evidence of diverse fluvial processes and morphology and active recovery to a natural equilibrium.
Negligible	Minor ephemeral drains and channels

Table 3.3.2 Magnitude of impact criteria

Duration of impact	Scale of impact (km)					
	<0.1	**0.1- 0.5**	**0.5 to < 1.5**	**1.5 to < 5**	**5 to < 10**	**> 10**
	Negligible	**Very Small**	**Small**	**Medium**	**Large**	**Very Large**
Short term: 1 to 12 months	Negligible	Negligible	Low	Low	Medium	Medium
Medium term: 1 to 5 years	Negligible	Low	Low	Medium	Medium	High
Long term: Over 5 years	Negligible	Low	Medium	Medium	High	High

Table 3.3.3 Magnitude of impact criteria definitions

Magnitude of Impact	Criteria
High	Project element will impact the geomorphology at a waterbody scale.
Medium	Project element will impact the geomorphology at a multi-reach scale.
Low	Project element will impact the geomorphology at a reach scale.
Negligible	Project element will impact the geomorphology at a local scale.
No change	Project element will have no impact on geomorphology.

Table 3.3.4: Assessment Matrix for Assigning Significance of Effect

Sensitivity	Magnitude of Impact (Adverse or Beneficial)				
	No Change	Negligible	Low	Medium	High
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major or Substantial
Very High	No change	Minor	Moderate or Major	Major or Substantial	Substantial

4 Current Baseline

4.1 Catchment Overview

4.1.1 The River Mole originates south of Crawley in West Sussex and flows through Surrey for approximately 80 km before reaching the Thames at Molesey. The catchment of the River Mole has an area of 512 km^2, and forms five per cent of the Thames catchment area (Environment Agency, 2022). The watercourses scoped into this assessment are in sub-catchments of the River Mole, including the Mole (upstream of Horley), Gatwick Stream, and Burstow Stream.

4.1.2 The catchment terrain of the watercourses is dominated by the Low Weald topography of the Wealden Basin and underlain by Wealden Group clay. Surface geology mainly comprises alluvium and river terrace sands and gravels (BGS, 2019).

4.1.3 The River Mole sub-catchment area upstream of Horley is approximately 30 km^2, and includes urban areas of Crawley and Three Bridges, and Gatwick (Environment Agency, 2018). The Mole forms at the confluence of the tributaries of Ifield Brook and Baldhorns Brook, north of Crawley, where it flows north-eastwards through mainly rural land, receiving runoff from field drains. This section of the watercourse has a naturally meandering planform and wide channel (approximately 5 metres).

4.1.4 At the southern perimeter of Gatwick, the River Mole is joined by Crawter's Brook. Crawter's Brook is a narrow stream of approximately 2 metre width which rises in Tilgate Forest in the south and flows northwards through Crawley via a network of culverts and open channels towards the southern perimeter of the airport. The watercourse is realigned westwards along a straightened channel on the southern side of the airport to meet the River Mole. The River Mole then runs broadly northwards via a culvert with a syphon overflow used in flood conditions under the existing main and northern runways. North of the runways, the River Mole re-emerges from the culvert and syphon. The River Mole is realigned and straightened to flow westwards, and subsequently northwards, and is joined by Man's Brook, a small 2-4-metre-wide stream which rises at Tilgate wood and flows north-eastwards through agricultural land to the west of before flowing into the River Mole. The River Mole is also joined by Westfield Stream, a small realigned and heavily modified channel which rises northwest of the runway, connecting to the Mole via a balancing pond. The River Mole has been realigned around the northern perimeter of the airport, confined in a low valley between the airport infrastructure and urban residential areas. The River Mole passes under the London Road (A23) bridge, after which it meets its confluence with Gatwick Stream. Downstream of the confluence, the River Mole continues northwards confined between London Road (A23) and an urban residential area, before passing under the Brighton Road (A23) bridge at Longbridge Roundabout. The River Mole has a naturally sinuous planform as it flows northwards through managed arable and pasture land onward beyond the study area.

4.1.5 Gatwick Stream is a tributary of the River Mole. It rises in Worth Forest below Clays Lake in West Sussex and flows northwards through Tilgate Forest, through Maidenbower, Three Bridges and Tinsley Green to the confluence with the River Mole. Tilgate Brook is a tributary of Gatwick Stream, approximately 300 metres in length. Crawley Sewage Treatment Works (STW), operated by Thames Water, is located to the east of the Gatwick Stream, downstream of Crawley, immediately to the southeast of London Gatwick Airport.

4.1.6 Gatwick Stream is approximately 8 km in length, with a catchment area of 14 km^2 (Environment Agency, 2018). The river planform is sinuous as it flows through Tinsley Green: a mixture of wooded area and parkland. The stream then flows under Radford Road bridge and through the Gatwick Stream Flood Storage Area (owned and operated by GAL) to the south and southwest of Crawley STW. The width of the channel typically measures 4-5 metres along this section.

4.1.7 Just downstream of the STW, the watercourse passes through a culvert under the Brighton-London mainline railway and flows northwards along an engineered straightened course adjacent to the A23. The watercourse is narrower at this point with an approximate width of 3 metres. The watercourse is culverted under the South Terminal building and under Airport Way, where it re-emerges into Riverside Garden Park, to the north of the A23, as a 900-metre-long section of natural meandering channel. Towards the downstream section within Riverside Garden Park, the watercourse is straightened as it flows between the A23 and residential areas, before joining the River Mole to the southeast of Longbridge Roundabout.

4.1.8 Burstow Stream is a tributary of the River Mole. It rises at Crawley Down in West Sussex, flowing through predominantly rural areas and the urban area of Copthorne, joining the River Mole just north of Horley. Burstow Stream is approximately 2 km away from the airport, however a tributary of the watercourse is within the study area. Burstow Stream Tributary (also known as Haroldslea Stream) is a tributary of the Burstow Stream. It is a small channel fed by several drains from agricultural land and road drains. The stream is typically less than 2 metres in width. Current OS mapping indicates the stream originates south of Horley as a drain along Balcombe Road and is culverted under the M23 motorway. The stream flows mostly in an open channel through the residential area east of Horley.

4.2 Historical Change Analysis

4.2.1 To identify historical geomorphological and land use changes, a series of digitised pre-WWII 1:10,560 scale OS maps and post-WWII 1:25,000 scale OS maps have been used in GIS, available through the National Library of Scotland (National Library of Scotland, 2019). The results are presented in **ES Appendix 11.9.1 Figure 4.2.1** (Doc Ref. 5.3) and accompanying Table 4.2.1.

4.2.2 Historical OS mapping pre-1913 shows the land use within the study area was predominantly rural, including agricultural land around the River Mole, Crawter's Brook and Burstow Stream tributary. Gatwick Stream flowed through a mixture of wooded area and parkland.

4.2.3 Since the 1930s, all receptors have been significantly modified, which predominantly relate to the expansion of the airport and creation of associated transport links. The most significant changes include the realignment of the River Mole for construction of the North Terminal during the 1980s (Table 4.2.1, locations 11-12), various modifications to the course of Crawter's Brook since the 1950s (Table 4.2.1, locations 5-6, 14) and straightening of Gatwick Stream in the 1930s (Table 4.2.1, location 3).

Table 4.2.1: Historical Analysis of Watercourses in Study Area

Location	Date	Comment
1	Pre-1900	The River Mole was originally split into two channels to power the (now disused) Horley Mill since about the 13th century. The channel was again modified to form one channel in the following century post 1959 after the mill's closure.
2	1935	The confluence between the River Mole and Gatwick Stream was severed by construction of the A23. The River Mole was straightened downstream in alignment with the A23.
3		Gatwick Stream was straightened to allow for the construction of the A23.
4	1945-1955	Unnamed tributary of the River Mole is removed following airport expansion.
5	1945-1960	Crawter's Brook was realigned to join the River Mole further upstream for construction of the runway.
6		A channel alongside the runway was constructed to connect the River Mole and Crawter's Brook, north of the runway.
7		The River Mole was culverted under the runway.
8	1970s	Burstow Stream culverted for construction of the M23.
9	1980s	The remaining channel of Crawter's Brook, north of the runway, was removed for construction of the North Terminal. The connecting channel to the River Mole adjacent to the runway was also removed.
10		Man's Brook was shortened to join the new channel of the River Mole further upstream to make way for the North Terminal.
11		The River Mole was realigned 0.5 km northwest from its original position for construction of the North Terminal.
12		The River Mole was realigned along an existing stream (Westfield Stream), encircling ancient woodland (Brockley Wood).
13	1960-2000	The confluence between Burstow Stream and its tributary was modified.
14		Crawter's Brook straightened again at far west of airside perimeter.
15	Post-2000	The Mole biodiversity area was created upstream of Man's Brook, which included naturalisation of the watercourse and ecological improvements.
16		Gatwick Flood Alleviation Scheme helping to prevent flooding in areas downstream. The main channel of Gatwick Stream was enhanced with natural river features such as pools, fast flowing areas and native wetland. Control gates were added to enable excess water to collect in the low-lying grassland.

4.3 Site Channel Characteristics

4.3.1 Table 4.3.1 to Table 4.3.4 include a detailed description of channel characteristics and photographs of the watercourses surveyed for each of the site visits undertaken to capture the baseline conditions. Channel dimensions provided were measured using cross-sectional data on Flood Modeller, unless otherwise stated.

4.3.2 A photographic record is included in **Annex 1** of this appendix.

Crawter’s Brook – Gatwick Airside to Confluence with the River Mole

Table 4.3.1: Crawter's Brook Site Characteristics

Representative image	Description
 Photo 1: Mid-channel vegetated bars  Photo 2: Damaged gabion mattresses  Photo 3: Bank erosion downstream of gabions	The valley is broad and formed in Wealden Clay with localised areas of river terrace superficial deposits. The floodplain is constrained on either side by the airport Perimeter Road South, the airport’s fence, and a grassy strip to the south on the left bank, and the airport main runway to the north on the right bank. The floodplain is also constrained to the north adjacent to the bank top by a low (<0.5 m) narrow (approximately 1 metre) grassy embankment along its length. The channel itself is covered by netting crossing from the bank top. This section of Crawter’s Brook has been heavily modified and straightened for its entire length, with evidence of dredging on the channel bed. It is a trapezoidal channel with relatively steep uniform banks and uniform flow types. The channel banks consist of clay and made ground, including concrete rubble and brick but are largely undefended and stable. Bank height varies from 3-4 metres, and water depth is <1 metre. The channel water width during baseflow conditions is typically 4 metres and bankfull width is approximately 12 metres. Bedforms visible during the site survey include mid-channel vegetated bars dispersed through the upstream length of the channel (Photo 1), formed of reeds and long grasses, and one instance of large woody debris in the channel. Channel form and flows become increasingly uniform downstream, with sediment having dropped out further upstream to form the vegetated bars. Left and right bank characteristics are similar in that the riparian vegetation consists of mostly continuous coarse grasses and sparse small shrubs in the upstream extent. Some woody debris from shrubs is within the channel, resulting in localised changes in flow patterns. Vegetation is patchy in places where the channel banks are defended by concrete lining and geotextiles, particularly at Old Brighton Road South bridge. Both vegetation density and the number of vegetated bars decreases downstream. Slightly beyond the Old Brighton Road South Road bridge (adjacent to Perimeter Road South) on the outside bend of the channel, a section of gabion mattresses on the right bank is significantly damaged (Photo 2), with cobbles having come loose from the cages, likely as result of high discharge events (Photo 3). This area appears to have experienced erosion in the past as the failed banks have since vegetated over. Downstream of these defences on the right bank, localised active erosion continues to occur, where clay and made ground rubble has crumbled away from the bank side (Photo 3). In these areas, the bank has become over-steepened resulting in the destabilisation of the bank formed of unconsolidated materials. Observations indicate that animal burrowing may be resulting in erosion of bank top material under the netting. Erosion on the right bank occurs for 300 metres downstream. Existing pressures include five outfalls on the left bank, three bridges including concrete abutments and sloping masonry on adjacent banks, deteriorated geotextiles, vertical concrete walls at the confluence with the River Mole before being culverted under the runway, two slipways with gates, and one concrete drain structure with vertical concrete walls.

The Mole – Runway crossing to Confluence with Gatwick Stream

Table 4.3.2: River Mole Site Characteristics

Representative image	Description
 Photo 1: Mid-channel vegetated bar  Photo 2: Embankment view from right bank  Photo 3: Concrete lined outfall structure set into the right bank	The valley is broad and formed in Wealden Clay and alluvium superficial deposits. The valley is marginally steeper to the west of the River Mole where limestone bands in the Wealden Clay have formed low hills. The River Mole has been re-routed and modified following airport expansion. It is culverted beneath the airport runway and situated west of its original natural course. Embankments have been built up along much of the channel length to form an 'artificial valley' which channels the water between the surrounding infrastructure. Upstream of the runway culvert within the airport perimeter, the channel is straightened and over-deepened. The banks are steep to vertical, formed of earth and heavily vegetated by brambles and woody scrub. The bankfull width is approximately 12 metres, and the bank height is 1.6 metres. Estimated mean annual flow upstream of the runway culvert is 0.451 m^3/sec, and Q95 flow is 0.046 m^3/sec. There were glide flow conditions in the channel. The channel bed was not visible due to turbid conditions; therefore, no bed features were observed. Netting covering the channel had fallen into the channel in places and acted as a rubbish screen collecting litter and impounding flow. Approaching the runway culvert, the channel is split by a concrete dividing wall which channels flow during high flow conditions into a syphon. The channel to the syphon is concrete lined and falls steeply towards the syphon chamber. Notable gravel accumulation has occurred along this section of engineered channel across the full channel width, which has partially become vegetated with grass. The River Mole's course continues towards northwards over a weir before meeting the confluence with Crawter's Brook. Upstream of the weir, vegetated berms have formed continuously along the toe of the right bank, naturally narrowing the channel and increasing sinuosity and flow velocity. Downstream of the weir, the channel is heavily engineered with concrete bed and banks. The River Mole enters the runway box culvert with divider wall. The culvert dimensions are approximately 4.57 metres width by 2.29 metres height. The culvert extends 513.5 metres under the airport runway (Dyer & Butler, 2016). Gates at the culvert outlet were fixed open at the time of surveying due to siltation on the channel bed. Exiting the culvert, the channel is wide with a bankfull width of 20 metres and height of 2 metres. The banks are gently sloping and predominately vegetated with grasses and woody scrub. Sloping masonry is located on the banks around the culvert outlet. Downstream of the confluence with the syphon channel, the River Mole narrows to 15 metres bankfull width and flows around a sharp $>90^0$ bend into a 300-metre straightened section of channel with embankments on either side. The floodplain is constrained west of the channel by an artificial pond (Pond A). Glide flow conditions dominate this section of channel; however, flow was impounded in places where old netting covering the channel has collapsed into the channel, trapping rubbish and debris. Siltation on the bed was evident, particularly in these locations. The bed and banks are generally uniform and there were few bed features, with the exception of vegetated berms towards the downstream of the straightened section. Downstream, the River Mole has been re-naturalised to create a biodiversity rich area, where the river has been engineered with a sinuous planform and wider floodplain with public access along the left bank of the river. The floodplain is up to 150 metres wide. The channel is narrower with 5-7 metres bankfull width and 0.5 metres bankfull height, and the banks are shallow and gently sloping. The banks are mainly vegetated with grasses and scattered trees. Westfield Stream inputs into the River Mole via a grated culvert. Glide flow conditions dominate, and the bed material is mainly silt, sand and fine gravel. Downstream of the confluence with Man's Brook, the river planform decreases in sinuosity, and is straightened as it flows around the perimeter of the long stay car park to the confluence with Gatwick Stream. Channel bankfull width is typically between 4-7 metres and the bank heights are typically approximately 1 metre. The channel banks are gently graded and formed in clay. Deciduous woodland is planted on the valley sides along the edge of the floodplain. The floodplain narrows to 40-70 metres width downstream of Man's Brook. The floodplain is constrained downstream of Man's Brook by Horley/Charlwood Road, Povey Cross Road and the settlement of Hookwood. The floodplain on the right of the channel is constrained by airport infrastructure, including hangars, the long stay car park, and two artificial ponds (Pond D and Pond M). Bedforms include large mid-channel vegetated bars dispersed throughout the length of the channel, formed of reeds and long grasses, and numerous instances of large woody debris in the channel, resulting in non-uniform flow types (Photo 1). Left and right bank characteristics are similar in that the riparian vegetation includes mostly continuous coarse grasses on the sloping embankments, and scattered shrubs and small deciduous trees along the channel sides (Photo 2). Long grasses and reeds dominate the upstream banks and floodplain. Tree density increases downstream, particularly on the right bank. During the survey, there was no observable erosion of the banks, however water was frequently over-topping the banks and footpath on the floodplain. Between Man's Brook and the confluence with Gatwick Stream, there are several notable existing pressures on the watercourse including Povey Cross road bridge, London Road (A23) bridge with concrete abutments, several outfalls from drains and Pond D also releases water from a concrete lined outfall structure on the right bank (Photo 3).

	Downstream of the confluence with Gatwick Stream, the River Mole widens to approximately 15 metres bankfull width and 2 metres height banks. Estimated mean annual flow downstream of the confluence is 1.181 m^3/sec, and Q95 flow is 0.137 m^3/sec. The banks have a composite form and are vegetated by grasses, shrubs and mature trees. Rippled and glide flow conditions dominate, and fine gravel and silt is present on the channel bed. Wood is present on the channel bed which generated flow variability. Brighton Road bridge crosses the channel and features concrete abutments and downstream hard bank protection. Two outfalls are located either side of the bridge. Localised erosion of the steeper banks downstream of the bridge was observed.

Gatwick Stream – Tinsley Bridge to Confluence with the Mole

Table 4.3.3: Gatwick Stream Site Characteristics

Representative image	Description
 Photo 1: Netting over the Gatwick Stream  Photo 2: Erosion of vertical right bank and scattered vegetation	The valley is broad and formed in Wealden Clay and Upper Tunbridge Sands bedrock and alluvium superficial deposits. The floodplain of Gatwick Stream can be considered in three sections. From Tinsley Bridge to the Brighton-London mainline railway the river has been almost entirely realigned as part of the Upper Mole flood attenuation scheme. The channel is constrained by embankments on both sides, and control gates allow the low-lying grasslands to the left of the channel to collect excess water during extreme flood events. The channel itself is covered by netting crossing from the bank top (Photo 1). The eastern floodplain is also constrained by Crawley STW. Between the railway and Riverside Garden Park, the floodplain is entirely constrained and disconnected by the A23, pathway and railway which are parallel to the watercourse. Gatwick Stream is also culverted beneath the railway crossing, London Gatwick Airport South Terminal, and the A23 crossing. Through Riverside Garden Park to the confluence with the Mole, the floodplain is mostly constrained on the right (north) of the watercourse by residential properties, whilst the left side is mostly unconstrained. The channel bankfull width is between 4-6 metres and bank top channel width varies between 9-11 metres. Depth is typically <1 metre and bank height varies between 1 and 3 metres. Estimated mean annual flow upstream of the Mole confluence is 0.436 m^3/sec, and Q95 flow is 0.056 m^3/sec. Between Tinsley Bridge and the railway, the channel has a sinuous planform with relatively steep banks and varied flow types. The channel is actively meandering. The channel banks consist of clay and sandy soil. Bedforms include vegetated mid-channel bars dispersed along its length, formed of reeds and long grasses, and numerous instances of woody debris in the channel giving rise to areas of faster flow and pools. The bed and bedform materials were not clearly visible during the site survey due to high water levels and turbidity. Riparian vegetation mainly comprised continuous deciduous trees and Himalayan Balsam upstream of the realigned section, and coarse grasses and small shrubs downstream. The vegetation was stripped from near-vertical sections of the right bank that are actively eroding (Photo 2). Vegetated bars are also encouraging erosion of both banks by pushing the flow towards the banks. There is one outfall on the right bank and the river is culverted downstream near Crawley STW. From the culverted section under the railway to Riverside Garden Park, the river is straight with relatively steep, root-bound clay banks and mainly uniform flow types. Between the railway culvert and Pond E, the channel is concrete lined. Immediately downstream of the concrete lining, the bed level drops where the river has scoured the natural bed and banks. Gabion mattresses protect both banks along this section (Photo 3). The bed and bedform materials were not clearly visible during the site survey due to high water levels and turbidity, however, cobbles were noted downstream of the gabion mattresses. Riparian vegetation included a dense mixture of shrubs and deciduous trees lining both banks. Woody debris was visible in the channel, varying the flow patterns locally. There was no other evidence of bank erosion. The river is canalised by vertical concrete walls and concrete lining before flowing through the South Terminal culvert. The channel briefly re-emerges through a short naturalised wooded section, with one outfall and pipe crossing, before flowing under the A23. Through Riverside Garden Park, the channel is sinuous with moderately steep root-bound clay banks and varied flow types. The banks and bed are concrete lined as the river exits the A23 culvert, flowing over a weir structure. Along the right bank the banks appear over-steepened in sections with evidence of erosion (Photo 4). Several small sections of the right bank are protected by brick walls as they abut gardens of residential properties. The bed and bedform materials were not clearly visible during the site survey due to high water levels and turbidity. Riparian vegetation includes continuous mature deciduous woodland and shrubs. Woody debris was visible in the channel, varying the flow patterns locally. The channel flows parallel to the A23 for 370 metres before meeting the confluence with the River Mole.

 Photo 3: Gabion mattresses and erosion of bank  Photo 4: Over-steepened banks along straightened section	

Burstow Stream Tributary – M23 Road Bridge Crossing

Table 4.3.4: Burstow Stream Tributary Site Characteristics

Representative image	Description
 Photo 1: Concrete lined channel from culvert	The valley is broad and formed in Wealden Clay bedrock and widespread river terrace superficial deposits. The floodplain is constrained and dissected by the M23 spur road crossing, formed of a high embankment which crosses the path of the stream perpendicularly, and the Balcombe Road and residential properties which abut the left side of the channel. Observations on site indicate that the channel has a bank top channel width between 1-2 metres, and bank height is <1 metre. This section of Burstow Stream tributary has been heavily modified to accommodate the road embankment into which it is culverted. The channel banks are relatively steep suggesting the channel has been deepened in the past. During the site visit, discharge was low, and water was not flowing, suggesting that the channel is dry for most of the year. Estimated mean annual flow upstream of the M23 spur is 0.015 m^3/sec, and Q95 flow is 0.002 m^3/sec. There were no notable bedforms and the bed material was mostly covered by thick deposits of leaf litter. Downstream beyond the culvert there were gravels and silts within the bed substrate amongst the leaf litter. Both left and right bank characteristics show the banks are formed of root-bound clay further upstream and downstream of the culvert. Riparian vegetation consisted of a high density of continuous shrubs and deciduous trees on the bank top, which cause the stream to be overgrown and shaded. The channel is concrete lined for several metres from the culvert both upstream and downstream (Photo 1).

 Photo 2: Pipe crossing close to culvert	Existing pressures include the 1.067m diameter corrugated pipe culvert which extends 60m under the M23 spur and embankment and a pipe crossing close to south side of culvert (Photo 2).

Man's Brook – Horley Road to River Mole confluence

Table 4.3.5: Man's Brook Site Characteristics

Representative image	Description
 Photo 1: Over-deepened upstream section on Man's Brook, showing over-steep banks and turbid nature of channel  Photo 2: Pool-riffle morphology, gravel bars and natural wood deflectors in Man's Brook in downstream historically realigned section	The valley is broad and formed in Wealden Clay and alluvium superficial deposits. The valley is steeper to the west where limestone bands in the Wealden Clay have formed low hills. The floodplain is relatively unconstrained with the exception of Horley Road to the north. Most of this part of the tributary has not been modified, with only the 100 metre section up to the confluence having been historically realigned to join the River Mole during the 1980s following shortening of the watercourse to make way for the Northern Terminal. The unmodified and realigned section are distinctly different in terms of the channel geometry and geomorphological features present. Observations on site indicate that the unmodified section of channel which flows through Brook Farm is over-deep, likely as a result of incision of the bed following historical alterations to the watercourse length (Photo 1). The banks are mainly vertical and over-steepened, likely as a result of rapid incision of the clay bed. Localised erosion and undercutting of the banks were observed, resulting in channel widening over time. The bank height is 2 to 3 metres, and the bank top channel width ranges from 6 to 8 metres. Erosion of the channel bank face at outer meander bends was evident, due to erosion driven by flood flows which reach bank top level. Scour of the bank was observed on the underside of a bridge crossing situated on an outer meander bend. Localised erosion was also observed where tree topples, and collapse of over-steepened banks have occurred. The bank top is mostly lined by deciduous trees (such as oak and hawthorn) and bordered by grassy meadow. The watercourse in this section is partially shaded by tree cover. The banks are formed in root-bound clay and soil, which are mostly exposed where the banks are vertical, and locally covered by riparian vegetation and ivy where the bank profile is less steep. During the site visit, discharge was low, and flow was perceptible. The channel water was generally turbid, however fine gravel riffles were present in distinct areas, followed by deeper pools on meander bends. Gravel lateral bars were also present. Existing pressures on this section include several farm bridges and footpath crossing, and one road crossing. According to anecdotal evidence from the landowner, the stream has continuous flow annually, only having dried out once in Summer 2022. At the downstream of the unmodified section where the channel has been realigned (downstream of the large land drain outfall), a large wood dam was present in the channel formed of fallen tree stumps and captured wood debris. The channel flow has been impounded, and flow diverted around the dam during higher flows has resulted in erosion of the left bank face. Flow is impounded a second time downstream by a smaller wood dam at the pedestrian footbridge crossing, resulting in turbid conditions. Degraded geotextile bank protection was observed at the footbridge. Downstream of this, however, the channel bank top height and width reduce and flow velocity increases. The channel bank top width is 3 to 4 metres, and the bank top height is <1m and the bank profile is gently sloping. Wood material in the channel is evident along this section, acting as natural flow deflectors leading to bank erosion and deposition of gravel bars and riffles (Photo 2). The channel has a well-developed pool-riffle morphology, with clear flowing water and an abundance of gravel on the channel bed. The banks are formed in clay with exposures of shale/mudstone where the bank is eroding. Riparian and floodplain vegetation consists of scattered to continuous deciduous trees (mainly hawthorn) and grassy meadow on the bank top, which cause the stream to be partially shaded. The watercourse continues in this way up to the confluence with the River Mole.

5 Future baseline

5.1.1 The future baseline for the geomorphology of the watercourses is primarily affected by changes in climate, ongoing natural adjustment in the watercourses and changes due to implementation of local policy measures. These have the potential to affect the watercourses directly and indirectly at different scales by altering the hydrological regime and hydromorphological condition.

5.2 Initial Construction Phase: 2024-2029

5.2.1 It is anticipated that climate change would not have a significant impact on the geomorphology before 2029 when compared to the baseline assessment. Therefore, no climate change effects have been considered for the initial construction phase. There will be some evolution of the watercourses due to natural adjustment.

5.3 First Full Year of Opening: 2029

5.3.1 It is anticipated that airport growth and any effects from climate change would not have a significant effect on geomorphology when compared to the baseline assessment. Therefore, changes to the baseline are not expected for the first year of opening (2029), with exception for continued evolution of the watercourses due to natural adjustment.

5.4 Interim Assessment Year: 2032

5.4.1 It is anticipated that airport growth and any effects from climate change would not have a significant effect on geomorphology when compared to the baseline assessment. Therefore, changes to the baseline are not expected for the interim assessment year (2032), with exception for continued evolution of the watercourses due to natural adjustment.

5.5 Design Year: 2038

Evolution due to Climate Change

5.5.1 Over a medium to long-term time period, climate change could potentially alter the hydrological regime of the watercourses. Increased frequency/severity of droughts and floods could potentially lead to the watercourses adjusting to different patterns of erosion and deposition. However, it is likely that the adjustment would remain localised and of relatively low magnitude given the modified channel types, and relatively short period to 2038.

Evolution due to Natural Adjustment

5.5.2 The River Mole, Gatwick Stream and Man's Brook are currently exhibiting some evidence of channel adjustment. These channels have been assessed as having a low to moderate energy, with limited competence to actively move the course of the planform. It is anticipated that if left undisturbed, the watercourses would continue to adjust slowly laterally and potentially through incision within the defined wider corridor so that over time the baseline will change. The remaining watercourses in the study area exhibited less evidence of adjustment, with lower energies, and are considered unlikely to adjust significantly so channel adjustment is not expected.

Evolution due to Meeting Policy Objectives

5.5.3 The Thames River Basin Management Plan (RBMP) provides details of the anticipated ecological status (which is partly dependent on stream morphology) for the WFD water bodies within the study area by 2027 (Defra, 2015). It is anticipated that WFD water body status and the quality elements (including hydromorphology) would improve with implementation of local measures specified by the Thames RBMP. It is therefore anticipated that some of the lower quality (poor and moderate) WFD water bodies will begin to move towards good status/potential by the design year.

5.5.4 The Thames RBMP outlines future local measures in the River Mole catchment, these are listed in full in **ES Appendix 11.9.2: Water Framework Directive Compliance Assessment** (Doc Ref. 5.3). Of note are the following which could lead to improvement in individual quality elements: tackling non-native species, removal of fish barriers, and restoration of more natural morphology where man-made modifications exist (Defra, 2015).

5.6 Assessment Year: 2047

5.6.1 It is anticipated that the future baseline for the Assessment Year 2047 would reflect the changes described in the Design Year 2038, including further evolution due to climate change, natural adjustment and meeting the policy objectives in the Thames RBMP.

6 Mitigation and Enhancement Measures Adopted as part of the Project

6.1 Initial Construction Phase: 2024-2029

6.1.1 Construction impacts would be mitigated through best practice measures secured within **ES Appendix 5.3.2: Code of Construction Practice** (Doc Ref. 5.3). The implementation of these measures would lessen the magnitude of the impact, for example by reducing the amount of fine sediment washed into the channel downstream of the works. This will reduce the length of the channel adversely impacted and the duration of impact.

6.1.2 Renaturalisation of the River Mole would begin in 2024 and would require excavation and earthworks along a 417-metre length of the existing channel. Implementation of best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1) and the offline construction of the renaturalised channel would reduce the release of fine sediments to the channel and downstream and reduce the likelihood of any unexpected large-scale change. The length of the channel adversely impacted, and duration of the impact would be reduced. The Project element would deliver an overall improvement to the geomorphology of the watercourse through re-meandering and naturalisation of the channel.

6.1.3 Construction of the runway culvert modifications and daylighted channel extension to accommodate the runway layout changes would require floodplain and in-channel works on the River Mole. Construction impacts would be mitigated through best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1).

6.1.4 Construction of the Museum Field Flood Compensation Area (FCA) would begin in 2024 and would involve lowering the existing ground level by up to 2.6 metres. The floodplain compensation areas would connect to the watercourse by lowering the stream bank of the River Mole along a 6m length of the left bank. Construction impacts would be mitigated through best practice measures secured in **ES Appendix 5.3.2: Code of Construction Practice** (Doc Ref. 5.3). For example, this would include reducing the amount of fine sediment washed downstream in the River Mole.

6.1.5 Construction impacts associated with lowering of Car Park X to provide a compensatory floodplain storage area and daylighted channel extension to the River Mole culvert and syphon would also be mitigated through best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1).

6.1.6 Construction of the Longbridge Roundabout surface access arrangements would begin in 2028. This would involve replacement and widening of the existing Brighton Road overbridge at the River Mole by an additional 6.4 metres, widening of the existing London Road overbridge by an additional 9.65 metres over the River Mole, and development in the floodplain to accommodate widening and modifications to the surface access arrangements and one new outfall from a highway drainage attenuation pond. Best practice measures to mitigate the construction impacts would continue to control the impacts, for example minimising riparian vegetation clearance to maintain bank stability.

6.2 First Full Year of Opening: 2029

6.2.1 During the first full year of opening, impacts to the geomorphology would be caused through construction of the South Terminal and North Terminal surface access arrangements which would begin in 2029. This would involve extension of Burstow Stream Tributary culvert. For the River Mole, Gatwick Stream and Burstow Stream tributary this would also involve development in the floodplain. Ongoing adjustment of the geomorphology is expected to continue as the watercourses adapt and adjust to construction works associated with various watercourses. Best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1) to mitigate the construction impacts would continue to control the impacts.

6.3 Interim Assessment Year: 2032

6.3.1 Ongoing adjustment of the geomorphology is expected to continue as the watercourses adapt and adjust to the associated construction works. Best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1) to mitigate the construction impacts would continue to control the impacts.

6.4 Design Year: 2038

6.4.1 Operational activities have the potential to impact on the geomorphology of the watercourses. These impacts are associated with the flood risk mitigation which includes channel renaturalisation, creation of flood storage areas, culvert modification and daylighted channel extension. Impacts are also associated with the change to road layouts, as part of the Project, which involve the extension of a culvert. Impacts are also attributed to the new water treatment system. The impact of these elements can be reduced through the implementation of the following design recommendations that have been incorporated in principle at this stage. These design recommendations would be developed through the detailed design stage:

- Flood compensation areas:
  - Varied bank form where banks are being lowered/altered to improve natural variance of flow in the channel.
  - Sufficiently wide spillway inlets/outlets connecting to the watercourse to minimise local effects on flow velocity.
  - Follow Design Manual for Roads and Bridges (DMRB) (CD 529) good practice design of outfalls and culverts (Standards for Highways, 2021).
  - Ecological planting to restore natural vegetation to the floodplain.
  - Soft/bio engineering would be used in preference to concrete where natural banks require protection at the connecting spillways to the new flood compensation areas, e.g., pre-seeded coir matting. Provides opportunity to re-plant riparian vegetation and stabilise the bank.
- Channel renaturalisation:
  - Timing of works to allow renaturalised channel to vegetate over before flow is initiated to reduce likelihood large-scale change and release of fine sediments downstream. Vegetation to establish over spring for 3-6 months.
  - Varied cross sections to mimic natural process, bed and bank forms.
  - Addition of suitable substrate with appropriate grain size distribution.
  - Suitable river type for the bed gradient of the realigned channel to maintain sediment transport capability.
  - Creation of a more natural planform to improve floodplain coupling and flow regime.
  - Multiple stage channel to ensure natural and varied flow conditions (not only the 1% (1 in 100) Annual Exceedance Probability (AEP) event).
  - Movement of sediment downstream if deposition occurs along new renaturalised channel (maintenance).
  - Retain portions of existing channel to create backwaters in new renaturalised channel.
- Culvert/daylighted channel extension:
  - Follow DMRB (CD 529) good practice design of outfalls and culverts (Standards for Highways, 2021) and CIRIA (C786) culvert guidance documents (Benn, et al., 2019).
  - Depress invert to maintain sediment transport capability.
  - Maintain natural bed gradients which allow the continuity of flow and sediment transfer.
  - Designed with splayed wing walls to reduce the light and dark barrier.
  - Inclusion of baffles or low flow channel to retain sediment in the culvert and create suitable depth of flow under a range of conditions.
  - Marginal planting on berms and fish resting pool.
  - Daylighted channel extension with road specification grid in portion outside of Taxiway Juliet graded area until edge of taxiway strip and security fence/airside track.

6.4.2 Other geomorphological impacts related to access arrangements can be offset by improvements and environmental enhancement in other parts of the catchment within the Project area. Such embedded mitigation includes landscaping and ecological planting on the newly created floodplain compensation areas.

6.5 Assessment Year: 2047

6.5.1 No further mitigation is required during the Assessment Year following Project completion. The mitigation secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1) applied during construction, and the measures described through the detailed design stage (as indicated for the Design Year 2038) are expected to provide sufficient mitigation to ensure no significant effects.

6.6 Monitoring

6.6.1 Regular monitoring of any change to the channel bed and banks would be undertaken, particularly in the vicinity of the River Mole renaturalised channel, the Museum Field FCA spillway, Car Park X outfall, and Gatwick Stream outfall following completion of the Project. This would be undertaken using fixed point photography or other means. If significant negative change occurs, appropriate mitigation would be implemented. It is anticipated that monitoring would be included as a requirement in the **Draft Development**

Consent Order (Doc Ref. 2.1). Any monitoring programme developed would have a resolution and timing appropriate to the impacts being monitored. It is recommended that the monitoring is carried out over a period of between 3 to 5 years, and data is collected at intervals of 3 to 6 months, and post-flood or high discharge events.

7 Impact Assessment

7.1 Assessment of Effects

7.1.1 The effects of the Project on the water environment along with a methodology as to how the effects have been assessed are presented within **ES Chapter 11: Water Environment** (Doc Ref. 5.1), Section 11.4. A summary of the effects on geomorphological elements during the construction and operational phases of the Project is provided in Table 7.2.1 to Table 7.5.1. These effects have been assessed with the embedded mitigation outlined in Section 6 in place.

7.2 Initial Construction Phase: 2024-2029

7.2.1 This section considers the potential effects of the activities that are likely to be carried out during initial construction phase of the Project. The construction activities are outlined in **ES Chapter 5: Project Description** (Doc Ref. 5.1). Each receptor has been assessed for the impacts in Table 7.2.1.

Table 7.2.1: Initial Construction Phase Impacts for Geomorphology

Description of Impact	Receptor	Duration	Importance of Receptor	Magnitude of Impact	Significance of Effect	Significant or not significant
General construction activities relating to the Project have potential impacts on all watercourses. These may include: ▪ Increase to suspended sediment loads due to channel disturbance from working in the channel, and runoff from construction areas. Impacts upon sediment transport and bed substrate downstream. This would have a localised effect on the geomorphology of the channel, limited by the mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) that will be put in place, that reduces the release of fine sediment into the channel, for example through use of a silt barrier or filter fence. ▪ Localised increase in potential for erosion of bed and banks due to excavation and earthworks, and removal of riparian vegetation. The mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) would also reduce the potential for erosion by use of temporary bank and bed protection and re-establishment of riparian vegetation, where necessary. ▪ Localised loss of and damage to riparian vegetation due to vegetation clearance. The mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) reduces the impact by re-establishment of riparian vegetation and minimising area impacted. ▪ Localised disruption of quantity and dynamics of flow and sediment supply, due to changes in bed and bank form during construction. The mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) reduces the impact by minimising the area impacted and protecting bed and banks where necessary.	River Mole	Medium-term	High	Negligible Adverse	Minor Adverse	Not significant
	Gatwick Stream	Medium-term	High	Negligible Adverse	Minor Adverse	Not significant
	Crawter's Brook	Medium-term	High	Negligible Adverse	Minor Adverse	Not significant
	Burstow Stream Tributary	Medium-term	Low	Negligible Adverse	Negligible Adverse	Not significant
Renaturalisation of the River Mole requires excavation and earthworks along an approximately 417 m length of existing channel (468 m when including existing syphon open channel). These activities may impact the existing watercourse by: Localised destabilisation of banks due to bank top loading and ground vibration. The mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) follows best practice measures which would minimise works on the bank top and reduce the potential for instability using temporary bank and bed protection, where necessary.	River Mole	Medium-term	High	Low Adverse	Minor Adverse	Not significant

Description of Impact	Receptor	Duration	Importance of Receptor	Magnitude of Impact	Significance of Effect	Significant or not significant
Localised damage to existing bank face due to modification and removal of bank material. The effects are localised as the Project element only requires a small section of the existing bank to be removed to connect the existing channel to the new renaturalised channel. Local to reach scale loss of natural bed forms and materials due to infilled original channel. The mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) would involve addition of suitable substrate to the re-aligned channel to create the natural bed conditions for the given river type. Local destabilisation of banks due to vegetation clearance, as vegetation binds the bank material and draws water. The control measures (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) reduce the duration and scale of the impact by re-establishment of riparian vegetation following works and by minimising the area impacted. Change in the quantity and dynamics of flow and sediment supply, due to changes in bed and bank form, channel planform, cross-section and gradients, as the channel adjusts. Implementation of best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1), and the offline construction of the renaturalised channel would reduce the release of fine sediments to the channel and downstream and reduce the likelihood of any unexpected large-scale change. The length of the channel adversely impacted, and duration of the impact would be reduced with offline construction of the renaturalised channel and implementation of best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1). Although natural bed and bank forms in the existing channel would be lost, the Project would deliver an overall improvement to the geomorphology of the watercourse through re-meandering and naturalisation of the channel, creating an additional c. 160 m length of renaturalised watercourse, with a further c. 150 m of existing watercourse retained as backwaters, and reduction in the syphon open channel length by 13 m. There will be an overall additional 297 m length of watercourse in the valley. Therefore, the overall significance is Minor Adverse.						
Construction of the culvert modifications and extension north of the runway to accommodate the proposed airfield infrastructure and runway would involve replacing part of the downstream section of the existing culvert and creation of a daylighted channel extension. The channel that the River Mole runs in from the exit of the existing culvert would be extended northwards by 36 metres to enter the new section of river valley. The portion of the River Mole which crosses below the level of the new taxiway strip would be carried in a new section of concrete channel covered by a highways specification grid at ground level, for a length of 26 metres to where the river leaves the airfield boundary. The use of the grid would allow daylight to reach the watercourse. The River Mole syphon (which activates only in flood conditions) would be modified and extended. A length of 40m of existing syphon channel would be covered under the runway strip in a closed box channel. This would then be extended in a closed box channel for 26m in length to connect to the new section of river valley. These activities would have the permanent effect of loss of existing bed and bank form and material, and riparian vegetation. This can result in localised disruption of quantity and dynamics of flow and sediment supply. The control measures (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) reduce the impact by re-establishment of riparian vegetation and minimising area impacted. The area potentially impacted is also relatively small, and part of the existing culvert would be replaced. The existing channel is also	River Mole	Medium-term	High	Negligible Adverse	Minor Adverse	Not significant

Description of Impact	Receptor	Duration	Importance of Receptor	Magnitude of Impact	Significance of Effect	Significant or not significant
heavily modified. There is the potential increase to suspended sediment loads due to channel disturbance from working in the channel. This would have a localised impact on the geomorphology of the channel, limited by the mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) that would be put in place to reduce these effects.						
A small weir (300mm high) is proposed to the River Mole across the southern face of the east box of the culvert that conveys the river beneath the runways. Construction of the weir would require in-channel works on the bed and banks at the watercourse confluence between Crawter's Brook and the River Mole. The bed and banks at this location are lined with concrete and no bed features are present. There is the potential for localised, temporary disruption of quantity and dynamics of flow and sediment during construction at both the upstream and downstream of the proposed weir due to the in-channel works and change to the cross-sectional form of the watercourse. The effects are localised and temporary, and mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) following best practice measures would minimise adverse effects. The overall significance of the effect would be Minor Adverse.	River Mole	Short-term	High	Low Adverse	Minor Adverse	Not significant
The construction of the Museum Field FCA would involve lowering the existing ground level on the floodplain by up to approximately 2.6 metres below ground level, excavating between 80,000 to 88,000m^3 of material. The FCA would connect to the River Mole via a spillway which would involve lowering the watercourse bank. The spillway connecting the River Mole to the FCA would be an excavated trapezoidal channel 6-10m wide and 1.6m deep. These activities may impact the watercourse by: ▪ Localised damage to bank face due to modification and removal of bank material. The impacts would be localised as the Project element would only require a small section of bank to be removed for the spillway connection. The mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) would also reduce the impact by minimising the area impacted and replacing natural bank material, where possible. ▪ Localised loss of natural bed forms and materials due to excavation works. The impacts would be localised as the Project element only requires a small section of bed for the spillway connection. The mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) would also reduce the impact by minimising the area impacted and replacing natural bed material, where possible. ▪ Destabilisation of banks due to vegetation clearance, as vegetation binds the bank material and draws water. The impacts would be localised as the Project element only requires a small section of bank to be removed for the spillway connection. The mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) also reduces the duration and scale of the impact by re-establishment of riparian vegetation following works and by minimising the area impacted. ▪ Localised disruption of quantity and dynamics of flow and sediment supply, and release of fine sediments into the channel. This would occur due to changes in bed and bank form, channel planform, cross-section and gradients as the channel adjusts. The impacts would be localised as the Project element only requires a small section of bank and bed for the construction of the spillway connection. This would have a temporary and localised effect on the geomorphology of the channel due to the mitigation (secured as a requirement in Schedule 2 of the **Draft**	River Mole	Medium-term	High	Low Adverse	Minor Adverse	Not significant

Description of Impact	Receptor	Duration	Importance of Receptor	Magnitude of Impact	Significance of Effect	Significant or not significant
Development Consent Order (Doc Ref. 2.1)) that would be put in place, which would reduce the release of fine sediment into the channel, e.g., through use of silt barriers or filter fences during construction. The effects would be localised and mostly temporary with the provision of best practice measures adopted through the mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)), therefore the overall significance would be Minor Adverse.						
Ground lowering and increase of the depth of water in the floodplain in Museum Field FCA would increase sediment loading within the River Mole during construction. The effect would be localised as the FCA is set back from the watercourse and implementation of mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) would reduce the release of fine sediments entering the channel. Temporary works associated with the FCA would isolate the FCA from the River Mole during construction reducing the risk of the FCA flooding during construction, and the release of fine material into the River Mole.	River Mole	Medium-term	High	Low Adverse	Minor Adverse	Not significant
Construction of a temporary bridge is required over the River Mole at its narrowest point to connect the haul road from Museum Field to the north-west zone of Airfield (on west side of Pond A) in order to remove construction traffic from local roads. The bridge would span 42m over the watercourse with a width of 7.9 metres and abutment height of 1.3m setback from the bank top. Construction of the bridge would require removal of vegetation from the floodplain; however, the bridge would be elevated over the watercourse so not to interact with the river banks or bed directly. Shading of the river bank and bed by the bridge has the potential to impact existing riparian vegetation, however the road will be in place for one year and the impacts would be localised as the Project element impacts a short length of watercourse and small footprint on the floodplain setback from the bank top. The effects would be temporary with the provision of best practice measures adopted through the mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)), such as reinstatement of vegetation following the works, where required. Therefore, the overall significance would be Minor Adverse.	River Mole	Medium-term	High	Negligible Adverse	Minor Adverse	Not significant
The works to provide a FCA in Car Park X, south of Crawter's Brook, would involve lowering of the car park ground level by a depth of up to 2 metres in an area of approximately 54,000m^2. The FCA would connect to the River Mole downstream via an outfall structure, which may take the form of a flapped culvert. The construction of the outfall headwall would impact the River Mole by: • localised damage to bank face due to modification and removal of bank material as the Project element only requires a small area of the bank for the outfall. • temporary release of fine sediments into the watercourse and sediment pollution. This would have a localised effect on the geomorphology of the channel due to the mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) that would be put in place, which reduces the release of fine sediment into the channel.	River Mole	Medium-term	High	Negligible Adverse	Minor Adverse	Not significant
Ground lowering and increase of the depth of water in the floodplain in Car Park X would have the effect of increased sediment loading within Crawter's Brook during construction. The effect would be localised as the car park is set back from the watercourse and implementation mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) would reduce the release of fine sediments entering the channel. Furthermore, the temporary works associated with the FCA would isolate	Crawter's Brook	Short-term	High	Negligible Adverse	Minor Adverse	Not significant

Description of Impact	Receptor	Duration	Importance of Receptor	Magnitude of Impact	Significance of Effect	Significant or not significant
the FCA from Crawter's Brook during construction reducing the risk of the FCA flooding during construction, and the release of fine material into Crawter's Brook.						
Construction of new surface access arrangements at Longbridge Roundabout would involve replacement and widening of the existing A23 Brighton Road bridge over the River Mole by an additional 6.4 metres and increasing the span by 5 metres, development in the floodplain to accommodate widening and modifications to the A23, and concrete headwall for the a new outfall connecting the highway drainage attenuation basin downstream of the bridge. The activities would impact the watercourse by localised disruption of quantity and dynamics of flow and sediment supply. This would occur due to: • localised damage to bank face due to modification and removal of bank material and riparian vegetation as the Project element only requires a small area of the bank to be removed for the outfall and bridge widening • temporary release of fine sediments into the watercourse and sediment pollution runoff from construction areas This would have a localised effect on the geomorphology of the channel due to the mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) that would be put in place. The effects would be Minor Adverse which is not significant.	River Mole	Short-term	High	Negligible Adverse	Minor Adverse	Not significant
Construction of new surface access arrangements at Longbridge Roundabout would involve widening of the existing A23 London Road bridge to the south over the River Mole. The bridge would be widened by approximately an additional 9.7 metres (maximum), with abutment length increased by 12.4 metres, and span length increased by 6 metres. The activities would impact the watercourse by localised disruption of quantity and dynamics of flow and sediment supply. This would occur due to: • localised damage to bank face due to modification and removal of bank material and riparian vegetation as the Project element only requires a small area of the bank for the bridge widening • temporary release of fine sediments into the watercourse and sediment pollution runoff from construction areas This would have a localised effect on the geomorphology of the channel, limited by the mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) that would be put in place. The effects would be Minor Adverse which is not significant.	River Mole	Short-term	High	Negligible Adverse	Minor Adverse	Not significant
Two small permanent access bridges are to be constructed over Man's Brook, east and west of Brook Farm. The bridges are to be suitable for agricultural use and to enable pedestrian access. The bridges are clear span bridges with no bed or bank reinforcement or support in the watercourse. The bridge span is up to 8 metres and the width up to 4.2 metres, with a soffit level of 0.6m higher than the bank top. The foundations are no less than a distance of 1 metre from the watercourse. The length of the bank disturbed by the activity shall extend to no more than 2 metres to either side of the bridge. Construction of the bridges would require removal of vegetation from the floodplain; however, the bridge would be elevated over the watercourse so not to directly interact with the river banks or bed. Localised destabilisation of banks may occur due to bank top loading and ground vibration during construction. The mitigation	Man's Brook	Short-term	High	Low Adverse	Minor Adverse	Not significant

Description of Impact	Receptor	Duration	Importance of Receptor	Magnitude of Impact	Significance of Effect	Significant or not significant
(secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) follows best practice measures which would minimise works on the bank top and reduce the potential for instability using temporary bank and bank top protection, where necessary, and reinstating vegetation, where possible. The impacts would be localised as the Project element only requires a small section of bank top for the construction of the bridges. The effects would be localised and mostly temporary. Therefore, the overall significance would be Minor Adverse.						

7.3 First Full Year of Opening: 2029

7.3.1 This section considers the potential effects of the activities that are likely to be carried out during first full year of opening of the Project. The activities are outlined in **ES Chapter 5: Project Description** (Doc Ref. 5.1). The receptor has been assessed for the impacts in Table 7.3.1.

Table 7.3.1: First Full Year of Opening Impacts for Geomorphology

Description of Impact	Receptor	Duration	Importance of Receptor	Magnitude of Impact	Significance of Effect	Significant or not significant
Construction of new surface access arrangements (South Terminal) would involve the M23 road widening and culvert extension of 4 metres on Burstow Stream Tributary to accommodate the proposed highway and new retaining wall. A land ditch adjacent to Burstow Stream Tributary upstream of the culvert is also proposed. These activities may impact the watercourse by localised disruption of quantity and dynamics of flow and sediment supply. This would occur due to changes in bank and bed form, channel cross-section and gradient, temporary release of fine sediments into the watercourse and sediment pollution runoff from construction areas. The effects would be localised as the Project element only requires vegetation clearance and bank modification along a small section of bank for culvert extension and concrete headwall. The effects would be temporary with the provision of best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1).	Burstow Stream Tributary	Short-term	Low	Negligible Adverse	Minor Adverse	Not significant
Construction of new surface access arrangements (North Terminal) would be set back from the watercourse, however there is the potential for sediment pollution due to runoff from construction areas. This would have a localised effect on the geomorphology of the channel, limited by the mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) that would be put in place, that reduces the release of fine sediment into the channel.	Gatwick Stream, River Mole	Short-term	High	Negligible Adverse	Minor Adverse	Not significant
Change to the geomorphology of the watercourse is expected to continue as the watercourses adapt and adjust to associated construction works. Best practice measures to mitigate the construction impacts through the mitigation (secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)) would continue to control the impacts, as described in Section 7.2.	River Mole, Gatwick Stream, Crawter's Brook, Man's Brook, Burstow Stream Tributary	Medium-term	High to Low	Negligible Adverse	Minor Adverse - Gatwick Stream, River Mole and Crawter's Brook Negligible – Burstow Stream Tributary	Not significant

7.4 Interim Assessment Year: 2032

7.4.1 This section considers the potential effects of the activities that are likely to be carried out during the interim assessment year of the Project. The activities are outlined in **ES Chapter 5: Project Description** (Doc Ref. 5.1). The receptor has been assessed for the impacts in Table 7.4.1.

Table 7.4.1: Interim Assessment Year Impacts for Geomorphology

Description of Impact	Receptor	Duration	Importance of Receptor	Magnitude of Impact	Significance of Effect	Significant or not significant
Change to the geomorphology of the watercourse is expected to continue as the watercourses adapt and adjust to associated construction works. Best practice measures to mitigate the construction impacts through the mitigation secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1) and design of mitigation in accordance with best practice guidance and standards would continue to control the impacts, as described in Section 7.2.	River Mole, Gatwick Stream, Crawter's Brook, Man's Brook, Burstow Stream Tributary	Medium-term	High to Low	Negligible Adverse	Minor Adverse – Gatwick Stream, River Mole and Crawter's Brook Negligible – Burstow Stream Tributary	Not significant

7.5 Design Year: 2038

7.5.1 This section mainly considers the potential effects of the operational activities and are considered long-term impacts. Often it is difficult to quantify the magnitude of long term impacts due to the timescales over which they may occur and the resilience of the environment to adapt to future changes, therefore expert judgement is used to undertake the assessment. Each receptor has been assessed for the impacts in Table 7.5.1.

Table 7.5.1: Design Year Impacts for Geomorphology

Description of Impact	Receptor	Duration	Importance of Receptor	Magnitude of Impact	Significance of Effect	Significant or not significant
Renaturalisation of the Mole north of runway in two-stage channel						
Reinstatement of a more naturalised planform and morphology on the River Mole has the long-term effect of improving the flow regime and channel diversity along the section of the renaturalised channel and downstream. Floodplain improvements and re-meandering improves floodplain-coupling. Part of the existing channel will be utilised to form a backwater environment at the upstream and downstream of the realignment, promoting morphological diversity in the channel. Planting of natural floodplain vegetation has the effect of improving riparian habitats and improving bank stability, downstream sediment dynamics and flow regime. The impacts would improve the geomorphology of the watercourse at a multi-reach scale, as many of the impacts would affect the watercourse downstream, for example the sediment dynamics and flow regime. The effect would also be long-term and therefore significance of the impact is considered Moderate Beneficial.	River Mole	Long-term	High	Medium Beneficial	Moderate Beneficial	Significant

There is potential for reduction in water velocity along the renaturalised channel, which may cause deposition at this location, and sediment starvation and erosion downstream. These changes would arise due to the changes in cross-sectional form and channel gradient. The channel length in the renaturalised section is to be increased by approximately 160 m, changing channel gradient from 1:1250 to 1:1890. This ties into the existing downstream channel which has a gradient of 1:2035. A further c. 150 m of the original watercourse will be retained as backwaters, and the syphon open channel length will be reduced by c. 13 m resulting in an overall 297 m additional watercourse length within the valley. A comparison of baseline and with-scheme channel velocity data on the River Mole shows that in the renaturalised section, channel velocity is expected to reduce during flood events (**Annex 2**). Comparison with Hjulström charts show transport of silt and sand is maintained, however less material is eroded. Furthermore, medium sized gravel is marginally more likely to be deposited during flood events, however it is not expected to have a major adverse effect on the watercourse (refer to **Annex 2**). Detailed design work on the renaturalised channel is required to mitigate these potential effects. This mitigation would include creating a suitable bed type for the river gradient of the realignment to maintain sediment transport capability; and a multiple stage channel to ensure natural and varied flow conditions; creation of varied cross-sections to mimic natural process, bed and bank forms; and addition of suitable substrate. The impact is local to reach scale, however with appropriate design of the renaturalised channel, the scale of the effect would be reduced. Natural channel adjustment would also be expected during the operational phase. Therefore, the overall significance of the effect is Minor Adverse.	River Mole	Long-term	High	Low Adverse	Minor Adverse	Not significant
Culvert modification and channel extension, and re-provisioning of syphon north of runway						
Modification of the existing culvert and channel extension would involve the creation of a daylighted channel covered by highways specification grid. The daylighted channel extension on the River would extend northwards by circa 26 metres (subject to detailed design) to enter the new section of river valley. These works would have the permanent effect of loss of existing bed and bank form and material, and riparian vegetation. The homogeneity of the new channel cross-section creates the potential for loss of natural variance in velocities and secondary flows cells, leading to changes in velocity and geomorphological processes. The potential length of the channel impacted is relatively small, and part of the existing culvert would be replaced. Provision of the River Mole renaturalised channel and other culvert design features (Section 5.4), such as daylighting part of the existing culvert and channel extension, would act to mitigate these effects.	River Mole	Long-term	High	Negligible Adverse	Minor Adverse	Not significant
A small weir (300mm high) is proposed to the River Mole across the southern face of the east box of the culvert that conveys the river beneath the runways. This would enable the concentration of summer low flows in the west box to improve fish passage. During summer low flow conditions, the weir would have the effect of locally altering flow characteristics at the upstream of the west box of the culvert and downstream through the culvert to the north side of the runway. These include impacts to the velocity and water depth from the culvert entrance, through to the extended culvert exit. There is potential for localised sediment deposition at culvert entrance at the east box weir where flows are concentrated into the west box during low flow conditions. A potential reduction in velocity may allow sediment to deposit immediately upstream of the weir on the east box culvert to form a low lateral bar and channelising flow to the west box culvert. This is not anticipated to adversely impact the geomorphology of the watercourse. Velocity and water depth are anticipated to increase through the culvert during low flow conditions due to the effect of the weir channelizing flow through the west box culvert and concentrating flow. Due to the concrete bed and bank protection at the culvert entrance, scour is not anticipated to occur as a result of	River Mole	Long-term	High	Medium Beneficial	Moderate Beneficial	Significant

changes to flow characteristics. Changes to velocity and water depth in the culvert have the potential to adversely impact the riverine sediments and marginal vegetation in the culvert, which form part of the embedded mitigation for the daylighted culvert channel extension. These effects would be minimised by the inclusion of baffles on the bed to retain sediment. Marginal vegetation will also be planted on berms above the low flow channel and once established, are unlikely to be adversely impacted during low flow conditions. Flow continuity and sediment transfer will be improved during summer low flow through the length of the culvert. Therefore, the significance of the effect is Moderate Beneficial.						
Flood compensation area in Museum Field and connecting spillway						
Creation of the FCA and connecting spillway would improve floodplain-channel coupling during flood conditions. Lowering the banks for connecting the spillway to the FCA has the effect of localised loss of existing bank form. However, the impact would be reduced with mitigation designed to vary bank form where banks are being lowered/altered, which would maintain or improve natural variance of flow in the channel. There is the risk of sediment accretion at the inlet/outlet of the spillway into the River Mole, where flow velocity may be locally affected. Detailed design work on the spillway would be required to mitigate these effects. This would include a suitably wide spillway inlet/outlet to disperse the effects on flow velocity. Ground lowering and planting of grassland in the flood storage area has the effect of loss of natural floodplain vegetation. These alterations to the baseline could encourage erosion of the banks and bed along the connecting spillway during flood events. The scale of impacts would be reduced with mitigation including ecological planting to restore natural vegetation to the floodplain and use of soft/bio engineered bank protection if banks need to be protected. The length of bank impacted would be relatively small and not entirely natural, and the flood storage area is set back from the watercourse. Furthermore, enough time would have passed since the construction phase for the river to naturally adjust and for vegetation to establish on the banks to aid bank stability. Therefore, the significance of the effect is Minor Adverse.	River Mole	Long-term	High	Low Adverse	Minor Adverse	Not significant
Flood attenuation and ground lowering in Car Park X						
Ground lowering and increase to depth of water in the floodplain in Car Park X has the effect of reduction in area of floodplain-channel coupling during receding flood levels as flood water is carried to the outfall on the River Mole. The area impacted is relatively small and set back from the watercourse.	Crawter's Brook	Long-term	High	Negligible Adverse	Minor Adverse	Not significant
Construction of the outfall headwall from the FCA has the effect of loss of existing banks and localised changes to sediment transfer and flow patterns in the channel. The length of channel impacted is relatively small. There is also the risk of sediment accretion at the outfall into the River Mole, where flow velocity may be locally affected. Flow control on the outfall drain and filtering of pollutants would reduce the impact on flow and sediment transfer. The length of channel impacted is relatively small.	River Mole	Long-term	High	Negligible Adverse	Minor Adverse	Not significant
New surface access arrangements						
New surface access arrangements (South Terminal) Permanent change to the baseline would include loss of natural bed and bank form, and riparian vegetation due to the M23 road widening and culvert extension by 4 metres. Homogeneity of the channel cross-section has the potential for loss of natural variance in velocities and secondary flow cells, leading to changes in velocity and geomorphological processes. There is existing concrete lining along the upstream and downstream of the culvert on Burstow Stream Tributary and only a relatively small area is	Burstow Stream Tributary	Long-term	Low	Negligible Adverse	Negligible Adverse	Not significant

potentially impacted. Permanent loss of natural banks would occur due to creation of a new concrete headwall for the upstream of the culvert. The length of channel impacted is relatively small.						
New surface access arrangements (North Terminal) The new surface access arrangements (North Terminal), including the proposed noise barrier and associated earthworks, would be setback from the watercourse, however there would be permanent loss of floodplain and natural vegetation due to encroachment of highway footprint onto existing natural floodplain.	Gatwick Stream, River Mole	Long-term	High	Negligible Adverse	Minor Adverse	Not significant
New surface access arrangements (Longbridge Roundabout) Replacement and widening of the A23 Brighton Road and London Road overbridges at Longbridge roundabout would result in permanent loss of floodplain and natural vegetation due to encroachment of highway footprint onto existing natural floodplain. Permanent change to the baseline would also include: the loss of natural bed and bank form; localised changes to sediment transfer and flow patterns; and loss natural riparian vegetation. This is due to the widening and modifications on the existing overbridges and new concrete outfall headwall connecting the highway drainage attenuation basin. Flow control on the outfall drains and filtering of pollutants would reduce the impact on flow and sediment transfer. The length of channel impacted is relatively small.	River Mole	Long-term	High	Negligible Adverse	Minor Adverse	Not significant
Two small access bridges provided over Mans Brook, east and west of Brook Farm will have the effect of constricting lateral migration of the watercourse within the floodplain. However, given the low energy nature of the stream and the lengthy timescales over which lateral change would occur, the magnitude of the effects is likely to be Negligible Adverse and the overall significance would be Minor Adverse. Furthermore, the bridges are designed so that there is no bed or bank reinforcement or support in the watercourse, therefore there are no direct in-channel impacts on the geomorphology of the watercourse during its operation. There will be permanent loss of bank top vegetation within the footprint of the bridge foundations, and shading effects on the bank and bed beneath the structure have the potential to impact riparian vegetation. However, the existing stream is already partially shaded, and the bridges impact a short length of the watercourse. The overall significance would be Minor Adverse	Man's Brook	Long-term	High	Negligible Adverse	Minor Adverse	Not significant
New water treatment works						
New water treatment works at the east of Gatwick Stream will treat an additional 100l/s from the long-term storage lagoon. This is in addition to the current 65l/s. Cleaned water will be returned to the lagoon and overflow will be connected to an existing pollution lagoon overflow pipe which discharges into the Gatwick Stream via a 600 mm pipe. The existing outfall will be unaltered. The existing outfall pipe at the Gatwick Stream is set into a vertical outer meander bank with a concrete headwall and flat concrete apron. The pipe outfall is operated by a flapped valve. During operation, additional discharge from the treatment works has the potential to increase the duration of maximum flows from the outfall, which subsequently impacts flow velocity in the watercourse in the immediate vicinity of the outfall. Given the position of the outfall on the outer meander, the opposite bank is naturally accreting, and erosion risk is low. Alterations to flow variance can have a positive impact by encouraging the natural evolution of the watercourse through processes of erosion and deposition. The length of watercourse impacted is small and the overall significance is Minor Beneficial.	Gatwick Stream	Long-term	High	Negligible Beneficial	Minor Beneficial	Not significant

7.6 Assessment Year: 2047

7.6.1 No further effects are anticipated beyond those described in the Design Year 2038.

8 Summary

8.1.1 This assessment evaluates the impacts of the Project and the embedded flood mitigation measures and their potential effects on the geomorphology of the River Mole, Gatwick Stream, Crawter's Brook, Man's Brook and Burstow Stream Tributary in the study area, during the construction and operational phases of the Project.

8.1.2 The assessment finds that during the initial construction phase of the Project, there would be minor adverse impacts on the River Mole associated with the renaturalisation of the channel and creation of Museum Field FCA which is part of the embedded flood mitigation measures. The effects would be temporary, however, and the channel renaturalisation would deliver an overall improvement to the geomorphology of the watercourse, supporting WFD objectives during operation.

8.1.3 There would be negligible to minor adverse impacts during construction, including creation of the FCA in Car Park X and daylighted channel extension, weir and modifications on the River Mole syphon channel and culvert. These impacts would be mitigated through the implementation of best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1). No significant effects on the watercourses are anticipated.

8.1.4 There would be minor adverse impacts on the River Mole associated with construction of the surface access arrangements at Longbridge Roundabout, and on Man's Brook with the construction of two farm access bridges. During the first full year of operation, there would be a negligible to minor adverse impact on the watercourses as adverse effects would be minimised through the implementation of best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1) and watercourses would adapt and adjust to ongoing construction works. No significant effects on the watercourses are anticipated.

8.1.5 There would be minor adverse impacts through the construction of the new surface access arrangements at the South Terminal and North Terminal. With the provision of mitigation and best practice measures secured as a requirement in Schedule 2 of the **Draft Development Consent Order** (Doc Ref. 2.1)during the interim assessment year 2032, there would be a negligible to minor adverse impact on the watercourses as they adapt and adjust to associated construction works. No significant effects on the watercourses are anticipated.

8.1.6 During the design year 2038, there would be minor to negligible adverse impacts associated with operational activities on the watercourses. These relate to the River Mole renaturalisation, Museum Field FCA and culvert modifications. There would be a moderate beneficial impact on the River Mole with the implementation of the mitigation proposed and further detailed design work. This would have a potential significant beneficial effect on the River Mole. Other remaining impacts on the watercourses associated to the Project, such as new surface access arrangements, would be offset by improvements and environmental enhancement in other areas of the catchment, as part of the embedded mitigation. No significant effects are anticipated in assessment year 2047.

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10 Glossary

10.1 List of Acronyms

Table 10.1.1: List of Acronyms

Term	Definition
AEP	Annual Exceedance Probability
DCO	Development Consent Order
Defra	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges
EIA	Environmental Impact Assessment
ES	Environmental Statement
FCA	Flood compensation area
GAL	Gatwick Airport Limited
OS	Ordnance Survey
PEIR	Preliminary Environmental Information Report
RBMP	River Basin Management Plan
SAC	Special Area of Conservation
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
STW	Sewage Treatment Works
WFD	Water Framework Directive

10.2 Glossary of terms

Table 10.2.1: Glossary (adapted from Osterkamp, 2008; Environment Agency, 2009)

Term	Description
Adjustment	The tendency of stream channels to change in size and shape in response to the changing effects of water, sediment, dissolved solids, and organic matter that alter them or pass through them.
Bank	A sloping margin of a natural, stream-formed, alluvial channel that confines discharge during non-flood flow. Designation of a right or left bank is done when looking in the downstream direction.
Bank material	The sediment of which the mostly sloping sides, or banks, of a stream channel are formed; like bed material, it is mostly indicative of the suspended-load transported by streams during non-flood periods.
Bars	In-channel sediment of relatively coarse bed material, typically coarse sand through cobbles in size, that is generally deposited during the recession of a high flow and is mostly exposed during periods of low flow. Bars may become vegetated when stable.
Bed	Bottom surface of a watercourse upon which water and sediment moves during periods of discharge.
Bed material	Sediment of which the mostly horizontal bed of a stream channel is formed; it is mostly indicative of the bed-load sizes transported by the stream
Catchment	The area from which precipitation contributes to the flow in a borehole spring, river or lake. This includes tributaries and the areas they drain.
Channel	A natural, or constructed, passageway or depression of perceptible linear extent containing continuously or periodically flowing water and sediment, or a connecting link between two bodies of water.
Channel erosion	Detachment and transport, possibly followed quickly by re-deposition, of channel bed or bank material by concentrated flow in areas of open-channel flow.
Conveyance	A measure of the amount of water that can pass through a stream-channel section without spilling onto higher surfaces as flood flow.
D50	The median particle diameter or median particle size.
Deposition	Accumulation into beds or irregular masses of loose sediment or other rock material by any natural agent.
Discharge	The movement downstream per unit length of channel of a volume of water; water discharge is given in volume per unit time, typically cubic meters per second ($m^3 s^{-1}$).
Disturbance	Any short-term alteration, natural or imposed, of the land surface that results in a change of geomorphic, hydrologic, or biological processes from a state of approximate equilibrium to one of relative instability.
Good status	WFD status achieved by a surface water body when both the ecological status and its chemical status are at least good.
Gradient	The rate of elevation change between two specified sites of horizontal distance measured along the thalweg of the channel; it is generally expressed as a non-dimensional number ($m\ m^{-1}$).
Hydromorphology	Describes the hydrological and geomorphological processes and attributes of surface water bodies.
Morphology	Describes the physical form and condition of a surface water body, for example the width, depth and perimeter of a river channel, the structure and condition of the riverbed and bank.
Pressures	Human activities such as abstraction, effluent discharges or engineering works that have the potential to have adverse effects on the water environment.
Q95	The flow in cubic metres per second which was equalled or exceeded for 95% of the flow record. The Q95 flow is a significant low flow parameter.
Restoration	Applied to stream corridors that have been altered through human activity, is the attempt to recreate the adjusted physical and biological conditions that were present prior to the alteration.
Riparian vegetation	Vegetation in part of the fluvial landscape inundated or saturated by flood flows; the area consists of all surfaces of active fluvial landforms up through the floodplain.
River Basin Management Plan	For each River Basin District, the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 requires a River Basin Management Plan to be published. These are plans that set out the environmental objectives for all the water bodies within the River Basin District and how they will be achieved. The plans will be based upon a detailed analysis of the pressures on the water bodies and an assessment of their impacts. The plans are reviewed and updated every six years.
Status	The physical, chemical, biological, or ecological quality of a waterbody.
Suspended sediment	Sediment moved in suspension in water and is maintained in suspension by the upward component of turbulent currents or by colloidal suspension.

Annex 1

Photographic Record

Introduction

A1.1 Photographic record locations are shown in **ES Appendix 11.9.2 Figure 4.2.2** (Doc Ref. 5.3). Photographs 1-7, 9-20, and 37-43 were captured in March 2022. Photographs 8, 21-36, and 38-116 were captured in September 2019. Photos were collected on an iPad Pro Model A1652 using ESRI ArcCollector software. Camera specification: 8 MP, f/2.4, 31mm (standard), 1.12µm, autofocus.

River Mole

River Mole – Upstream of runway culvert to Longbridge roundabout		
		
Photo 1: Rubbish caught in old netting at upstream of runway culvert	Photo 2: Syphon channel from River Mole and gravel accumulation next to drop chamber	Photo 3: Fine to medium sized gravel accumulated on syphon channel
		
Photo 4: Upstream view from weir, berm formed on right bank narrowing channel	Photo 5: Weir structure upstream of culvert	Photo 6: Confluence of River Mole and Crawter's Brook


Photo 7: Runway box culvert inlet and divider wall


Photo 8: Runway box culvert inlet with debris trapped on divider wall


Photo 9: Runway box culvert outlet with security gates open buried in silt


Photo 10: Downstream view of runway culvert outlet, channel is notably wide


Photo 11: Straightened section of River Mole and old netting impeding flow


Photo 12: Straightened section of River Mole covered by netting

		
Photo 13: Straightened section of River Mole, steep banks and small berms on left bank	Photo 14: Towards end of straightened section of River Mole, wide and steep banks	Photo 15: End of straightened section of River Mole, wide and steep banks
		
Photo 16: Biodiversity area to northwest of airport, lower banks narrower channel	Photo 17: Biodiversity area to northwest of airport, open floodplain	Photo 18: Culvert outfall from Westfield Stream on left bank

Photo 19: Biodiversity area to northwest of airport, glide flow

Photo 20: Overview of biodiversity area northwest of airport

Photo 21: River Mole biodiversity area during flood conditions

Photo 22: River Mole biodiversity area during flood conditions

Photo 23: Backwater and large wood in channel through biodiversity area

Photo 24: Glide flow conditions during higher-than-average flow

		
Photo 25: River Mole biodiversity area, small, vegetated bars and riffles	Photo 26: River Mole valley through biodiversity area, vegetated island in channel	Photo 27: Glide flow conditions during higher-than-average flow
		
Photo 28: River Mole valley and floodplain around the northwest of the airport	Photo 29: Concrete outfall from Pond D	Photo 30: Vegetated mid-channel bar

		
Photo 31: Approach to London Road bridge, roots submerged in channel	Photo 32: Outfall on right bank upstream of London Road bridge, concrete headwall	Photo 33: Downstream side of London Road bridge
		
Photo 34: Channel downstream of London Road bridge, berms formed at margins	Photo 35: Confluence of River Mole (left) with Gatwick Stream (right)	Photo 36: Upstream view from Brighton Road bridge over River Mole

Photo 37: Ditch outfall on right bank immediately upstream of Brighton Road bridge

Photo 38: Downstream side of Brighton Road bridge

Photo 39: Dry ditch outfall on left bank immediately downstream of Brighton Road bridge

Photo 40: Downstream view from Brighton Road bridge

Photo 41: Steep banks and minor erosion of left bank downstream of bridge

Photo 42: Wood in channel increasing flow variability

Photo 43: Downstream River Mole at extent of study area, gentler banks, improved floodplain connection and increased sinuosity

Gatwick Stream

Gatwick Stream – Radford Road bridge to confluence with River Mole

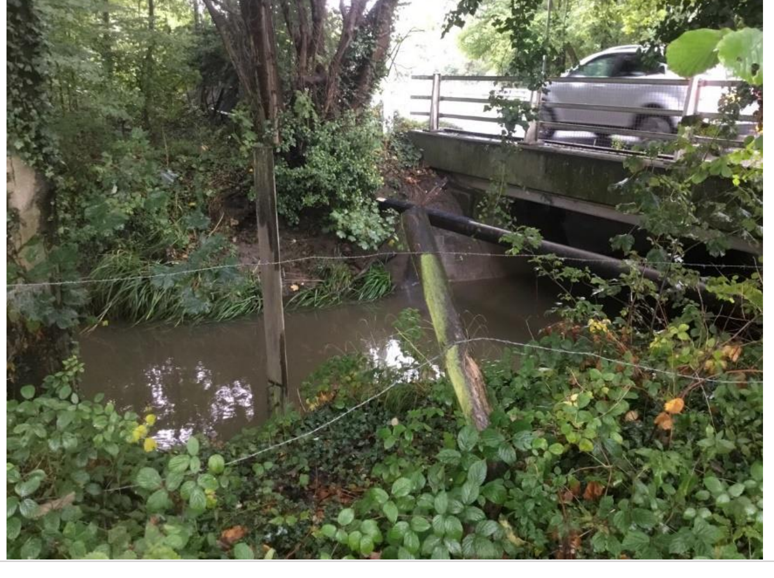


Photo 44: Radford Road bridge at furthest upstream extent

Photo 45: Wooded area south of Gatwick Stream biodiversity area

Photo 46: Himalayan balsam along banks of Gatwick Stream at upstream of biodiversity area

Photo 47: Rubbish accumulation at margins of channel

Photo 48: Netting over channel within Gatwick Stream biodiversity area

Photo 49: Tall emergent grasses formed along margins of channel, erosion of steep right banks

Photo 50: Bulrushes established along margins of channel, bare steep banks

Photo 51: Channel surrounded by sloping embankment and fencing through biodiversity area

Photo 52: Outfall with concrete headwall on right bank

Photo 53: Increasingly vegetated banks and margins in downstream part of biodiversity area in channel, varied flow conditions

Photo 54: Localised bank erosion of steep banks and slumping of material

Photo 55: Narrow section of channel resulting in increased velocities

Photo 56: Channel feeds through wastewater treatment plant infrastructure

Photo 57: Gatwick Stream passes under the Brighton Main Line railway

Photo 58: Channel is concrete lined from railway downstream along straightened section to footpath bridge

		
Photo 59: Run flow conditions, nick point in channel over step resulting in scour	Photo 60: Gabion rock baskets provide bank protection on left bank due to scour at nick point in channel	Photo 61: Rapid run flow conditions in channel
		
Photo 63: Steep banks along straightened section, transition to glide flow towards South Terminal	Photo 64: Low floodplain connection and channel is constrained by road and footpath	Photo 65: Vertical heavily vegetated banks approaching South Terminal

		
Photo 66: Concrete vertical walls on approach to South Terminal culvert	Photo 67: South Terminal culvert inlet	Photo 68: South Terminal culvert outlet
		
Photo 69: Downstream of South Terminal culvert outlet	Photo 70: Several pipe crossings over Gatwick Stream	Photo 71: Culvert inlet under Airport Way and London Gatwick Airport shuttle line (outfall on right bank, view obscured by vegetation

		
Photo 72: Airport Way culvert outlet and weir structure	Photo 73: Downstream of Airport Way culvert	Photo 74: Gatwick Stream as it enters Riverside Garden Park
		
Photo 75: Gatwick Stream in the upstream part of Riverside Garden Park, heavily vegetated and shaded, varied flow types	Photo 76: Gravel accumulation along margins of channel on inner meanders	Photo 77: Alternating glide and run flow conditions

		
Photo 78: Mature trees and generally steep banks along Gatwick Stream through Riverside Garden Park	Photo 79: Riverside Garden Park Lake on floodplain next to Gatwick Stream	Photo 80: Gatwick Stream downstream of Riverside Garden Park
		
Photo 81: Gatwick Stream has been straightened downstream of Riverside Garden Park and flow conditions are less varied, predominately glide flow	Photo 82: Bank protection including wooden slats and gabion baskets on right bank as bank protection adjacent residential area (right of image)	Photo 83: Steep heavily vegetated banks along straightened section of Gatwick Stream approaching confluence with River Mole

 Photo 84: Downstream view of confluence of Gatwick Stream (right) and the River Mole (left)	

Crawter's Brook

Crawter's Brook between airport perimeter fence at upstream and River Mole confluence		
		
Photo 85: Crawter's Brook at upstream airport perimeter fence	Photo 86: Steep banks vegetated by tall grasses and herbs	Photo 87: Localised wood and organic accumulations at channel margins

Photo 88: Straightened planform, appears over-deepened. Bird netting covering channel

Photo 89: Concrete blockwork bank exposed on left bank

Photo 90: Vegetated mid channel bars adjacent to gated slipway into channel (submerged)

Photo 91: Geotextile over clay banks exposed

Photo 92: Concrete blockwork on right bank

Photo 93: Concrete blockwork on left bank and mid channel vegetated bars

Photo 94: Multiple pipe crossings downstream of concrete access bridge

Photo 95: Gabion mattresses on right bank outer meander formed of stone rubble

Photo 96: Damaged gabion mattresses, evidence of high discharge damaging defences

Photo 97: Bank erosion and slumping of material into channel

Photo 98: Animal burrowing in failed banks

Photo 99: Bank erosion extending under bird netting on right bank

		
Photo 100: Concrete outfall on left bank	Photo 101: Concrete outfall on left bank	Photo 102: Localised vegetated bars
		
Photo 103: Concrete outfall and vegetated spillway	Photo 104: Low embankment on right bank with small breaks	Photo 105: Former bridge abutments and spillway connecting to outfall on left bank at Car Park X

Photo 106: Gravel access path on left bank at Car Park X

Photo 107: Access bridge and concrete abutments

Photo 108: Bird netting over straightened, trapezoidal channel

Photo 109: Uniform and steep bank profile

Photo 110: Concrete outfall and spillway on left bank at Car Park X

Photo 111: Confluence of Crawter's Brook and River Mole

Burstow Stream Tributary

Burstow Stream Tributary – Upstream of M23 spur to downstream along Balcombe Road		
		
Photo 112: Concrete lined channel upstream of culvert, heavily shaded	Photo 113: Pipe crossing channel and culvert inlet, heavily shaded and vegetated	Photo 114: Culvert outlet heavily vegetated
		
Photo 115: Downstream of culvert along Balcombe Road, heavily shaded, no perceptible flow	Photo 116: Downstream of culvert along Balcombe Road, heavily shaded, no perceptible flow. Organic material including leave litter on bed.	

Man’s Brook

Man’s Brook – Horley Road to River Mole confluence

Photo 117: View of left bank at proposed bridge location, low shrubs and saplings on steep banks

Photo 118: Mature deciduous trees and meadow on bank top

Photo 119: Undercutting of bank opposite gravel bar, overhanging trees

Photo 120: Wood in channel forming natural flow deflectors

Photo 121: Fine gravel riffle followed by pool on downstream meander

Photo 122: Upstream view of gravel riffle and grass meadow on right bank

Photo 123: Farm bridge at Brook Farm from left bank

Photo 124: Scour of bed and left bank on outer meander under bridge

Photo 125: Collapse of bank material on outer meander immediately downstream of bridge


Photo 126: Downstream view from bridge showing steep to vertical bank profile


Photo 127: Upstream towards bridge from left bank showing erosion on outer meander bank face and vertical bank profile. Heavily shaded.


Photo 128: Downstream view from wooden pedestrian footbridge and pipe and cable crossing. Water is turbid downstream; however, flow is perceptible.


Photo 129: Upstream view toward wooden footbridge from smaller road crossing. Channel is wider and shaded by vegetation. Flow is perceptible.


Photo 130: Road bridge set into vertical bank face


Photo 131: Channel is over-deep with localised erosion on steep/vertical banks


Photo 132: Upstream from right bank showing localised widening of watercourse and incised nature of channel


Photo 133: Localised widening of channel and notable deposits of fine gravel and silt creating low flow channel


Photo 134: High vertical root-bound banks and turbid water. Flow is perceptible.


Photo 135: Left bank top and low embankment bordering watercourse and meadow


Photo 136: Vicinity of proposed bridge. Mature oaks, hawthorn and grass meadow on bank top. Root bound steep banks. Flow perceptible and turbid.


Photo 137: Incised ditch joining Man's Brook at downstream of field boundary


Photo 138: Large wood dam impounding upstream flow formed of wood debris and fallen trees. Erosion of left bank evident in background.


Photo 139: Small wood dam impounding flow. Lower bank top height. Heavily shaded.


Photo 140: Small gravel lateral bar pool-riffle morphology.


Photo 141: Natural wood deflector in channel from left bank. Gravel bar formation.


Photo 142: Large gravel bar and bed substrate. Natural wood deflector and narrowing of channel. Mudstone bedding on right bank.


Photo 143: Confluence of Man's Brook with the River Mole into low lying floodplain.

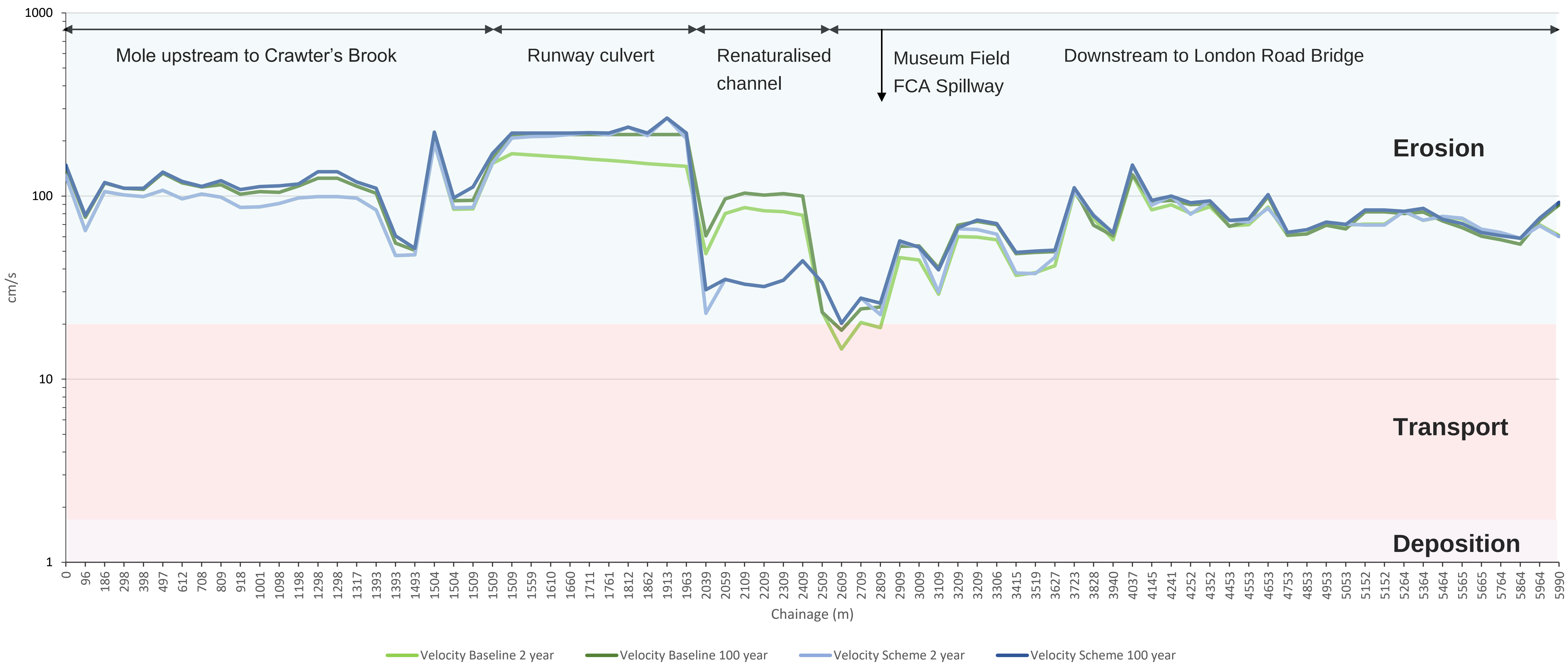
Annex 2

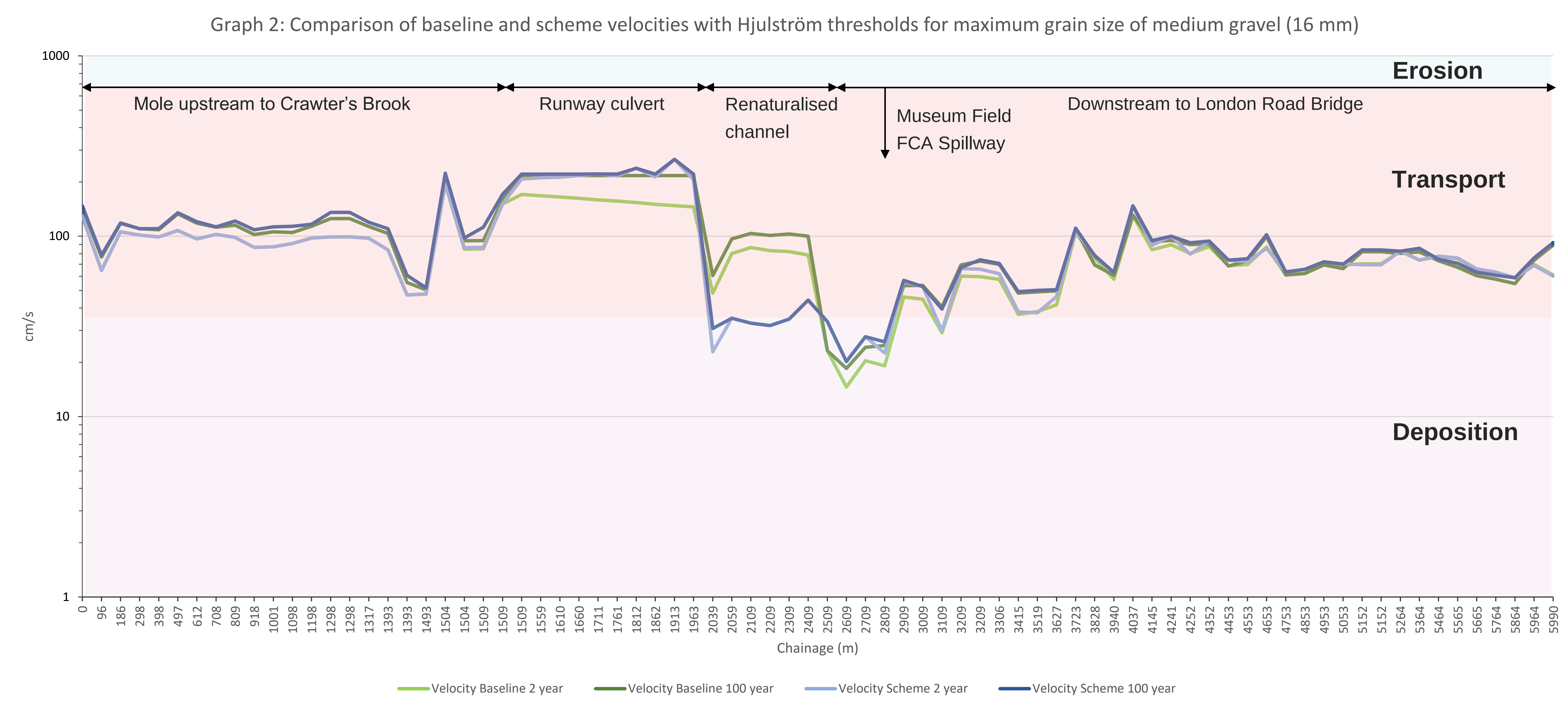
River Mole Renaturalisation

Velocity Comparison

A1.2 The graphs below show hydrological modelling data (see **ES Appendix 11.9.6: Flood Risk Assessment** (Doc Ref. 5.3)) for the baseline and scheme 50% (1 in 2) and 1% (1 in 100) AEP flood events at model nodes along the River Mole between the upstream extent of the detailed study area and the London Road bridge to the south of Longbridge Roundabout. Modelled results use the three hour flood duration curve. These results have been plotted against the Hjulström thresholds for erosion, transport and deposition of 'fine sand' (Graph 1), which is the assumed D50 grain size, and 'medium gravel' (Graph 2), which is the assumed maximum grain size. These are assumed sediment sizes based on field observations. Grain size is approximate and based on the Wentworth classification (Wentworth, 1922).

Graph 1: Comparison of baseline and scheme velocities with Hjulström thresholds for D50 grain size of fine sand (0.25mm)





A1.3 The comparison shows that immediately downstream of the runway culvert at the start of the channel renaturalisation, the with-scheme velocity is notably lower than the baseline velocity. Downstream of the renaturalised section, the with-scheme velocities are slightly higher than the baseline velocities. This indicates that in the with-scheme scenario, there is a subtler transition in velocities between the renaturalised section and the downstream channel when compared to the baseline. The comparison also shows that most fine sands will be either eroded or transported during 50% (1 in 2) and 1% (1 in 100) AEP flood events in both scenarios (Graph 1). Extrapolation of the differences between baseline and scheme velocities during the flood events for low flow conditions indicate the potential for deposition of fine sand at the renaturalised channel. Analogous sites of similar existing velocities immediately downstream of the channel renaturalisation show evidence of sedimentation on the channel bed during low flow. Detailed design of the channel renaturalisation, including creation of a two-stage channel, has the potential to mitigate these effects and maintain sediment transport continuity.

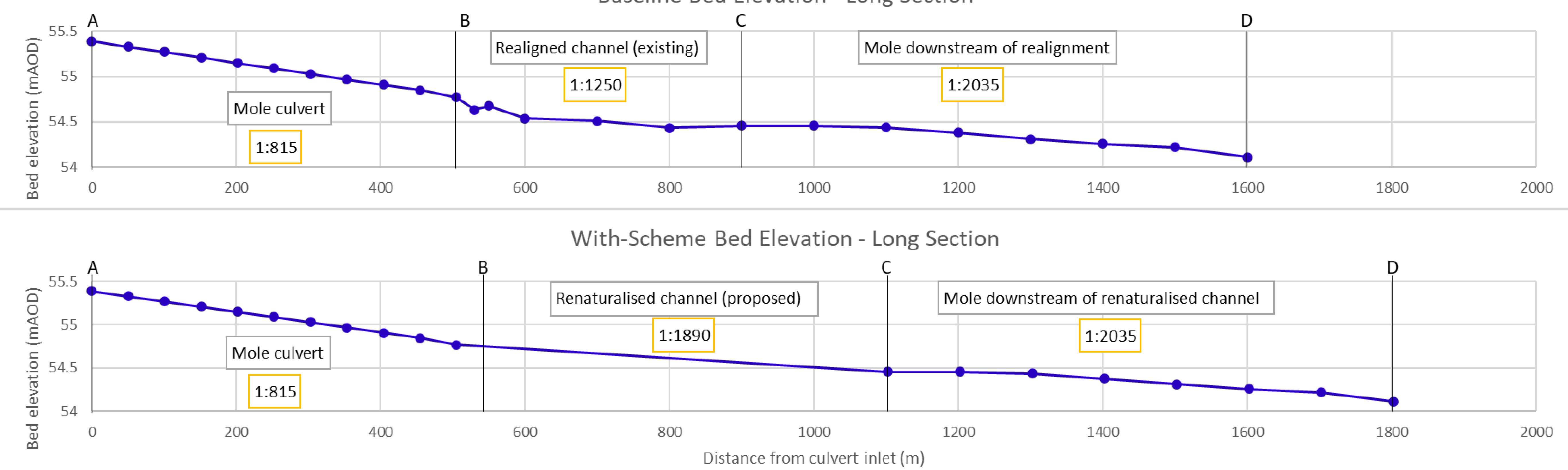
A1.4 The comparison of the thresholds for medium-sized gravel shows that there is likely to be marginally less transport and increased deposition of medium-sized gravel at the renaturalised channel during 50% (1 in 2) and 1% (1 in 100) AEP flood events (Graph 2). However, significant deposition would not be anticipated as reflected by analogous sites of similar existing velocities immediately downstream of the channel renaturalisation which do not show notable accretion of gravels. During low flow conditions in both scenarios, it is expected that gravel is deposited on the bed and stored throughout the channel in bars and riffles. These bedforms are present downstream of the section of channel to be renaturalised.

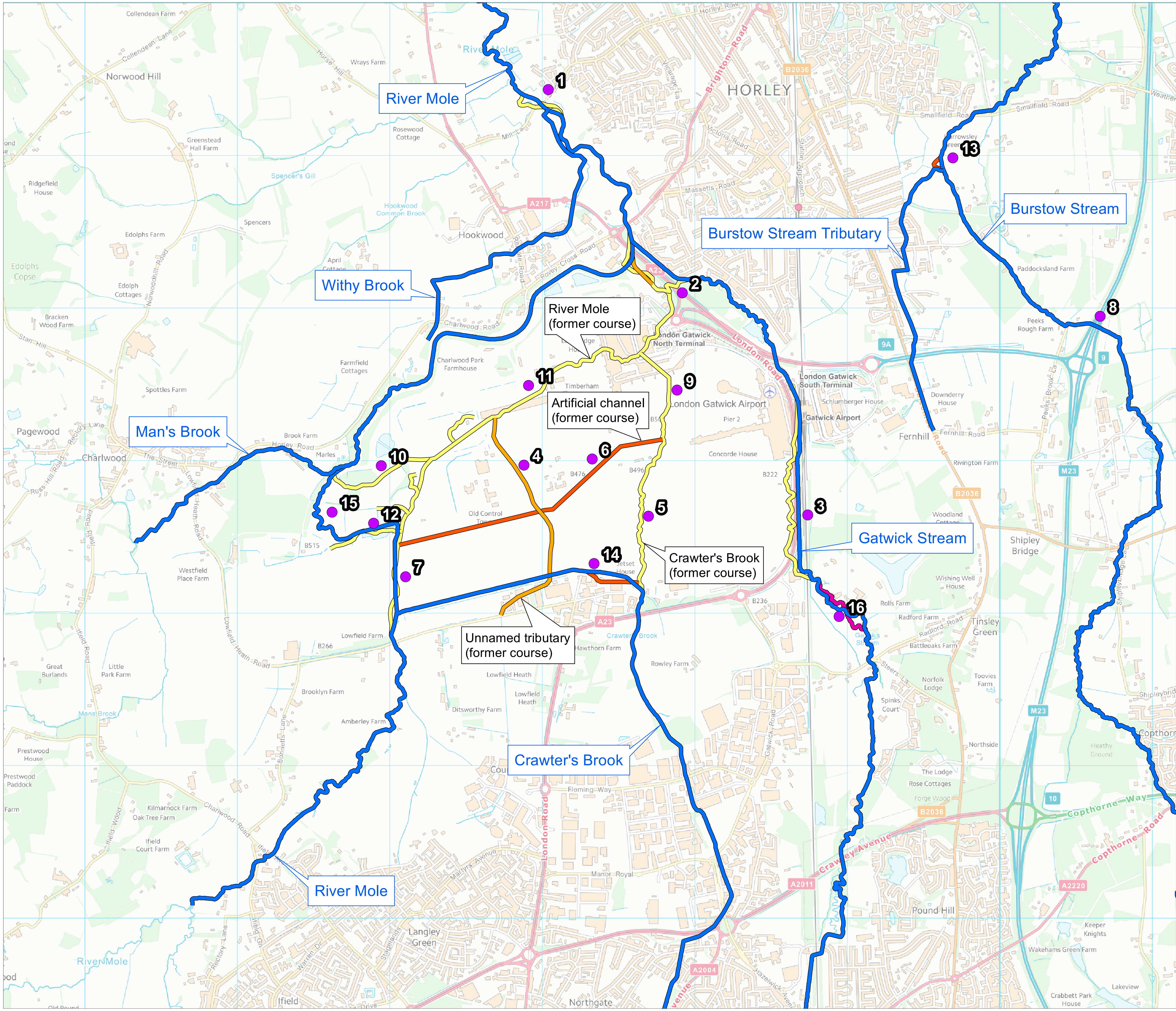
A1.5 Comparison of velocities in the vicinity of the Museum Field FCA spillway shows that with-scheme velocities are not significantly impacted by flows entering and exiting the spillway. Detailed design of the spillway, including creation of a suitably wide spillway inlet/outlet to disperse the effects on flow velocity has the potential to mitigate any effects and maintain sediment transport continuity. Regular monitoring of any change to the channel bed and banks could be undertaken particularly in the vicinity of the River Mole channel renaturalisation and Museum Field FCA spillway, following completion of the Project (Section 6.6).

Bed elevation and gradient

A1.6 The comparison of bed elevation and gradient for the baseline and with-scheme are shown in Graph 3. This shows the anticipated change in length and gradient resulting from the renaturalised channel. The channel is generally less steep due to the increased sinuosity and additional 160 m length of renaturalised channel. A length of c. 150 m is retained of the original watercourse as backwaters, and syphon open channel length will be reduced by c. 13 m. The overall additional watercourse length in the valley will be 297 metres. The change in gradient between the proposed renaturalised channel and the downstream is smaller than with the existing realigned channel.

Graph 3





LONDON GATWICK

KEY

- Locations of historical change
- Present day course

Historical Analysis

- OS 1:10,000 2000-2015
- OS 1:25,000 1955-1961
- OS 1:63,360 1945-1947
- OS 1:10,560 1888-1913

DOCUMENT

Environmental Statement
Appendix 11.9.1

DRAWING TITLE

Historical Analysis
Fluvial Surface Waterbodies

DATE

June 2023

ORIENTATION	DRAWING NO.	REVISION
N	FIGURE 4.2.1	For ES
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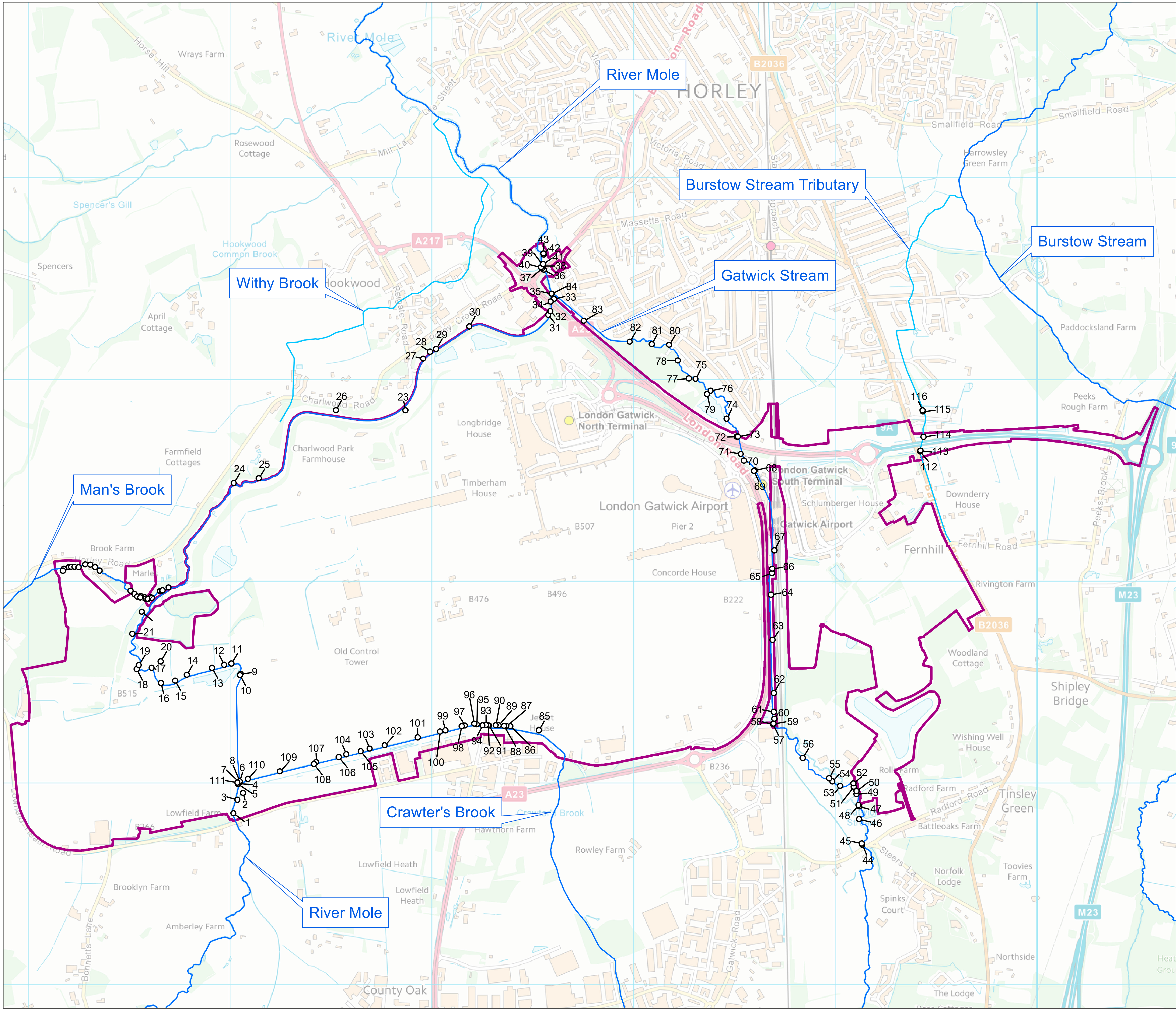

KEY

- Photo Location
- WFD waterbodies
- Non WFD waterbodies
- Project Boundary (DCO)

DOCUMENT

Environmental Statement
Appendix 11.9.1

DRAWING TITLE

Photographic Record Locations

DATE

June 2023

ORIENTATION	DRAWING NO.	REVISION
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