Gatwick Airport Northern Runway Project

Environmental Statement
Appendix 11.9.6: Flood Risk Assessment – Annexes 3-6 – Clean Version

Book 5

VERSION: 2.0

DATE: JUNE 2024

Application Document Ref: 5.3

PINS Reference Number: TR020005

APFP Regulations 5(2)(e) **Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009**

Annex 3

Airfield Surface Water Drainage Hydraulic Model Build Report

Table of Contents

1 Introduction

1.1 Purpose of modelling

1.1.1 This document forms Annex 3 to **ES Appendix 11.9.6: Flood Risk Assessment** (FRA) (Doc Ref. 5.3) of the Environmental Statement (ES) prepared on behalf of London Gatwick Airport (Gatwick). The ES presents the findings of the Environmental Impact Assessment (EIA) process for the proposal to make best use of Gatwick Airport's existing runways and infrastructure (referred to within this report as 'the Project'). The Project proposes alterations to the existing northern runway which, together with the lifting of the current restrictions on its use, would enable dual runway operations. The Project includes the development of a range of infrastructure and facilities which, with the alterations to the northern runway, would enable the airport passenger and aircraft operations to increase. Further details regarding the components of the Project can be found in the **ES Chapter 5: Project Description** (Doc Ref. 5.1).

1.1.1 This annex supports **ES Appendix 11.9.6: Flood Risk Assessment** (FRA) (Doc Ref. 5.3) as part of the ES. The FRA assesses the risk to and as a result of the Project for all sources of flooding for its lifetime including the consideration of climate change to demonstrate compliance with national planning policy. This annex documents the airfield surface water drainage hydraulic modelling undertaken to inform the FRA.

1.1.2 The existing airport surface water drainage network, can be divided into the sub-catchment areas which generally drain from south and southwest to the north of the existing storage/pollution control ponds A, M, Dog Kennel Pond and D. Where changes are proposed in these catchments an assessment of impact has been undertaken and measures developed to provide mitigation for effects where required as part the Project.

1.1.3 As part of the Project, Pond A would be removed to accommodate the relocation northwards of Taxiway Juliet and the Northern Runway, two storm durations have been modelled with the Project and mitigations in place to inform the Project design.

1.2 Methodology

1.2.1 Hydraulic modelling was undertaken using Innovyze ICM Version 2021.6.1, with the baseline scenario being the verified 2D model that was used to undertake the ES assessment.

1.2.2 The Hydraulic model used had been calibrated and verified in 2019 using flow survey data collected from September 2017 to May 2018.

1.2.3 The baseline scenario was updated to develop a future baseline for the Project as modifications would be made to Rapid Exit Taxiway Echo Romeo (RET-ER) in advance of the Project. This change has been included in all scenarios.

1.2.4 The future baseline scenario formed the baseline for subsequent 'with-Project' scenarios for the assessment. The new and amended areas of hard standing, roof areas and surface areas that will be delivered by the Project were included in the models. Details of these modifications are included **ES Chapter 5: Project Description** (Doc Ref. 5.1).

1.2.5 The results of the with-Project scenarios were then compared to the future baseline to ascertain the un-mitigated impact of the Project. Where an increase in flood risk offsite was identified mitigation was developed and included to ensure no increase in offsite flood risk for the duration of the Project incorporating the predicted effects of climate change.

1.2.6 Whilst other scenarios have been assessed in this report the preferred option is to remove Pond A and Car Park Y (CPY) storage area is at its largest tested volume of 32,000m^3 (Scenario 4 from Table 5.2.1).

1.3 Study area

1.3.1 A full description of the study area and Project is provided in **ES Chapter 4: Existing Site and Operation** (Doc Ref. 5.1), **ES Chapter 5: Project Description** (Doc Ref. 5.1) and **ES Chapter 11: Water Environment** (Doc Ref. 5.1).

2 Input data

2.1.1 The surface water drainage model constructed was based upon the design summarised in **ES Chapter 5: Project Description** (Doc Ref. 5.1), and the following sources:

(1) The existing verified 2d surface water model of Gatwick Airport with updated Boeing hanger layout and drainage

(2) Existing GIS Data owned by Gatwick

3 Rainfall runoff

3.1 Rainfall runoff methodology

3.1.1 There are two critical storm event durations for the airfield surface water drainage system at Gatwick. The first is a 30-minute summer event, which generates the maximum flood volume and extent in a convective (thunderstorm) type storm event across the entire airfield. Typically, a 60-minute or 30-minute storm event would be expected to be the critical event for a land area of hardstanding such as Gatwick.

3.1.2 However, because Gatwick has a controlled outlet at Pond D influencing flood risk at the North Terminal and apron during longer, higher volume, less intense rainfall events, a second 1440-minute winter event has also been assessed.

3.2 Climate change

3.2.1 The future baseline and with-Project scenarios have been run for the 1% (1 in 100) Annual Exceedance Probability (AEP) event with 30- and 1440-minute duration storms, further simulations have been modelled with an increase of 25% and 40% in rainfall intensity to incorporate the predicted impact of climate change based on Environment Agency guidance (Environment Agency, 2022). The 25% event has been used to design the mitigation measures and the 40% event adopted as a sensitivity test for an exceedance event. Further information is included in the **ES Appendix 11.9.6: Flood Risk Assessment** (Doc Ref. 5.3).

4 Baseline model build

4.1 Baseline model

4.1.1 'Gatwick SWM Phase 1 validated 2D drainage only' Hydraulic model was adopted as the starting point for the baseline model build. This model was validated in 2019 with a flow survey but updated to include the drainage for the Boeing Hangar development, which was not included in the original model.

4.2 RET Juliet taxiway build and mitigations

4.2.1 As part of works to be completed prior to the Project a new Rapid Exit Taxiway (RET) Juliet will be constructed prior to the first full year of operation of the Project. The baseline model has been updated to include the drainage associated with this RET

4.2.2 **Figure 4.2.1** and **Figure 4.2.2** indicate the proposed RET-ER location and drainage layouts. It has been assumed that the new RET would be connected to the existing drainage network in the Pond A catchment.

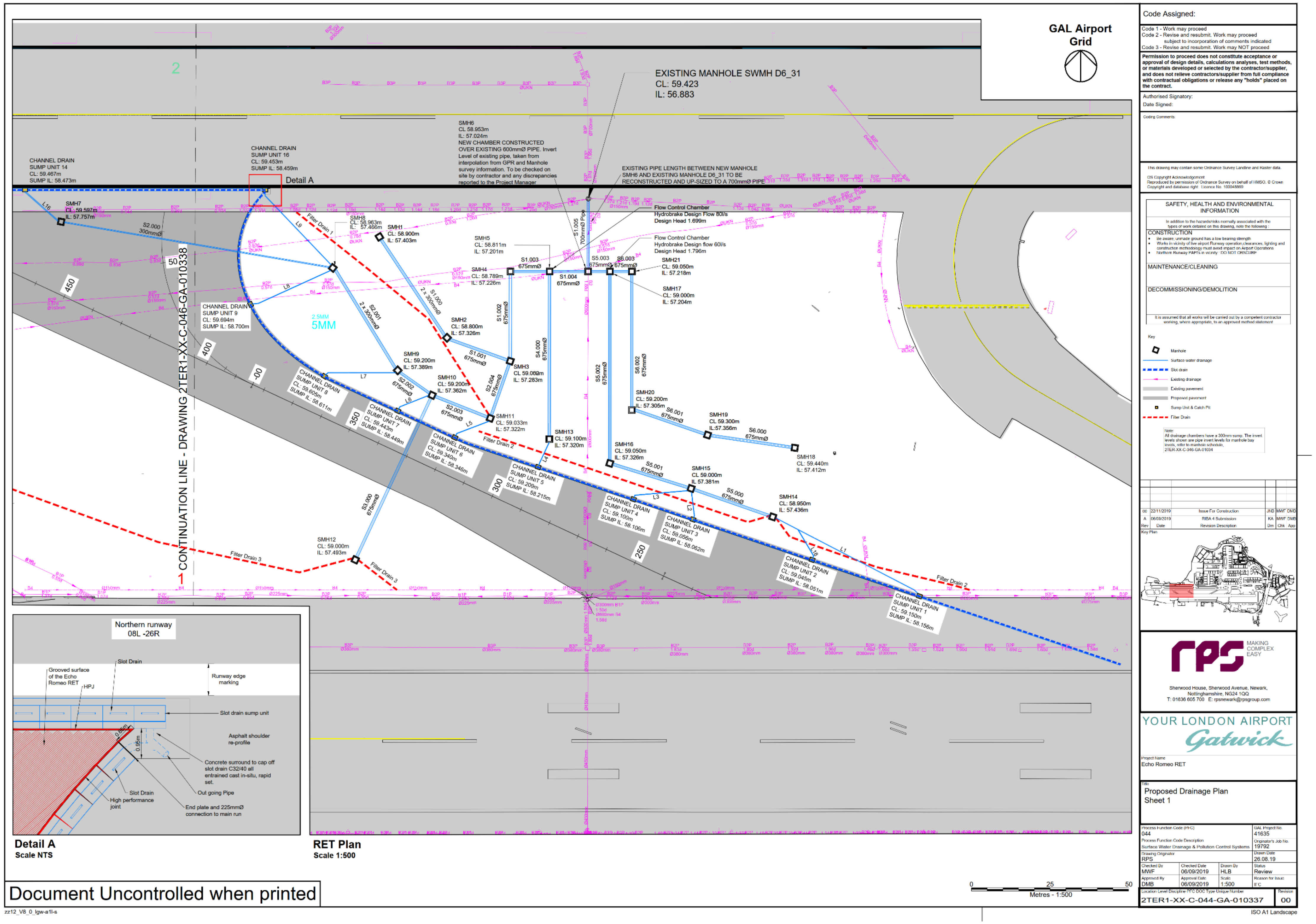


Figure 4.2.1 Rapid Exit Taxiway Juliet

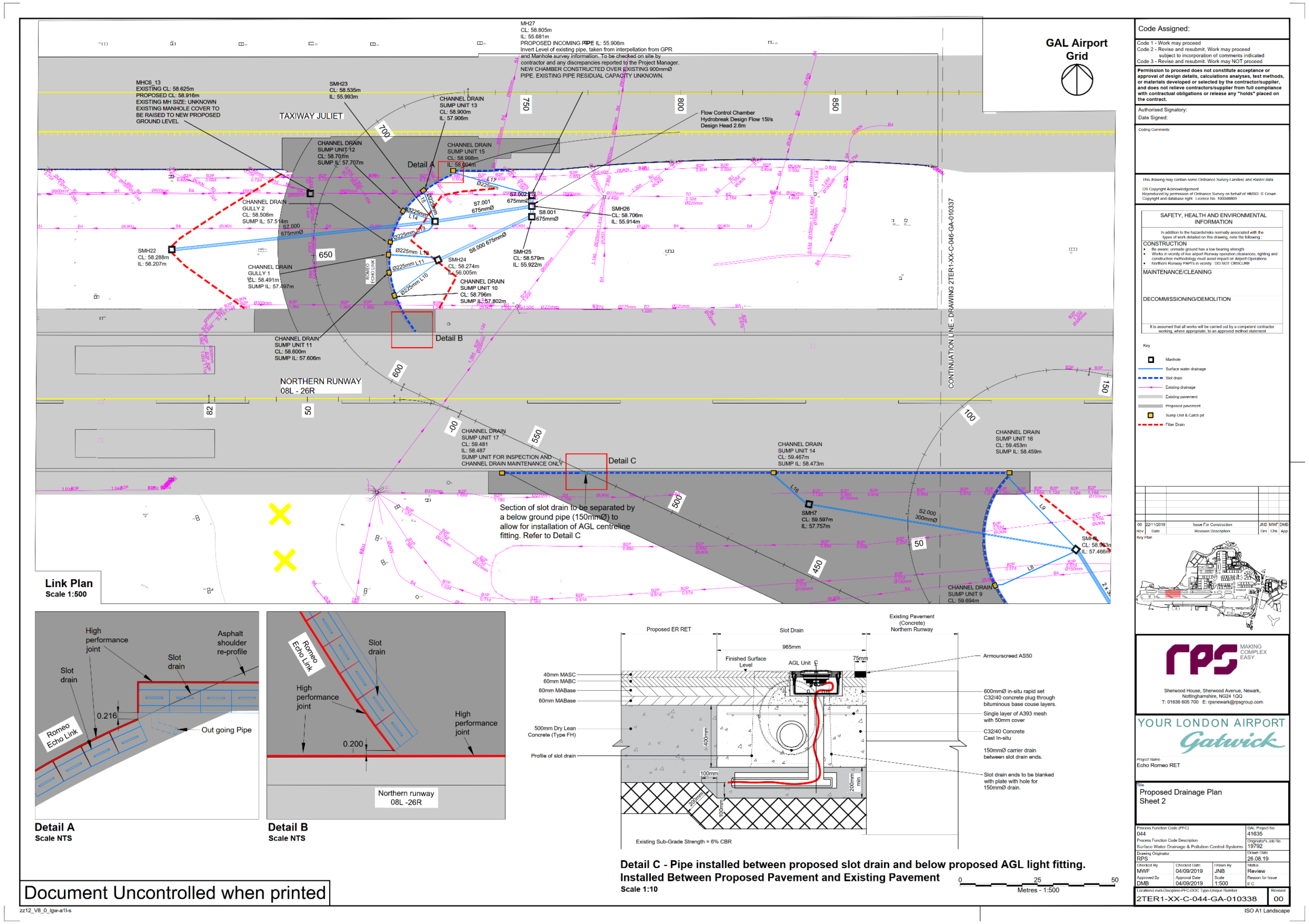


Figure 4.2.2 Rapid Exit Taxiway Juliet

4.2.3 As part of the proposed RET-ER works to minimise flooding from the increased surface area, the preliminary designs have assumed that there would be a limited discharge from the new RET into the existing Pond A catchment, restricted to a peak of 78l/s.

4.2.4 Further mitigation has been included as part of the new RET and a flood attenuation volume of 400m³ has been assumed to be included as part of the works.

5 With-Project model build

5.1 Mitigation requirements

5.1.1 A scenario was created of the existing drainage network model updated to include the new and amended areas of hardstanding, roof areas and surface areas that will be delivered by the Project.

5.1.2 This scenario was then updated with combinations of mitigation storage as listed in Table 5.1.1. The additional storage was assumed to comprise attenuation crates or similar structures. The underground storage areas were added to the model as storage nodes on an existing link (pipe), the link downstream of the node was then deleted and an orifice draining the storage added as a link. Modelling assumptions have been listed in Section 6.

5.1.3 Mitigation measures are proposed in each sub-catchment draining to ponds M and D, local to the amended pavement areas. Mitigation storage volumes have been sized to limit runoff from the additional net paved area to greenfield runoff rates during the median annual flood (the 50% (1 in 2) AEP event). This measure is directed to events up to and including the 1% (1 in 100) AEP plus an allowance for climate change event.

5.1.4 Greenfield runoff rates were estimated (from existing gauged flow data on the River Mole at Horley and the Gatwick Stream at the Gatwick Link) to be approximately 2.9l/s/ha.

5.1.5 Climate change impacts are assumed to increase runoff volumes from surface water drainage systems by 25% in accordance with current climate change guidance (Environment Agency, 2022) for increases in rainfall intensity. Using these criteria, the attenuation storage required is estimated to be approximately 850m³ for each net additional hectare of paved area (850m³/ha). It is assumed the volume would be provided via underground storage measures.

5.1.6 The proposed mitigations are summarised in Table 5.1.1and have been derived from the information provided in the reports: 20000-00-C-100-REP-000001 Airfield Flood Risk Note and Gatwick Airport Northern Runway Core Airfield Works Pond A Option 3C Technical Note and associated updated drawings that informed the ES design and assessment.

Table 5.1.1: Proposed surface water drainage flood mitigations

Storage Reference Number (Pond Sub-Catchment)	Mitigation Volume modelled (m³)	Discharge Limit (m³/s)
B (Dog Kennel Pond)	754	No restriction
J (Pond D)	635	0.4
K (Pond D)	175	0.1
L (Pond D)	1267	0.35
N (Dog Kennel Pond)	1267	0.05
O (Pond M)	1387	0.05
P (Pond D)	574	0.05
Q (Pond M)	496	No restriction
E (Pond M)	2,800	0.09 (pumped)
New Pond A (Pond A)	0 to 16,000	N/A
Car Park Y (CPY)	10,000 and 32,000	No restriction

5.1.7 The new Storage E which receives flows from the new hardstanding for the end around taxiway West has been proposed, this storage facility holds up to 2,800m³ of runoff and would be pumped directly into the upstream end of Pond M at a rate of 0.09m³/s.

5.1.8 The changes in airfield hardstanding and greenfield areas for the Project against the baseline are listed in Table 5.1.2. Where there is existing hardstanding that impacts the drainage system that has not been depicted in the baseline model it has been added into the mitigation model scenarios.

5.1.9 A key assumption whilst undertaking the modelling was that existing airfield hardstanding no longer required by Gatwick, would be removed and reinstated as Greenfield area to minimise additional attenuation needed.

Car Park Y storage tank

5.1.10 A new storage tank is proposed as part of the Project beneath CPY to reduce the risk of surface water drainage flooding in the fuel farm and cargo areas of the airfield and at North Terminal. Two scenarios for CPY storage tank have been run, one with a storage volume of 10,000 m³ storage capacity and the other with 32,000 m³.

New Pond A

5.1.11 The mitigation measures listed in this Section 5.1 have been tested via the hydraulic model. In the first set of scenarios Pond A is proposed to be moved northwards (Figure 5.1.1) and compressed into a smaller footprint reducing the capacity from 21,000m³ to 16,000m³.

5.1.12 As per Gatwick Airport Northern Runway Core Airfield Works Pond A Option 3C Technical Note, the pond invert level is 56.0m AOD with a maximum water depth of 2m. The new Pond A has a plan area of 8,000m² and a new emergency spillway into the River Mole set at a level of 58.0m AOD.

Pond A removal

5.1.13 A further set of scenarios tested the impact if Pond A is removed entirely, these scenarios also assume that there is no available overflow from the Pond A catchment to the River Mole.

5.1.14 It was assumed that a new pumped connection would be provided between the Pond A and Pond M catchments which would require a new pumping station in the Pond A catchment.

5.1.15 These scenarios assume that there is no overflow to the River Mole from the Pond A catchment.

5.1.16 In the future baseline scenario, a pump connects the Pond A catchment to the Pond M catchment and delivers flow at a rate of 0.078m³/s. The pump flow rate has been assumed to remain at 0.078m³/s as per the future baseline model. This scenario has been implemented in the proposed CPY attenuation variants

5.1.17

Table 5.1.2: Change in surface area and types

Catchment Area Differences									
Catchment	Baseline Scenario			Project with Mitigation			Change from Baseline (%)		
	Total area (m^2)	Hardstanding and roof (m^2)	Greenfield (m^2)	Total area (m^2)	Hardstanding and roof (m^2)	Greenfield (m^2)	Total change in Area	Total increase in Hardstanding	Total increase in Greenfield
Pond D	336.3	214.0	122.3	337.5	220.8	116.7	0.4%	2%	-2%
Pond M	42.8	31.1	11.7	53.7	37.46	16.6	26%	14%	11%
Pond A	44.6	24.4	20.2	49.6	30.5	19.1	11%	14%	-2%
Dog kennel pond dirty side	35.8	30.1	5.8	35.3	32.5	2.8	-1%	7%	-8%
Dog kennel pond clean side	16.3	14.8	1.5	16.3	15.0	1.3	0%	1%	-1%

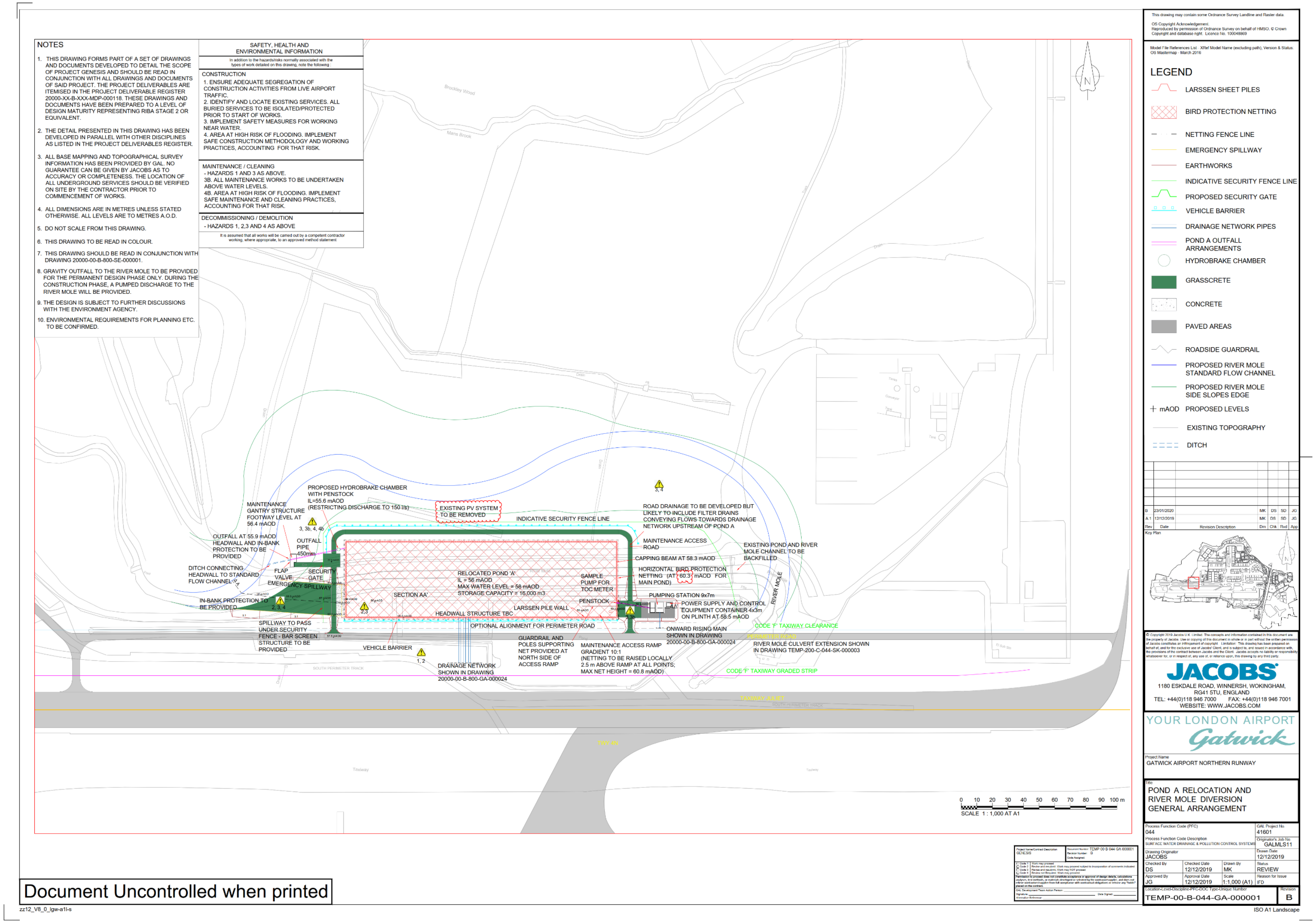


Figure 5.1.1 Proposed relocation of Pond A

5.2 Modelled scenarios

5.2.1 Table 5.2.1 lists the scenarios tested using the hydraulic model.

Table 5.2.1: Scenarios modelled

Scenario	Description	Storm Duration	
Baseline	Baseline	30 mins (summer)	1440 mins (winter)
1	Pond A + Mitigations, CPY at 10,000m^3	30 mins (summer)	1440 mins (winter)
2	Pond A + Mitigations, CPY at 32,000m^3	30 mins (summer)	1440 mins (winter)
3	Remove Pond A + Mitigations, CPY at 10,000m^3	30 mins (summer)	1440 mins (winter)
4 (Proposed)	Remove Pond A + Mitigations, CPY at 32,000m^3	30 mins (summer)	1440 mins (winter)

5.3 Model results

Future baseline model results

5.3.1 The future baseline model was run for the following events:

- 1% (1 in 100) AEP
- 1% (1 in 100) AEP + 25%
- 1% (1 in 100) AEP + 40%

5.3.2 The total volume of the surface water discharge for the 1440 events and the 30 min duration events is summarised in Table 5.3.1.

Table 5.3.1: Future baseline discharge volume

Scenario	Storm Event	Duration (min)	Volume of discharge (m^3)					
			Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
Baseline	M100	30	11,523	30,941	121,123	2,275	821	166,684
Baseline	M100	1440	29,415	33,949	308,471	7	19,350	391,192
Baseline	M100 +25%	30	13,770	30,949	142,415	2,633	1,079	190,845
Baseline	M100 +25%	1440	35,065	36,697	371,792	11,634	30,740	485,929
Baseline	M100 +40%	30	14,610	30,948	155,121	2,824	1,619	205,123
Baseline	M100 +40%	1440	35,065	36,697	371,792	11,634	30,740	485,929

5.3.3 The peak flows for the 1440 events and the 30 min duration events can be seen in Table 5.3.2.

Table 5.3.2 Future baseline peak runoff

Scenario	Storm Event	Duration (min)	Peak runoff rate (m^3/s)					
			Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
Baseline	M100	30	0.2	0.1	1.7	1.4	0.8	4.1
Baseline	M100	1440	0.4	0.1	1.7	0.2	0.8	3.2
Baseline	M100 +25%	30	0.2	0.1	1.7	1.4	1.0	4.3
Baseline	M100 +25%	1440	0.5	0.1	1.7	0.3	1.2	3.8
Baseline	M100 +40%	30	0.2	0.1	1.7	1.4	1.1	4.5
Baseline	M100 +40%	1440	0.5	0.1	1.7	0.3	1.2	3.8

With-Project model results

5.3.4 The with-Project models were run for same events as the future baseline scenario.

5.3.5 The total volume of discharge for the 30 and 1440 minute duration events for scenarios 1 to 4 are included as to Table 5.3.3 to Table 5.3.6.

Table 5.3.3: Scenario 1 Discharge volume

Storm Event	Duration (min)	Volume of discharge (m^3)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	13,420	30,932	121,961	2,253	851	169,416
M100	1440	38,623	33,761	309,356	8,851	3,161	393,751
M100 +25%	30	14,793	30,938	142,361	2,591	1,122	191,805
M100 +25%	1440	45,317	35,878	367,068	11,203	4,054	463,520
M100 +40%	30	17,104	30,942	155,889	2,772	1,284	207,990
M100 +40%	1440	49,824	37,554	406,463	12,661	4,608	511,111

Table 5.3.4: Scenario 2 Discharge volume

Storm Event	Duration (min)	Volume of discharge (m^3)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	13,389	30,933	123,125	2,253	852	170,551
M100	1440	38,589	33,771	314,935	8,851	3,160	399,306
M100 +25%	30	15,101	30,937	143,029	2,592	1,123	192,782
M100 +25%	1440	45,236	35,400	372,661	11,202	4,053	468,551
M100 +40%	30	17,063	30,943	157,306	2,771	1,284	209,367
M100 +40%	1440	49,743	37,180	410,532	12,660	4,608	514,723

Table 5.3.5: Scenario 3 Discharge volume

Storm Event	Duration (min)	Volume of discharge (m^3)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	12,097	30,932	120,630	2,254	851	166,763
M100	1440	30,900	33,761	301,563	8,851	3,161	378,235
M100 +25%	30	13,531	30,940	141,167	2,592	1,122	189,352
M100 +25%	1440	38,830	34,752	372,234	11,200	4,054	461,068
M100 +40%	30	14,446	30,942	153,630	2,772	1,284	203,075
M100 +40%	1440	42,563	37,502	399,248	12,661	4,608	496,583

Table 5.3.6: Scenario 4 (preferred) Discharge volume

Storm Event	Duration (min)	Volume of discharge (m^3)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	12,099	30,936	121,886	2,253	850	168,023
M100	1440	30,905	33,773	307,242	8,851	3,161	383,932
M100 +25%	30	13,528	30,826	142,038	2,647	1,122	190,162
M100 +25%	1440	38,828	35,867	362,030	11,203	4,054	451,982
M100 +40%	30	14,445	30,942	154,546	2,771	1,284	203,988
M100 +40%	1440	38,816	35,458	365,630	11,202	4,054	455,159

5.3.6 The peak outlet flows for the 30 and 1440 minute duration events for scenarios 1 to 4 are included in Table 5.3.7 to Table 5.3.10.

Table 5.3.7: Scenario 1 Peak runoff rate

Storm Event	Duration (min)	Peak runoff rate for 30min duration (m3/s)					
		M pond	Dog kennel	D pond	E pond	A pond	Total
M100	30	0.2	0.1	1.7	1.4	0.7	4.0
M100	1440	0.4	0.1	1.7	0.2	0.1	2.5
M100 +25%	30	0.2	0.1	1.7	1.4	0.9	4.3
M100 +25%	1440	0.5	0.1	1.7	0.3	0.1	2.7
M100 +40%	30	0.3	0.1	1.7	1.4	1.0	4.4
M100 +40%	1440	0.6	0.1	1.7	0.3	0.1	2.8

Table 5.3.8: Scenario 2 Peak runoff rate

Storm Event	Duration (min)	Peak runoff rate for 30min duration (m3/s)					
		M pond	Dog kennel	D pond	E pond	A pond	Total
M100	30	0.2	0.1	1.7	1.4	0.7	4.0
M100	1440	0.4	0.1	1.7	0.2	0.1	2.5
M100 +25%	30	0.2	0.1	1.7	1.4	0.9	4.3
M100 +25%	1440	0.5	0.1	1.7	0.3	0.1	2.7
M100 +40%	30	0.3	0.1	1.7	1.4	1.0	4.4
M100 +40%	1440	0.6	0.1	1.7	0.3	0.1	2.8

Table 5.3.9: Scenario 3 Peak runoff rate

Storm Event	Duration (min)	Peak runoff rate for 30min duration (m3/s)					
		M pond	Dog kennel	D pond	E pond	A pond	Total
M100	30	0.2	0.1	1.7	1.4	0.7	4.0
M100	1440	0.4	0.1	1.7	0.2	0.1	2.5
M100 +25%	30	0.2	0.1	1.7	1.4	0.9	4.3
M100 +25%	1440	0.5	0.1	1.7	0.3	0.1	2.7
M100 +40%	30	0.3	0.1	1.7	1.4	1.0	4.4
M100 +40%	1440	0.6	0.1	1.7	0.3	0.1	2.8

Table 5.3.10: Scenario 4 (preferred) Peak runoff rate

Storm Event	Duration (min)	Peak runoff rate for 30min duration (m3/s)					
		M pond	Dog kennel	D pond	E pond	A pond	Total
M100	30	0.2	0.1	1.7	1.4	0.7	4.0
M100	1440	0.4	0.1	1.7	0.2	0.1	2.5
M100 +25%	30	0.2	0.1	1.7	1.4	0.9	4.3
M100 +25%	1440	0.5	0.1	1.7	0.3	0.1	2.7
M100 +40%	30	0.3	0.1	1.7	1.4	1.0	4.4
M100 +40%	1440	0.5	0.1	1.7	0.3	0.1	2.7

5.3.7 The following series of tables (Table 5.3.11 to Table 5.3.14) show the difference in discharge volumes between the future baseline and Project scenarios.

5.3.8 Scenario 4 is the option adopted for the Project.

Table 5.3.11: Scenario 1 Difference in discharge volume from future baseline

Storm Event	Duration (min)	Difference in Discharge Volumes (m^3)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	1,897	-9	838	-22	29	**2,733**
M100	1440	9,208	-188	885	8,851	-16,190	**2,565**
M100 +25%	30	1,023	-10	-53	-42	43	**960**
M100 +25%	1440	10,252	-819	-4,724	-431	-26,686	**-22,409**
M100 +40%	30	2,494	-7	768	-52	-336	**2,867**
M100 +40%	1440	14,759	857	34,671	1,027	-26,132	**25,182**

Table 5.3.12: Scenario 2 Difference in discharge volume from future baseline

Storm Event	Duration (min)	Difference in Discharge Volumes (m^3)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	1,866	-8	2,003	-23	30	**3,868**
M100	1440	9,174	-178	6,464	8,851	-16,190	**8,121**
M100 +25%	30	1,331	-11	614	-41	44	**1,936**
M100 +25%	1440	10,171	-1,298	868	-432	-26,687	**-17,378**
M100 +40%	30	2,453	-6	2,185	-53	-335	**4,244**
M100 +40%	1440	14,678	482	38,739	1,026	-26,132	**28,794**

Table 5.3.13: Scenario 3 Difference in discharge volume from future baseline

Storm Event	Duration (min)	Difference in Discharge Volumes (m^3)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	574	-9	-492	-22	29	**80**
M100	1440	1,485	-188	-6,908	8,851	-16,190	**-12,950**
M100 +25%	30	-239	-9	-1,248	-41	43	**-1,494**
M100 +25%	1440	3,764	-1,946	441	-434	-26,686	**-24,861**
M100 +40%	30	-165	-6	-1,491	-51	-335	**-2,048**
M100 +40%	1440	7,498	805	27,456	1,027	-26,132	**10,654**

Table 5.3.14: Scenario 4 (preferred) Difference in discharge volume from future baseline

Storm Event	Duration (min)	Difference in Discharge Volumes (m^3)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	576	-6	763	-23	28	**1,339**
M100	1440	1,490	-176	-1,229	8,851	-16,189	**-7,253**
M100 +25%	30	-242	-123	-376	14	44	**-684**
M100 +25%	1440	3,763	-830	-9,762	-431	-26,686	**-33,947**
M100 +40%	30	-165	-6	-575	-52	-336	**-1,135**
M100 +40%	1440	3,751	-1,240	-6,162	-432	-26,686	**-30,770**

5.3.9 The following series of tables (Table 5.3.15 to Table 5.3.18) show the difference in peak flows between the future baseline and Project scenarios. As can be seen in the tables the peak flows have not been significantly impacted by the Project.

5.3.10 Scenario 4 is the option adopted for the Project.

Table 5.3.15: Scenario 1 Difference in peak runoff rate from future baseline

Storm Event	Duration (min)	Difference in Peak runoff (m^3/s)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100	1440	0.0	0.0	0.0	0.0	-0.7	**-0.7**
M100 +25%	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100 +25%	1440	0.1	0.0	0.0	0.0	-1.1	**-1.0**
M100 +40%	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100 +40%	1440	0.1	0.0	0.0	0.0	-1.1	**-0.9**

Table 5.3.16: Scenario 2 Difference in peak runoff rate from future baseline

Storm Event	Duration (min)	Difference in Peak runoff (m^3/s)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100	1440	0.0	0.0	0.0	0.0	-0.7	**-0.7**
M100 +25%	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100 +25%	1440	0.1	0.0	0.0	0.0	-1.1	**-1.0**
M100 +40%	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100 +40%	1440	0.1	0.0	0.0	0.0	-1.1	**-0.9**

Table 5.3.17: Scenario 3 Difference in peak runoff rate from future baseline

Storm Event	Duration (min)	Difference in Peak runoff (m^3/s)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100	1440	0.0	0.0	0.0	0.0	-0.7	**-0.7**
M100 +25%	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100 +25%	1440	0.1	0.0	0.0	0.0	-1.1	**-1.0**
M100 +40%	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100 +40%	1440	0.1	0.0	0.0	0.0	-1.1	**-0.9**

Table 5.3.18: Scenario 4 (preferred) Difference in peak runoff rate from future baseline

Storm Event	Duration (min)	Difference in Peak runoff (m^3/s)					
		Pond M	Dog kennel	Pond D	Pond E	Pond A	Total
M100	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100	1440	0.0	0.0	0.0	0.0	-0.7	**-0.7**
M100 +25%	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100 +25%	1440	0.1	0.0	0.0	0.0	-1.1	**-1.0**
M100 +40%	30	0.0	0.0	0.0	0.0	-0.1	**-0.1**
M100 +40%	1440	0.1	0.0	0.0	0.0	-1.1	**-1.0**

6 Model assumptions and limitations

6.1 Hydraulic modelling

6.1.1 The following assumptions have been made to develop the surface water drainage hydraulic models and assess the impact of the Project to inform the FRA:

- Ground levels are assumed to be the same as the closest adjacent node.
- Attenuation storage was assumed to be comprised of attenuation crates or similar.
- The proposed mitigation volumes were modelled as storage nodes.
- The top of the underground attenuation storage level has been assumed to be at least 1m below ground level.
- Mitigations are designed to attenuate rather than increase network capacity.
- Where additional storage has been included a diameter of 0.1m with a discharge at 5l/s has been assumed at all locations unless impacted by flooding. If a site was impacted by flooding due to the new discharge limits an analysis was undertaken and the discharge limit raised until sufficient flow could pass through the orifice without flooding upstream of the orifice whilst using as much of the storage volume as possible.

6.1.2 It was assumed that any impermeable area to be abandoned that has been impacted by the Project would be returned to greenfield.

6.1.3 It has been assumed that the validated baseline model is accurate and represents the hardstanding and greenfield accurately.

7 Summary

7.1.1 A hydraulic model has been constructed of the Gatwick airfield surface water drainage network. This model has then been run to determine the future baseline flood risk across the airfield and outflows from the network to receiving watercourses.

7.1.2 The model was updated to reflect the proposed Project elements and re-run for comparison to the future baseline in order to understand the Project's impact upon surface water flood risk across the airfield and to receptors.

7.1.3 A comparison of the two scenarios indicated that mitigation would be required to ensure no increase in flood risk to other parties. Consequently, the model was used to develop a surface water drainage mitigation strategy (Dunthorne and Mei 2020) encompassing a series of below ground storage and attenuation locations within the existing drainage network plus a storage tank beneath CPY.

7.1.4 The Project would increase airfield impermeable area that would result in a corresponding increase in the overall volume of runoff to receiving watercourses.

7.1.5 Scenario 4 is the preferred mitigation scenario for the airfield surface water drainage network which consists of the removal of Pond A and provision of a new below-ground storage tank under CPY of 32,000m^3.

7.1.6 As a result of the proposed mitigation strategy the Project would not increase peak rates of runoff to receiving watercourses for all events up to and including the 1% (1 in 100) AEP event plus an allowance for climate change of 25%, which would ensure no increase in flood risk to other parties.

7.1.7 A sensitivity test was undertaken to determine the effect of a more severe event: the 1% (1 in 100) AEP event plus an allowance for climate change of 40%. This similarly indicated that the mitigation strategy would ensure no increase in flood risk to other parties in such circumstances.

8 References

Published documents

Dunthorne, S. and Mei, B (2020) Project Genesis Core -airfield works flood risk study. Jacobs.

Environment Agency (2022). Flood risk assessments: climate change allowances. [online] GOV.UK. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

Jacobs (2019) Gatwick Airport Northern Runway Core Airfield Works Pond A Option 3C Technical Note. Jacobs.

9 Glossary

9.1 Glossary of terms

Table 9.1.1: Glossary

Term	Description
AEP	Annual Exceedance Probability, eg 1 per cent AEP is equivalent to 1 in 100 probability of flooding occurring in any one year (or, on average, once in every 100 years).
AOD	Above Ordnance Datum
CPY	Car Park Y (storage tank)
DCO	Development Consent Order
Defra	Department for Environment, Food and Rural Affairs. The government department responsible for environmental protection, food production and standards, agriculture, fisheries and rural communities in the UK. Among its responsibilities, Defra publishes guidance on, for example, flood modelling approaches and approaches to accounting for climate change in flood studies.
Development	The carrying out of building, engineering, mining or other operations, in, on, over or under land, or the making of any material change in the use of a building or other land.
EIA	Environmental Impact Assessment
Environment Agency (EA)	The Environment Agency is a non-departmental public body, established in 1995 and sponsored by DEFRA. Its responsibilities relate to the protection and enhancement of the environment in England. Environment Agency
ES	Environmental Statement
FRA	Flood Risk Assessment. A site-specific assessment of flood risk. This is a statutory report for submission with planning applications in England.
Gatwick	Gatwick Airport Limited
LiDAR	Light Detection and Ranging. A remote sensing technique to map the earth's surface

NPPF	National Planning Policy Framework. National planning policy published by the Government, most recently in July 2021. It replaces most of the previous Planning Policy Statements, including that regarding flood risk (PPS25).
NPPG	National Planning Practice Guidance. Supporting guidance to the NPPF, published by the Government in March 2014 and updated since as an online resource, available at: (http://planningguidance.planningportal.gov.uk/). It replaces previously published Government guidance, including that regarding flood risk.
NPS	National Policy Statement
RET	Rapid Exit (runway) Taxiway
RET-ER	Rapid Exit Taxiway – Echo Romeo
STW	Sewage (waste/foul water) treatment works

Annex 4

Integrated Hydraulic Model Build Report

Table of Contents

1 Introduction

1.1 Purpose of modelling

1.1.1 This document forms **Environmental Statement** (ES) **Appendix 11.9.6: Flood Risk Assessment** (FRA) **Annex 4** (Doc Ref. 5.3) prepared on behalf of London Gatwick Airport (Gatwick). The ES presents the findings of the Environmental Impact Assessment (EIA) process for the proposal to make best use of Gatwick Airport's existing runways and infrastructure (referred to within this report as 'the Project'). The Project proposes alterations to the existing northern runway which, together with the lifting of the current restrictions on its use, would enable dual runway operations. The Project includes the development of a range of infrastructure and facilities which, with the alterations to the northern runway, would enable the airport passenger and aircraft operations to increase. Further details regarding the components of the Project can be found in the **ES Chapter 5: Project Description** (Doc Ref. 5.1).

1.1.2 This report supports **ES Appendix 11.9.6: Flood Risk Assessment** (FRA) (Doc Ref. 5.3) as part of the ES. The FRA assesses the risk to and as a result of the Project for all sources of flooding for its lifetime including the consideration of climate change to demonstrate compliance with national planning policy. This annex documents the integrated catchment modelling (ICM) undertaken to inform the FRA.

1.1.3 The main sources of flooding to the Project are fluvial and surface water. The FRA has therefore assessed these sources through hydraulic modelling. Fluvial flood risk has been assessed via use of the Flood Modeller-TUFLOW River Mole fluvial model, which represents flood risk associated with out of bank flooding from Gatwick's main watercourses (Gatwick Stream, River Mole, Crawter's Brook and Man's Brook). Surface water flood risk has been considered through development of an InfoWorks ICM surface water drainage model, which represents flood risk associated with surface water accumulation and the existing drainage network. Further details of the surface water drainage model are provided in **ES Appendix 11.9.6: Annex 3** (Doc Ref. 5.3), whereas details of the River Mole fluvial model are provided in **ES Appendix 11.9.6 Annex 5** (Doc Ref. 5.3).

1.1.4 The purpose of the integrated catchment model is to undertake a sensitivity test to identify if there are any additional flood risks to and from the Project as a result of the interaction between the airfield surface water drainage network and principal watercourses. For this, both the surface water drainage model and the River Mole fluvial model were combined to build the integrated catchment model. The assessment of whether the Project would increase flood risk to other parties is considered in in **ES Appendix 11.9.6: Annex 3** (Doc Ref. 5.3) for the surface water drainage network and **ES Appendix 11.9.6: Annex 5** (Doc Ref. 5.3) for watercourses.

1.2 Methodology

1.2.1 Integrated catchment modelling was undertaken using modelling software InfoWorks ICM Version 2021.6.1. The extent of the surface water drainage network included within the integrated catchment model was identical to that of the surface water drainage model, whereas the fluvial model was truncated to the following upstream extents: River Mole at the Charlwood Road crossing, Crawter's Brook at the A23 crossing and Gatwick Stream at the A2011 crossing. Further details on the model build are described in Section 4.

1.2.2 The integrated catchment model utilised a one-dimensional (1D) / two-dimensional (2D) modelling approach within InfoWorks ICM, whereby the fluvial river reaches, in-channel structures and surface water drainage network were represented in the 1D model domain. The topography of the study area, representing overland flow paths and surface water flooding, was represented within the 2D model domain.

1.2.3 The baseline (existing situation) model scenario was updated to develop a future baseline for the Project as modifications would be made to Rapid Exit Taxiway Echo Romeo (RET-ER) in advance of the Project. This change has been included in all scenarios.

1.2.4 The Future Baseline scenario formed the baseline for subsequent 'with-Project' scenarios assessment. The new and amended areas of hard standing, roof areas and surface areas that will be delivered by the Project were included in the model. Details of these modifications are included in **ES Chapter 5: Project Description** (Doc Ref. 5.1).

1.2.5 Following the scenario changes made to the model, the Future Baseline and with-Project scenarios were simulated for the 5% (1 in 20), 1% (1 in 100) and 0.5% (1 in 200) Annual Exceedance Probability (AEP) events plus an allowance for climate change (see Section 3.2).

1.2.6 The results of the with-Project scenarios were then compared to the Future Baseline to ascertain the un-mitigated impact of the Project. Where an increase in flood risk offsite was identified mitigation was developed and included to ensure no increase in offsite flood risk for the duration of the project incorporating the predicted effects of climate change. Any increases to flood risk onsite would be managed through GAL's existing response strategy, as summarised in the **Flood Resilience Statement** in **ES Appendix 11.9.6: Annex 6** (Doc Ref. 5.3).

1.2.7 Whilst other scenarios have been assessed in this report the preferred option is where Pond A has been removed and Car Park Y (CPY) storage area volume is 32,000 m3 (With-Project Scenario, see Section 6).

1.3 Study area

1.3.1 A full description of the study area and Project is provided in **ES Chapter 4: Existing Site and Operation** (Doc Ref. 5.1**), ES Chapter 5: Project Description** (Doc Ref. 5.1) and **ES Chapter 11: Water Environment** (Doc Ref. 5.1).

2 Input data

2.1.1 The integrated catchment model was constructed based on the following datasets:

- The updated verified surface water drainage model detailed in **ES Appendix 11.9.6: Annex 3** (Doc Ref. 5.3). Both the Baseline and with-Project scenarios were provided for use within the ICM model.
- The updated River Mole fluvial model detailed in **ES Appendix 11.9.6: Annex 5** (Doc Ref. 5.3). Both Baseline and with-Project scenarios were provided for use within the ICM model.
- Environment Agency Light Detection and Ranging (LiDAR) DTM flown in 2020 at 1m horizontal resolution, downloaded from DEFRA website (DEFRA, 2022).
- OS MasterMap Topographic layer containing information on land uses within the study area downloaded from DEFRA website (DEFRA, 2022).
- **ES Chapter 5: Project Description** (Doc Ref. 5.1):
  - 20421 Portfolio Data Sheets - v9.8 - 21.04 2022
  - 41700-XX-C-HGN-CM-200003 - 3D Combined Highways DF4.dwg – CAD Drawing of the proposed A23 road alignment.
  - TEMP-XX-C-193-M3-200001.dwg – 3D CAD Drawing proposed Northern Runway Scheme drawing.

3 Hydrology

3.1 Hydrological inflow methodology

3.1.1 The hydrological inputs into the integrated catchment model were directly extracted from the surface water drainage model and River Model fluvial model.

3.1.2 Rainfall hyetographs were taken from the surface water drainage model and applied only to drainage network sub-catchments and not to the entire 2D domain to avoid double counting of flows in the model. Rainfall-runoff losses were accounted for, using an identical methodology to the surface water drainage model.

3.1.3 Hydrological inflows at the upstream extent of each watercourse were extracted from the River Mole fluvial model results and distributed lateral inflows were applied in accordance with the River Mole fluvial model.

3.1.4 No critical storm duration analysis was carried out with the integrated catchment model. As stated within **ES Appendix 11.9.6: Annex 3** (Doc Ref. 5.3), there are two critical storm durations when considering surface water flooding across Gatwick Airport: 30 minutes (summer) and 24 hours (winter). When considering fluvial flooding across Gatwick Airport (**ES Appendix 11.9.6: Annex 5** (Doc Ref. 5.3)) the critical storm duration was found to be six hours (winter). Therefore, the integrated catchment model was simulated for the following combinations: 30-minute rainfall profile with six hour storm induced fluvial inflows and 24-hour rainfall profile with six hour storm induced fluvial inflows.

3.1.5 In both storm duration combinations, the timing of the rainfall hyetographs and fluvial hydrographs were shifted to create a conservative alignment of peaks. For the 30-minute rainfall event, the rainfall hyetograph was delayed by 5 hours 45 minutes, to align with the time of peak in the fluvial model at the location of the fluvial inflows. Whereas for the 24-hour rainfall event, the fluvial inflows were delayed by 6 hours to align with the time of peak rainfall.

3.2 Climate change

3.2.1 The Future Baseline and with-Project scenarios have been run for the 5% (1 in 20), 1% (1 in 100) and 0.5% (1 in 200) AEP events. Further simulations have been modelled using the 1% AEP event with the following uplift combinations: +25% rainfall intensity (2070s epoch Central allowance) with +20% peak river flow (2080s epoch Higher Central allowance) and +40% rainfall intensity (2070s epoch Upper End allowance) with + 40% peak river flow (2080s epoch Upper End allowance). This incorporates the predicted impact of climate change based on Environment Agency guidance (Environment Agency, 2022). The 25% / 20% event has been used to design the mitigation measures and the 40% event adopted as a sensitivity test for an exceedance event. Further information is included in the **ES Appendix 11.9.6: Flood Risk Assessment** (Doc Ref. 5.3).

4 Baseline model build

4.1.1 The integrated catchment model was built by importing the River Mole fluvial model and surface water drainage model into InfoWorks ICM. The representation of cross-section data, in-channel structures, in-channel roughness, weir coefficients, surface water drainage network and ancillary structures are the same as the River Mole fluvial model and surface water drainage model respectively. The following sections describe the changes carried out that differ from the River Mole fluvial and surface water drainage models, for the purposes of the integrated catchment model build.

4.2 1D Fluvial Domain

4.2.1 In the 1D fluvial domain of the integrated catchment model, a stage-discharge rating curve is applied as downstream boundary condition. The data was extracted from the fluvial model results for the 1% (1 in 100) AEP event at node location MOLE_14712.

4.2.2 The control rules for the sluice gate operation at the Gatwick Flood Storage Area (Gatwick FSA) have been specified using a Real-Time Control (RTC) within ICM. The setting point of the sluice gate operation is based on water depth in the South Terminal culvert (07_2016), as per the River Mole fluvial model.

4.2.3 Because the River Mole fluvial model has been calibrated to observed data at the Gatwick FSA, the RTC has been specified to match the sluice gate operation provided within the fluvial model.

4.2.4 The control rules of the RTC are therefore as follows:

- If depth at 07_2016 is less than 2.586m then the gate opening is 1.8m.
- If depth at 07_2016 is between 2.586m and 2.766m then the gate opening should be 1.4m.
- If depth at 07_2016 is between 2.766m and 2.876m then the gate opening should be 1.15m.
- If depth at 07_2016 is between 2.876m and 3.006m then the gate opening is 1m.
- If depth at 07_2016 is greater than 3.006m then the gate opening is 1m.

4.3 1D Surface Water Domain

4.3.1 In the surface water network domain of the ICM model, the drainage network outfalls were connected to the nearest node in the river reaches to allow interaction of surface water with the fluvial system.

4.3.2 Subsequently, a network clean-up exercise was carried out, at locations with negative gradients present in the pipe network. Pipe invert elevations were then updated to provide a positive gradient if the original level was either assumed or inferred using the in-built ICM inference tools in the surface water drainage model.

4.3.3 Within the surface water drainage model, dummy channels were defined at outfalls into the River Mole. Within the integrated catchment model, these dummy channels were removed since the model includes explicit representation of river reaches from the fluvial model.

4.3.4 Ground elevation at 1D manhole nodes was inferred from 2D mesh elevation. The mesh was created using the latest 1m resolution 2020 LiDAR data.

4.4 2D Model Domain

4.4.1 The topography (ground model) of the integrated catchment model was defined using 1m resolution 2020 DTM data. This differs from the River Mole fluvial model which uses 5m resolution 2016 DTM data. One ‘patch’ was made using the 2022 DTM data in order to incorporate recent changes to the airport infrastructure (including Larkins Road and Boeing Hangar), which is in line with changes made to the Upper Mole fluvial model.

4.4.2 River reach bank lines were digitised based on channel cross-section ends and watercourse alignment. The bank elevations were extracted at 5m intervals from the ground model. The discharge coefficient was set to 1 and a value of 0.7 was used for modular limit.

4.4.3 For consistency with the River Mole fluvial model, a minimum model grid size of 5m (i.e. 25m^2 cell area) or equivalent Triangular Irregular Network (TIN) was required. This was implemented in the integrated catchment model by fixing the maximum and minimum triangle areas to 25m^2 and 5m^2, respectively. Terrain sensitive meshing with a maximum height variation of 0.15m was adopted, while a minimum angle of 25 degrees was adopted for meshing to allow elements to capture any sudden changes in ground elevation.

4.4.4 1D-2D linkage of manholes was set to default, i.e. “Depth” to have a smooth 1D/2D transfer of flows.

4.4.5 2D Mesh Zone layers were used to patch ditches and ponds in the ground model that were already represented in the surface water drainage model.

5 Future Baseline model build

5.1.1 The Future Baseline model incorporates all changes described within Section 4.

5.1.2 In addition, the baseline model was updated to include the Rapid Exit Taxiway Echo Romeo (RET-ER). All changes were adopted from the surface water drainage model detailed in **ES Appendix 11.9.6: Annex 3** (Doc Ref. 5.3).

5.1.3 Along with the changes from the surface water drainage model, the RET-ER was represented in the roughness zone layer by changing the roughness at the RET-ER to 0.02 (value for impermeable surfaces).

6 With-Project Model Build

6.1 With-Project

6.1.1 The Future Baseline model was updated to represent the new proposed highways improvements and the airfield modifications.

6.1.2 As part of the with-Project scenario, the representation of structures at A23 London Road and A23 Brighton Road were updated based on Option 2 of the Gatwick NRP – Highways Mitigation Report (Arup, 2022). Details are provided in Table 6.2.1.

6.1.3 The 3D CAD models (see Section 2) of the highways and northern runway alignments were stamped on the base DTM (1m 2020 LiDAR data) to represent the with-Project scenario within the ICM ground model.

6.1.4 All additional development works as part of the Project are detailed in Table 6.1.1 along with a description of how the 1D and 2D model domains were modified to represent the proposed works.

Table 6.1.1 List of Development Works

Datasheet Reference	Description	1D Modification	2D Modification
GP-169	Hotel adjacent to MSCP3	Sub-catchment runoff area updated	Building polygon added to roughness zone
GP-153-B	Removal of existing hard surface and replacing with landscape	No change to 1D	Roughness zones updated to value of 0.05
GP-016	Relocate hangar 7 NE facilities	Sub-catchment runoff area updated	Building polygon relocated in roughness zone
GP-012	Part of car parking to be converted to buildings	Sub-catchment runoff area updated	Building polygon added to roughness zone
GP-029/33/35	MSCP H multistorey car parks and offices from parking	Sub-catchment runoff area updated	Building polygon added to roughness zone
GP-039 a,b,c	Northwest Noise Bund	No change to 1D	Wall added to 2D
Gatwick NRP – Highway Development	A23 London Road Bridge	Length increased to 28.62m, width increased to 15.20m	No change in 2D
Gatwick NRP - Highway Development	A23 Brighton Road Bridge	Length increased to 25.0m, width increased to 13.6m	No change in 2D
Gatwick NRP – Highway Alignment	Project highways alignment	No change to 1D	New road alignment stamped onto ground model using 3D drawing
Gatwick Northern Runway Scheme	Northern Runway Alignment	No change to 1D	Elevations of airfield development stamped onto ground model using 3D drawing.
Gatwick Northern Runway Scheme	37 Two bridges over Man’s Brook		8m wide, 10m in length approach ramps to 1%+16%CC peak water level within floodplain
Gatwick Northern Runway Scheme	28 Weir on River Mole runway culvert	Weir unit added immediately upstream of the culvert.	No change

6.2 Mitigation requirements

6.2.1 Several measures are proposed to mitigate the impact of the Project on flood risk as described in detail in the Table 6.2.1 along with a description of how the 1D and 2D model domains were modified to represent the options.

6.2.2 Detailed descriptions of the mitigation options related to the surface water model are provided in **ES Appendix 11.9.6: Annex 3** (Doc Ref. 5.3). These are not presented in Table 6.2.1.

Table 6.2.1 List of Mitigation options

Datasheet Reference	Description	1D Modification	2D Modification
GP-119	Car Park Y storage	Sub-catchment runoff area updated and storage node added	No change in 2D
GP-087/GP-062	River Mole realignment/ Removal of Pond A/Syphon &	New cross-sections added. River Mole culvert and	River reach updated, addition of mesh level zone to represent River

Datasheet Reference	Description	1D Modification	2D Modification
	culvert taxiway impact	siphon length increased.	Mole and Pond A infill.
GP-118	Museum Field FCA and Bund	No change to 1D	Mesh level zone added
GP-145	Car Park X FCA	Added 1D culvert from Car Park X to River Mole.	The volume of 40,000 m^3 of Car Park X storage is represented using a storage node, which receives overtopping of from Crawter's Brook via an inline bank.
RET 9 and RET 10	Siphons under Taxiway	Siphons modelled as 1m diameter circular culvert (2No.'s)	No change in 2D
GP-039 a,b,c	Northwest Noise Bund drainage siphons beneath the bund	Siphons added as culverts	No change in 2D
Gatwick Northern Runway Scheme	Culverts beneath the proposed travel path route adjacent to Car Park Y and River Mole	No change	Culverts added as 2D Conduits

7 Modelled events and scenarios

7.1.1 The integrated catchment model was run for the 5% (1 in 20), 1% (1 in 100) and 0.5% (1 in 200) AEP events in addition to 1% (1 in 100) AEP +25% (rainfall hydrology) / +20% (fluvial flows hydrology) and +40% (rainfall and fluvial flows hydrology) climate change events with critical storm durations of 30 minutes and 24 hours rainfall events. The approach has been discussed in Section 3.

7.1.2 Table 7.1.1 lists the scenarios and events modelled.

Table 7.1.1 Scenarios Modelled

Scenario	Storm Duration	AEP Event				
		5% (1 in 20)	1% (1 in 100)	0.5% (1 in 200)	1% 1 in 100) + 25% / +20% CC	1% 1 in 100) + 40% CC
Baseline	6 Hours (Winter)		✓			
	30 mins (Summer)	✓	✓	✓	✓	✓
Future Baseline	24 Hours (Winter)	✓	✓	✓	✓	✓
	30 minutes (Summer)	✓	✓	✓	✓	✓
With-Project	6 Hours (Winter)		✓			
	24 Hours (Winter)	✓	✓	✓	✓	✓
	30 minutes (Summer)	✓	✓	✓	✓	✓

8 Model proving

8.1 Model numerical performance

8.1.1 Convergence refers to the ability of the modelling software to arrive at a solution that is close to the exact solution within a pre-specified error tolerance. InfoWorks ICM hydraulic modelling software provides run performance figures along with the acceptable error ranges that should be achieved during each model run. The concept of an acceptable error range has been adopted by the developers of the software, as numerical errors occur due to the quality of the data used, limitations of the software and underlying equation solving processes.

8.1.2 Numerical performance has been monitored throughout the model build process and during each simulation. A suitable model convergence was achieved for all the AEP events simulated for this study. Cumulative mass balance error reports associated with both 1D (i.e. fluvial and drainage system) and 2D domains (2D surface) have been considered. For all simulations undertaken, the latter parameters were found to be acceptable, staying within the +/-5% tolerance range recommended by the software developers (Innovyze, 2018). For example, for the 1% (1 in 100) AEP event with a 24-hour storm duration, a volume balance error of 0.001% was noted.

8.2 Model Validation

8.2.1 As described within **ES Appendix 11.9.6: Annex 5** (Doc Ref. 5.3), the River Mole fluvial model was calibrated against observed hydrometric data on both Gatwick Stream and the River Mole. For this reason, the integrated catchment model was not calibrated against the observed data and instead validated against the calibrated and verified River Mole fluvial model.

8.2.2 The validation against the River Mole fluvial model was conducted with the understanding that the following differences are present between the fluvial model and integrated catchment model methodologies:

8.2.3 Different numerical solving algorithm inherent to the software used for each model.

8.2.4 Different LiDAR DTM datasets were used within each model to inform ground elevations and banktop elevations along the watercourse.

8.2.5 The integrated catchment model includes explicit representation of the surface water runoff emanating from the airport that discharges into the river channel at Pond A and Pond D.

8.2.6 The integrated catchment model (baseline) results were compared against the River Mole fluvial model results only for the 1% (1 in 100) AEP event with a 6-hour storm duration.

8.2.7 The operation of Gatwick FSA sluice gates during the simulated event has been compared between the fluvial and integrated models, as shown in **Figure 8.2.1**. The opening and closing heights are shown to closely match, whilst there is a slight variation in the time of opening and closing of gates. This is due to the following differences between models:

8.2.8 The difference in LiDAR DTM datasets results in a variation of out of bank flows and in-channel flows between the two models.

8.2.9 As a result of this difference, the integrated catchment model predicts slightly higher flow would reach the sluice gates during the simulated event.

8.2.10 Surface water outfalls into Gatwick Stream upstream of the South Terminal culvert results in higher water levels at the culvert causing the sluice gates to remain closed longer than in the fluvial model.

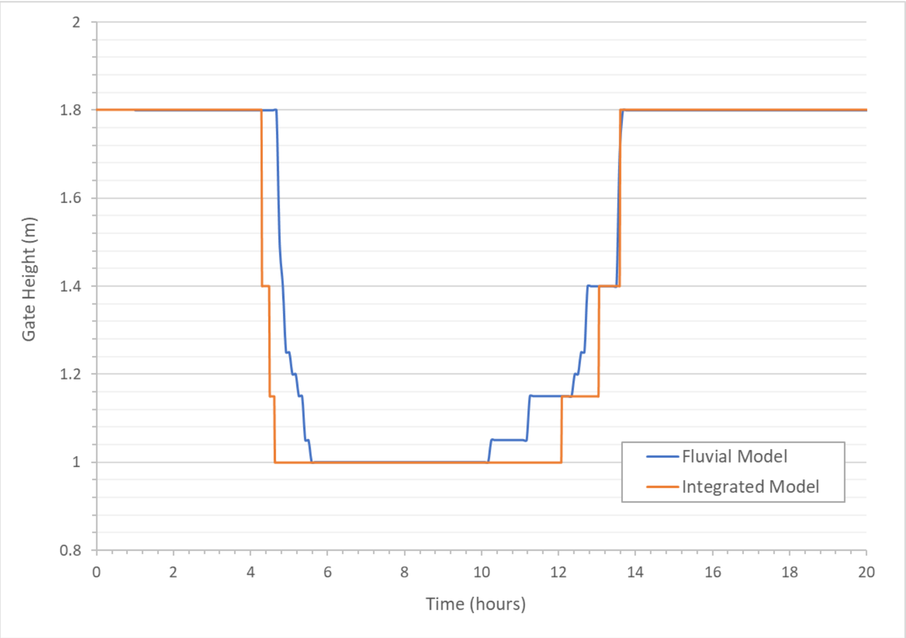


Figure 8.2.1 Sluice Gate opening height and time comparison between fluvial and integrated models

8.2.11 **Figure 8.2.2** to **Figure 8.2.5** show the flow comparisons between the fluvial and integrated models at model nodes on Man's Brook, Gatwick Stream, Crawter's Brook and River Mole respectively, where a good match between flow hydrographs can be observed.

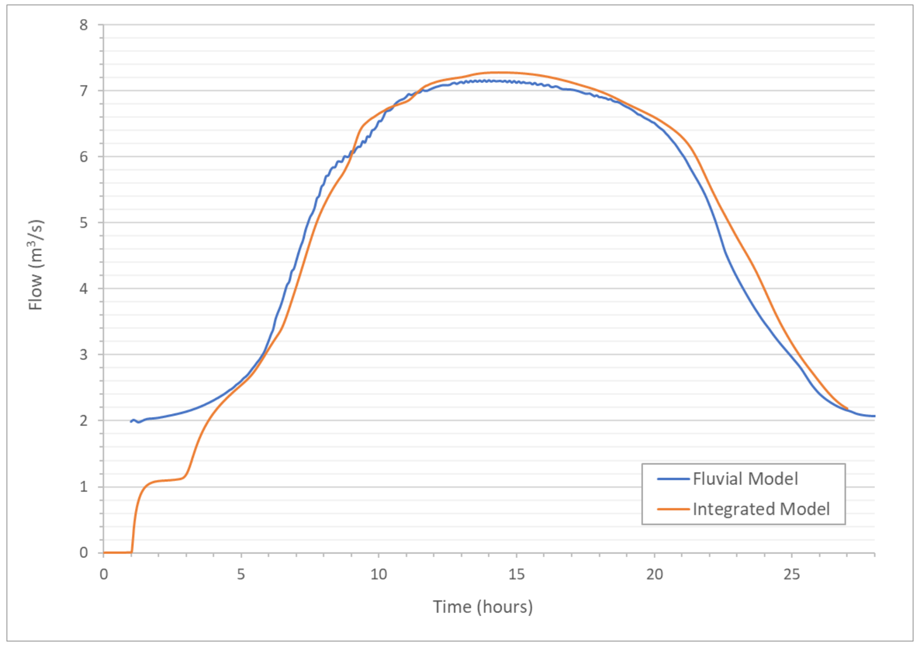


Figure 8.2.2 Flow comparison at node 12_0296 on Man's Brook between fluvial and integrated models

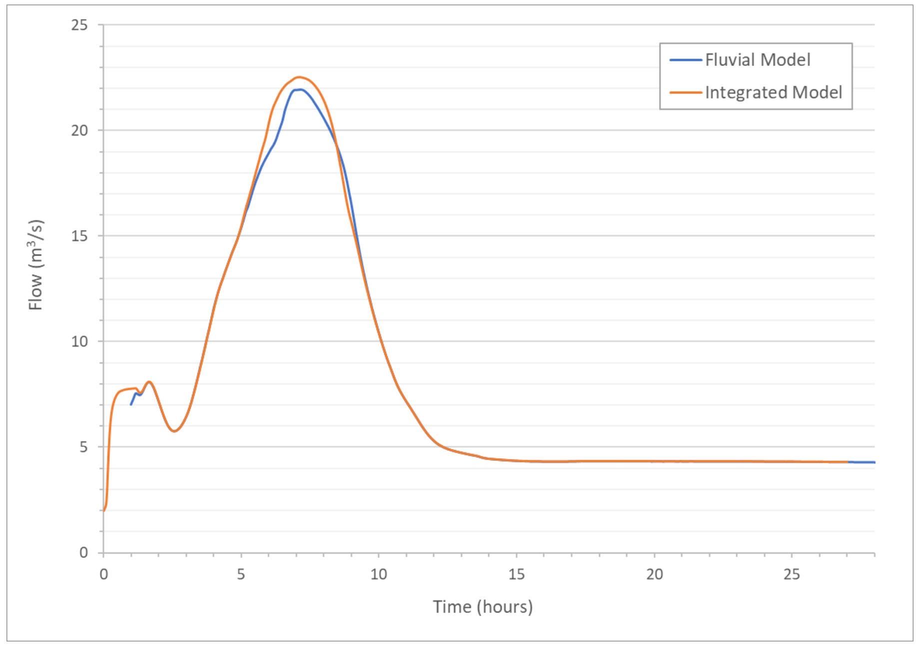


Figure 8.2.3 Flow comparison at node 07_4479 on Gatwick Stream between fluvial and integrated models

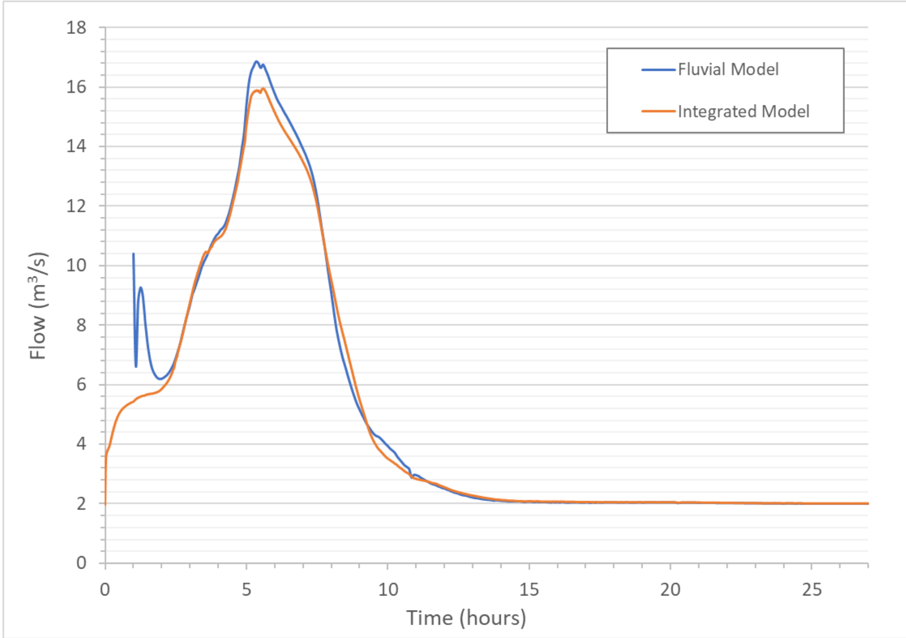


Figure 8.2.4 Flow comparison at node 03_1647 on Crawter's Brook between fluvial and integrated models

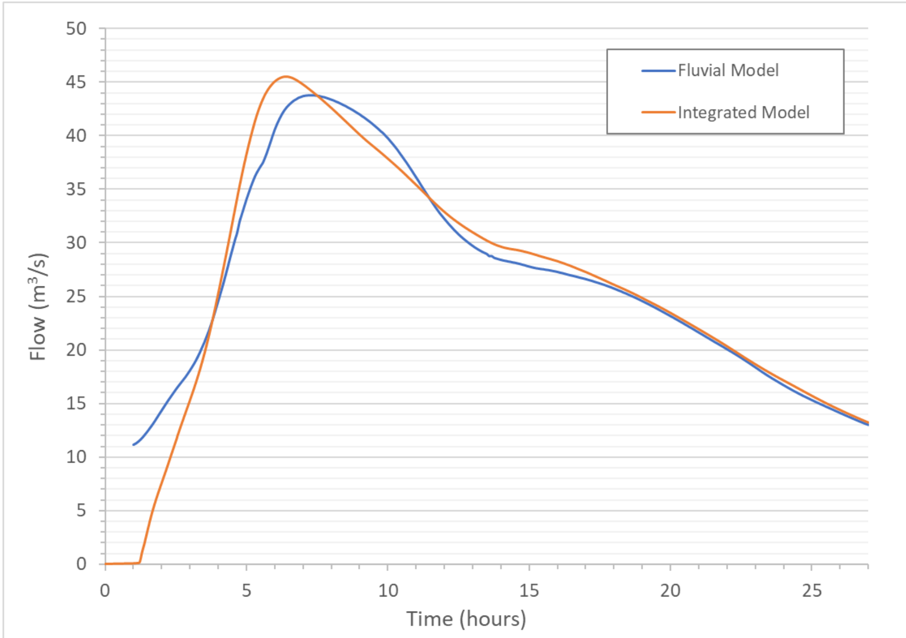


Figure 8.2.5 Flow comparison at node 13_2586 on River Mole between fluvial and integrated models

8.2.12 **Figure 14.1.1** shows maximum flood depth for the 1% (1 in 100) AEP 6-hour event from the integrated model compared to the maximum flood extent from the fluvial model for the same event.

8.2.13 **Figure 14.1.1** shows that on Man's Brook, Crawter's Brook, River Mole and Gatwick Stream there is a close match in maximum flood extent and flooding mechanisms between the two models.

8.2.14 The comparison of flows, flood extents and the operation of the sluice gates at Gatwick FSA gives a good confidence on the representation of river system within the integrated catchment model.

9 Model results

9.1 Future Baseline model results

9.1.1 Maps of maximum flood depths for the Future Baseline scenario are provided in Section **Error! Reference source not found.** (**Figure 14.2.1** to **Figure 14.2.6)**

9.1.2 The analysis of the Future Baseline model results is confined to Gatwick Airport and the watercourses surrounding it. The main areas that flood consistently across all events during a 30-minute storm duration, due to surface water, are the Gatwick airfield (green areas), Gatwick runway base, Boeing Hangar, Gatwick North Terminal. The maximum flood depths vary in the range of 100mm to 300mm.

9.1.3 The main areas that flood consistently across all AEP events for 30-minute storm duration from fluvial sources are both banks of River Mole downstream of Charlwood Road, properties along the banks of Crawter's Brook downstream of London Road, out of bank flooding upstream of London Road bridge, Riverside Garden Park and Car Park X immediately to the south of Airport Way and adjacent to London Road.

9.1.4 The fluvial flooding mechanisms for all AEP events during the 24-hour storm duration, are similar to the 30-minute storm duration. This is expected as the fluvial flooding is a product of the 6-hour storm duration inflows that are unchanged between the two simulations. During the 5% AEP event, there is no surface water flooding at Gatwick Airport overall. However, for higher magnitude AEP events (greater than or equal to 1% AEP), the Gatwick Cargo Centre, Cargo access roads, Car Park Y, departure and arrival area at the North Terminal, properties near the Perimeter Road East and the Gatwick airbase near the Racecourse Road are affected by the surface water flooding.

9.1.5 As a result of surface water interaction with the fluvial flooding mechanisms, additional areas of flood risk were highlighted that are not represented by the fluvial and surface water drainage models alone for all events. These additional areas of flood risk are described in Table 9.1.1.

Table 9.1.1 Future Baseline Additional Flood Risk Analysis

Event (AEP)	Additional Flood Risk analysis
5% (1 in 20)	No additional areas of flood risk when compared to the fluvial model, although flood extents are slightly greater around the upstream extent of River Mole. A similar trend has been observed for both modelled storm durations. Surface water flooding occurs across Gatwick Airport during the 30-minute duration, as described in Section 9.1.2.
1% (1 in 100)	Additional area of flood risk at the South Terminal culvert due to overtopping of Gatwick Stream left bank. Flood extents are generally greater around the airfield near to Racecourse Road. There is also additional flooding to the North Terminal and Gatwick Cargo Centre as a result of outfalls not being able to discharge from Pond D, leading to localised surface water flooding.
1% (1 in 100) +25% / 20%	General increase in flood extents and depth at the South Terminal culvert due to the additional overtopping shown in the integrated model. Same additional flooding to the North Terminal and Gatwick Cargo Centre. Flood extents are greater within the car park on the right bank of River Mole at the Gatwick Stream confluence.
0.5% (1 in 200)	Same trend as for 1% (1 in 100) + 25% / 20% event. No additional flooding mechanisms observed.
1% (1 in 100) + 40%	Same trend as for 1% (1 in 100) + 25% / 20% event. No additional flooding mechanisms observed.

9.2 With-Project model results

9.2.1 The maps of maximum flood depths for the with-project scenario are shown in **Figure 14.3.1** to **Figure 14.3.6** The comparisons of maximum flood extent against the future baseline scenario are provided in **Figure 14.4.1** to **Figure 14.4.6**.

9.2.2 With the inclusion of the Project and mitigation measures, flooding remains at the same locations as in the baseline model, however flooding from fluvial sources is generally reduced.

9.2.3 There are localised increases in flood depths due to surface water but ultimately the discharge at the pond outfalls into the watercourses is less than that of the Future Baseline scenario. This is due to the influence of the proposed mitigation measures which are found to reduce inflows to the respective ponds. The location of the ponds is shown in **Figure 9.2.1**. The impact of these mitigation measures on the surface water flooding is described in detail within **ES Appendix 11.9.6: Annex 3** (Doc Ref. 5.3).

9.2.4 As per the Future Baseline scenario, additional areas of flood risk were highlighted that are not represented by the fluvial and surface water drainage models alone for all events. These additional areas of flood risk are described in Table 9.2.1.

Table 9.2.1 With-Project Additional Flood Risk Analysis

Event (AEP)	Additional Flood Risk analysis
5% (1 in 20)	As per the Future Baseline scenario, there are no additional areas of fluvial flood risk when compared to the fluvial model, although flood extents are slightly greater around the upstream extent of River Mole. A similar trend has been observed for both modelled storm durations. As a result of increased impermeable surfaces, additional surface water flooding occurs across the airfield north of Hanger 6 and to the east of Larkins Road.
1% (1 in 100)	The additional area of flood risk at the South Terminal culvert remains as per the Future Baseline scenario. There is also additional flooding at Gatwick Cargo Centre, east of Larkins Road and on the airfield to the north of Hanger 6, as a result of increased impermeable surfaces.
1% (1 in 100) +25% / 20%	General increase in flood extents and depth at the South Terminal culvert due to the additional overtopping shown in the integrated model. Similar trend of surface water flooding as seen for the 1% AEP event with additional flooding mechanism observed to the North Terminal, Gatwick Cargo Centre, south of London Road at Car Park Y storage area and the airfield base near Racecourse Road.
0.5% (1 in 200)	Same trend as for 1% (1 in 100) + 25% / 20% event, with additional flooding mechanisms observed to the north of Charlwood Road near the left bank of River Mole.
1% (1 in 100) + 40%	Same trend as for 1% (1 in 100) + 25% / 20% event. No further additional flooding mechanisms observed.

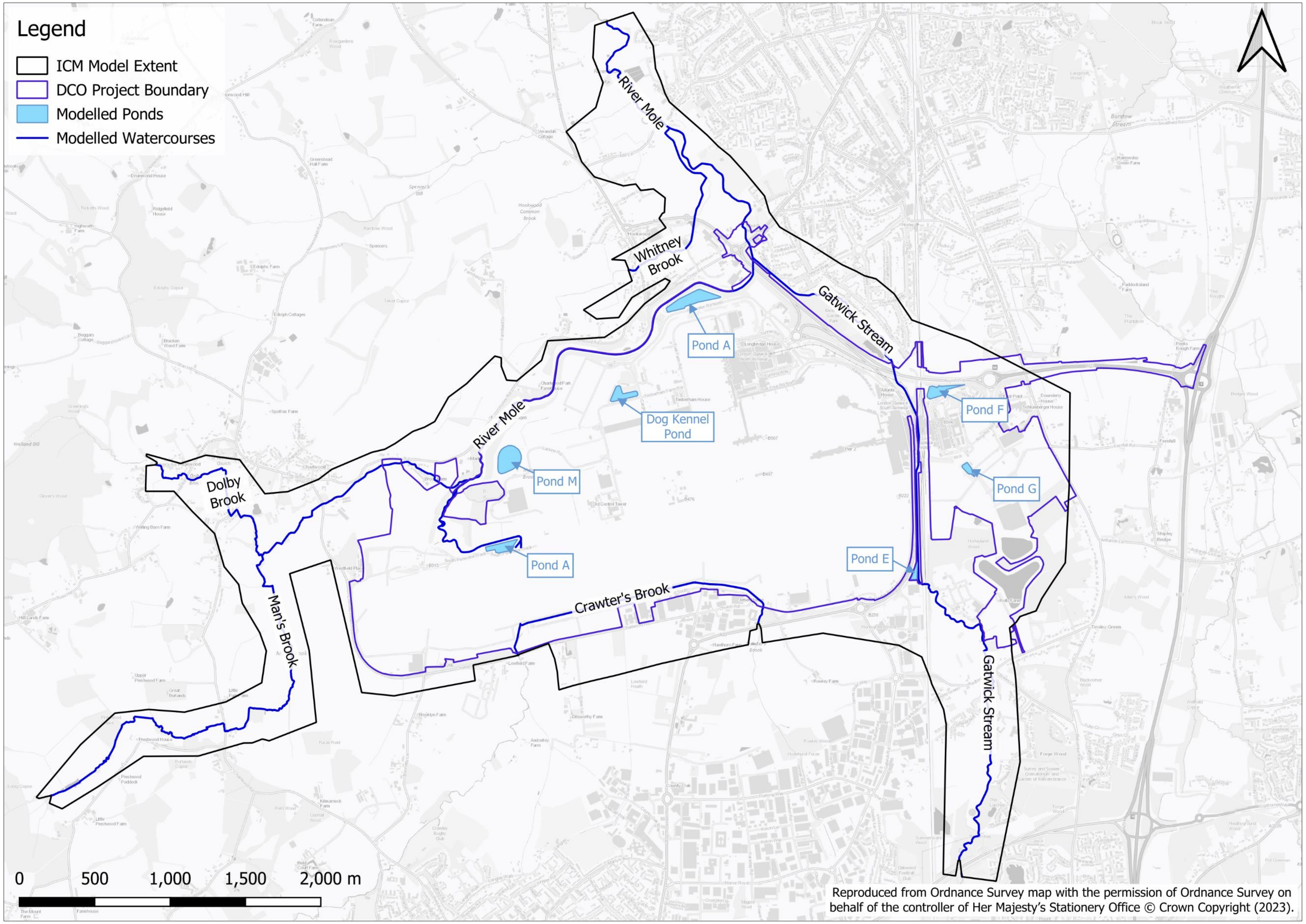


Figure 9.2.1 Location of Ponds

10 Model assumptions and limitations

10.1.1 The accuracy and validity of the integrated catchment model is dependent on the accuracy of the River Mole fluvial model and the surface water drainage model. Both models have been validated against observed data and are therefore considered to be appropriate for use.

10.1.2 Due to limited available OS MasterMap data, the Gatwick airfield required manual digitisation with the ICM roughness zones. Therefore, there is likely to be a difference in the actual boundary of the airfield when compared to the Integrated model.

10.1.3 Final detailed design of the with-Project and mitigation changes such as new buildings, car park areas or proposed open spaces has not been completed at this stage of study, therefore the current high-level design has been reflected in the model.

10.1.4 The RTC control rules within ICM software are less advanced than that of the fluvial model. For this reason, the RTC at the Gatwick FSA has been specified to mimic the movement of the sluice gates in the fluvial model as closely as possible within the constraints of the software.

10.1.5 Different storm durations have been applied for pluvial and fluvial storm events for the purposes of the integrated model and for producing a conservative estimate of flood risk. This would require two different storm durations to occur within adjacent catchments which has not been investigated through detailed hydrological analysis.

10.1.6 As the integrated model is to provide comparison to the fluvial model and surface water drainage model, no calibration exercise has been carried out.

10.1.7 As the integrated model is to provide comparison to the fluvial model and surface water drainage model, no sensitivity analysis has been carried out.

10.1.8 The pipe network clean-up has been restricted only to check negative slopes. Detailed checks of the network throughout the model domain was not in the scope of this study.

10.1.9 Maximum water level / depth difference maps between the Future Baseline and with-Project scenarios are not provided for the integrated model due to the variable 2D mesh used within InfoWorks ICM software. Due to the variable mesh, the 2D model grid is not identical between scenarios and therefore difference maps would be obscured by the difference in mesh.

10.1.10 Minor differences in maximum flood extent and depths outside of the Project Boundary were found to occur between the Future Baseline and With-Project scenarios within the integrated model results. These differences were solely due to the 2D variable mesh and not a result of the Project. Because the flood mechanism at these locations outside of the Project Boundary is purely fluvial, the fluvial model should be used to infer model results at these locations.

11 Conclusion

11.1.1 A hydraulic model has been constructed combining both the surface water drainage model and the River Mole fluvial model. The model has then been run as a sensitivity analysis to identify if there are any additional flood risks to and from the Project as a result of the interaction between the airfield surface water drainage network and principal watercourses.

11.1.2 The model was updated to reflect the proposed Project elements and re-run for comparison to the Future Baseline to understand the Project impact upon surface water and fluvial flood risk across Gatwick airport and to receptors. As per the surface water drainage and River Mole fluvial models, the model was used to represent the surface water drainage and fluvial mitigation strategy.

11.1.3 When considering the comparison of the integrated model to the fluvial and surface water drainage models, the integrated model has reflected the fluvial and surface water model results with additional areas of flooding shown to occur across Gatwick airfield due to the interaction between the two sources of flooding.

11.1.4 When considering surface water flood risk, a general increase in flood extent across Gatwick airfield was found to occur as a result of the Project. However, due to the proposed mitigations the Project would not increase peak rates of runoff or discharge volumes to receiving watercourses for all events up to and including the 1% (1 in 100) AEP event plus an allowance for climate change of 40%.

11.1.5 When considering fluvial flood risk, a general reduction in flood extent across Gatwick airfield was found to occur as a result of the Project. The integrated model was found to reflect the results of the fluvial model with slight increases in flood extents at the upper extent of the River Mole at the Charlwood Road crossing.

12 References

Arup (2022) Gatwick NRP – Highways Mitigations. 41700-XX-S-SBR-REP-200001.pdf

DEFRA (2022) DEFRA Data Download: https://environment.data.gov.uk/DefraDataDownload/?Mode=survey

Innovyze.(2018) https://www.innovyze.com/en-us/blog/troubleshooting-hydraulic-models-in-infoworks-icm,

13 Glossary

13.1 Glossary of terms

Table 13.1.1 Glossary of terms

Term	Description
ES	Environmental Statement
Flood Modeller	Flood Modeller 1D modelling software
FRA	Flood Risk Assessment
FSA	Flood Storage Area
ICM	InfoWorks Integrated Catchment Modelling software
LiDAR	Light Detection and Ranging A remote sensing technique to map the earth's surface
RET-ER	Rapid Exit Taxiway Echo Romeo
RTC	Real-Time controls for operational structures within InfoWorks ICM
TUFLOW	TUFLOW 2D modelling software

14 Figures

14.1 Integrated model compared to fluvial model

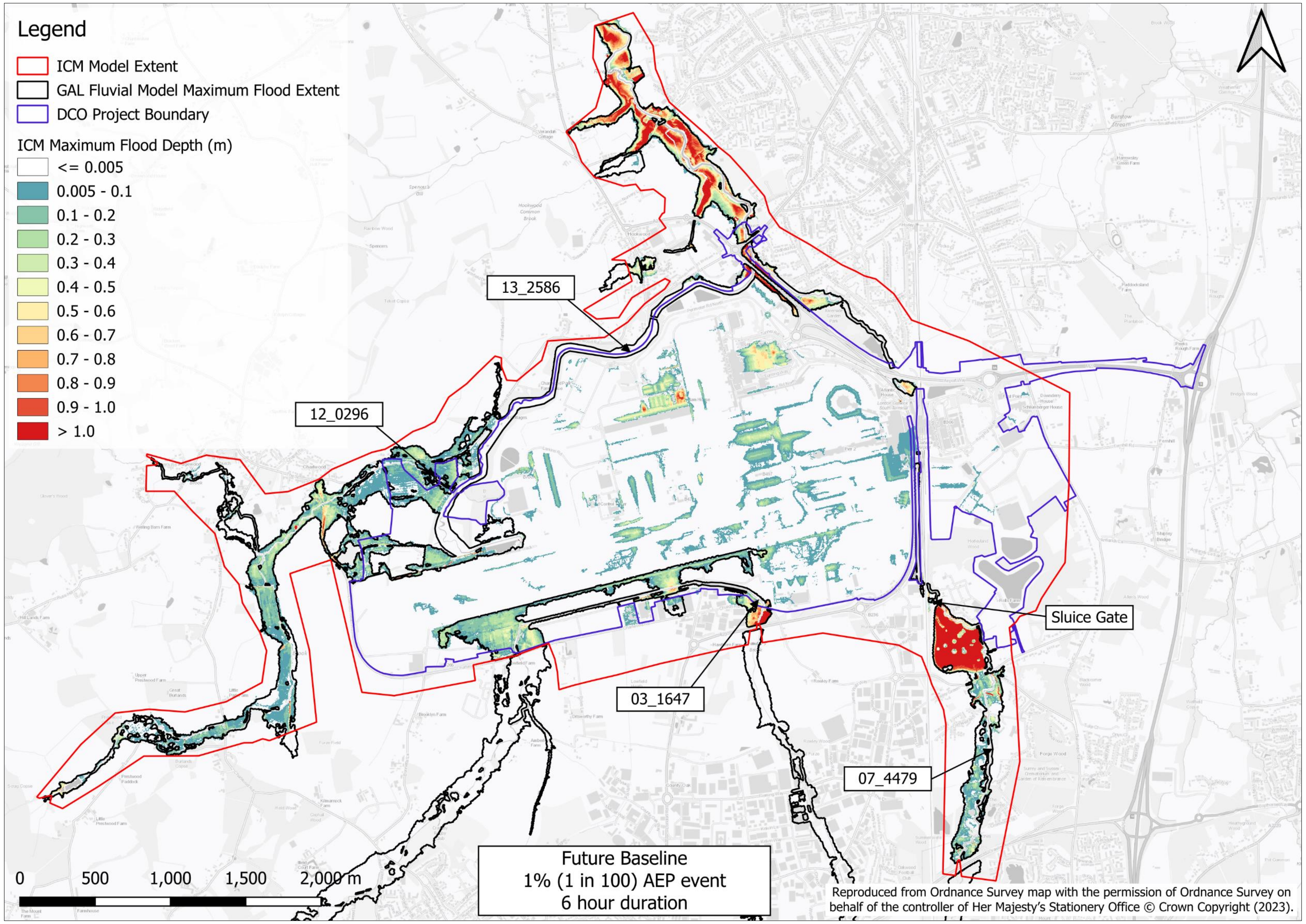


Figure 14.1.1 Future Baseline - Integrated model maximum flood depth compared to fluvial model maximum flood extent for the 1% (1 in 100) AEP 6-hour event

14.2 Future Baseline maximum flood depths

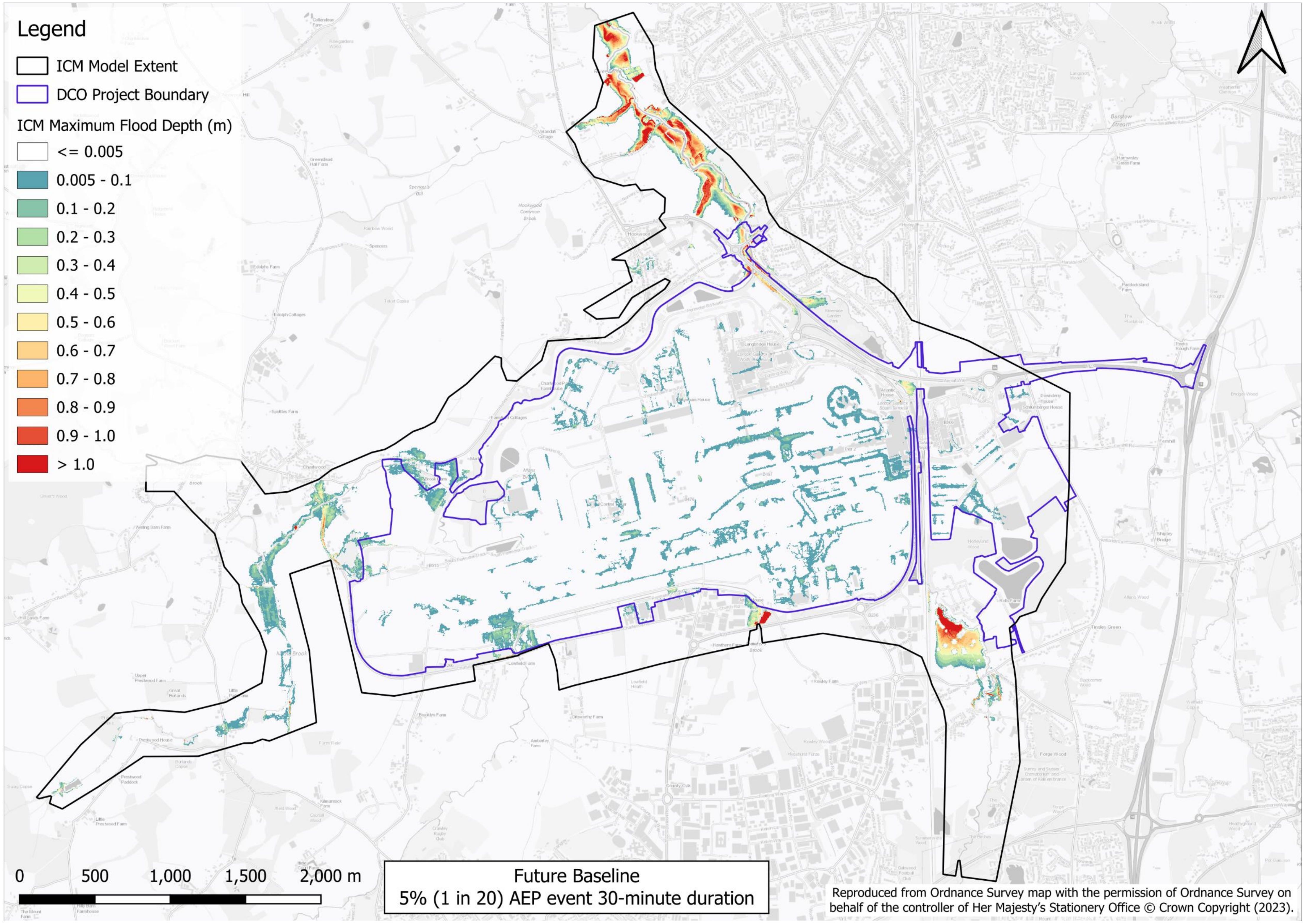


Figure 14.2.1 Future Baseline maximum flood depths for the 5% (1 in 20) AEP event 30-minute storm duration

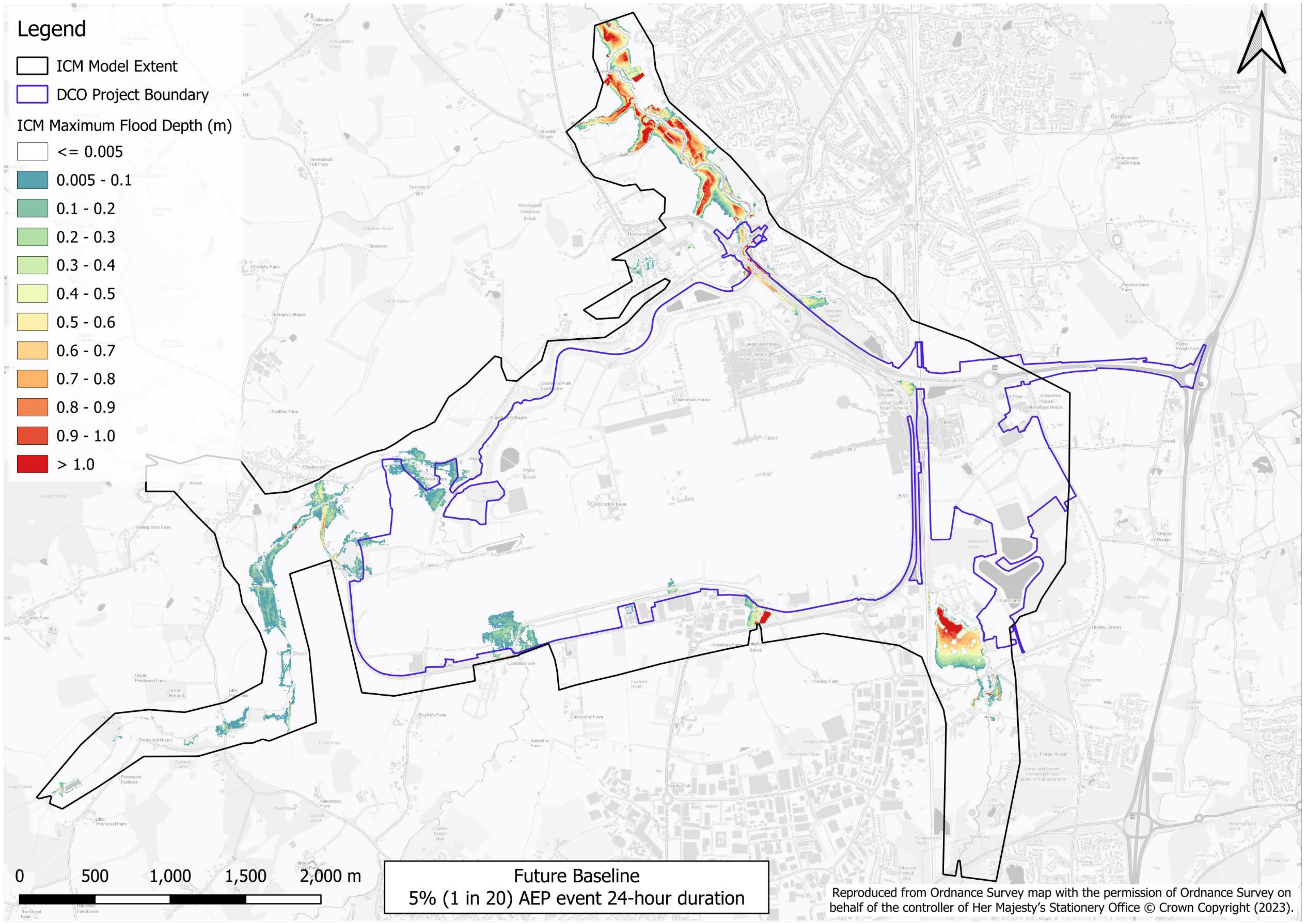


Figure 14.2.2 Future Baseline maximum flood depths for the 5% (1 in 20) AEP event 24-hour storm duration

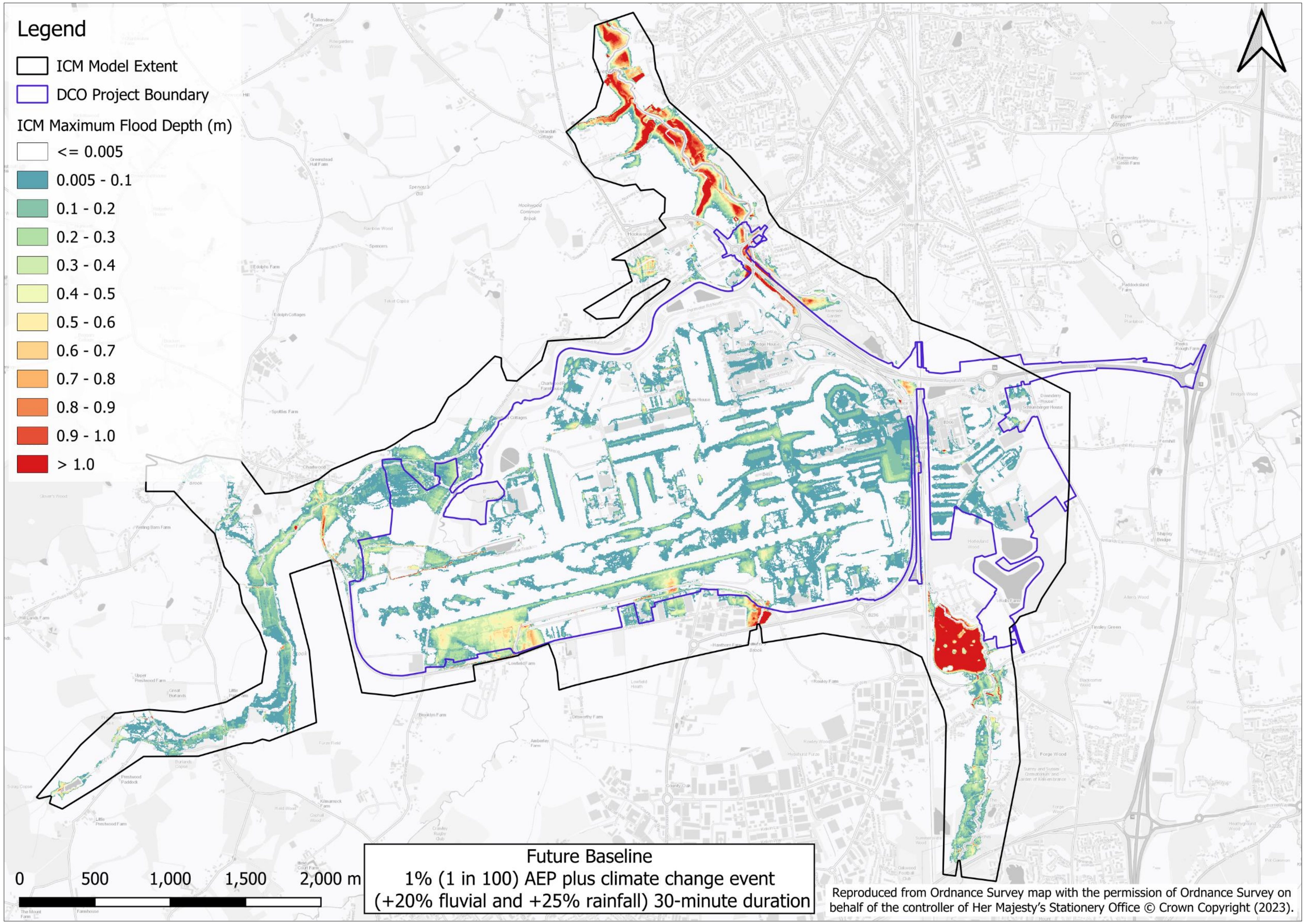


Figure 14.2.3 Future Baseline maximum flood depths for the 1% (1 in 100) AEP +20% fluvial and + 25% rainfall event 30-minute storm duration

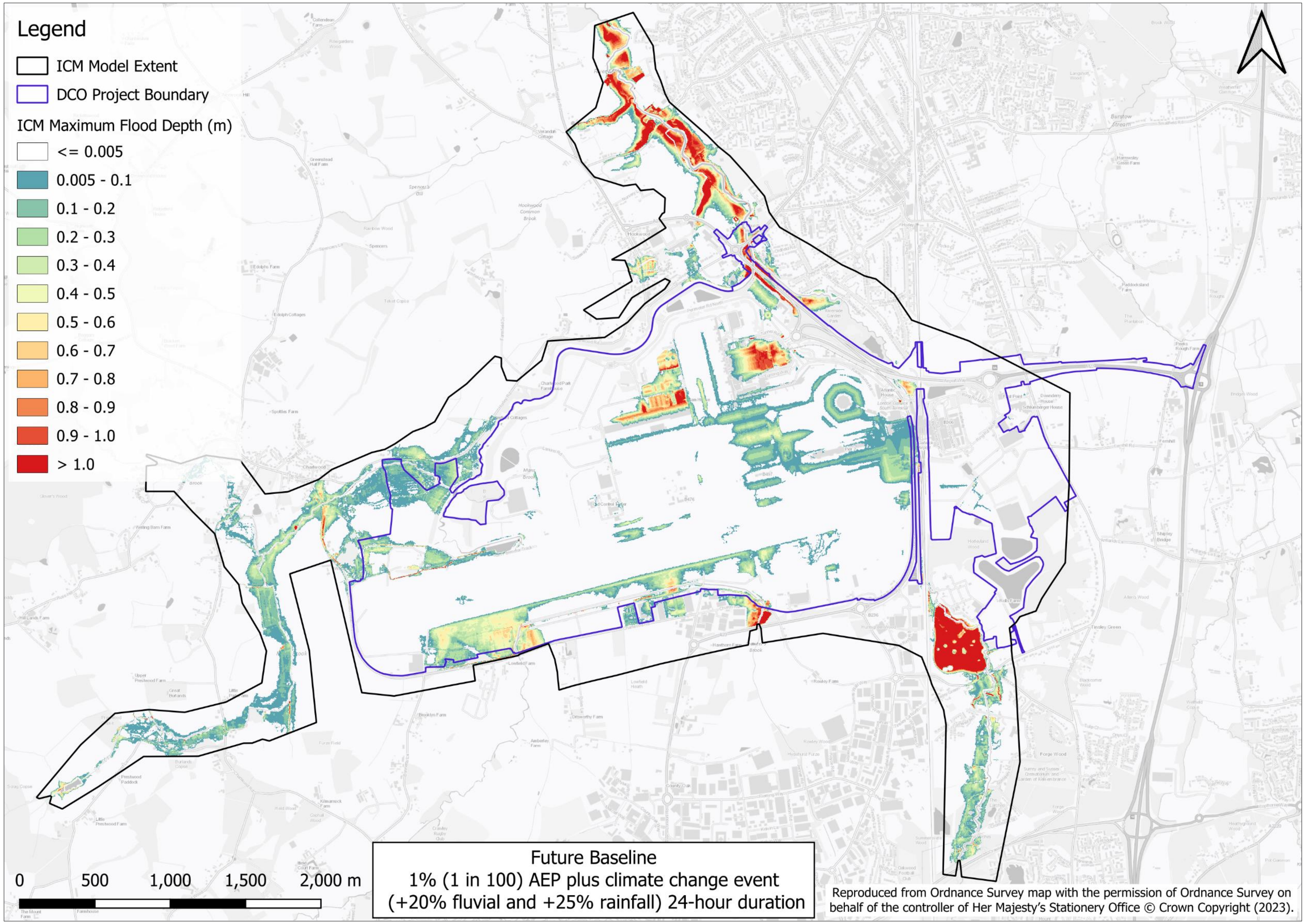


Figure 14.2.4 Future Baseline maximum flood depths for the 1% (1 in 100) AEP +20% fluvial and + 25% rainfall event 24-hour storm duration

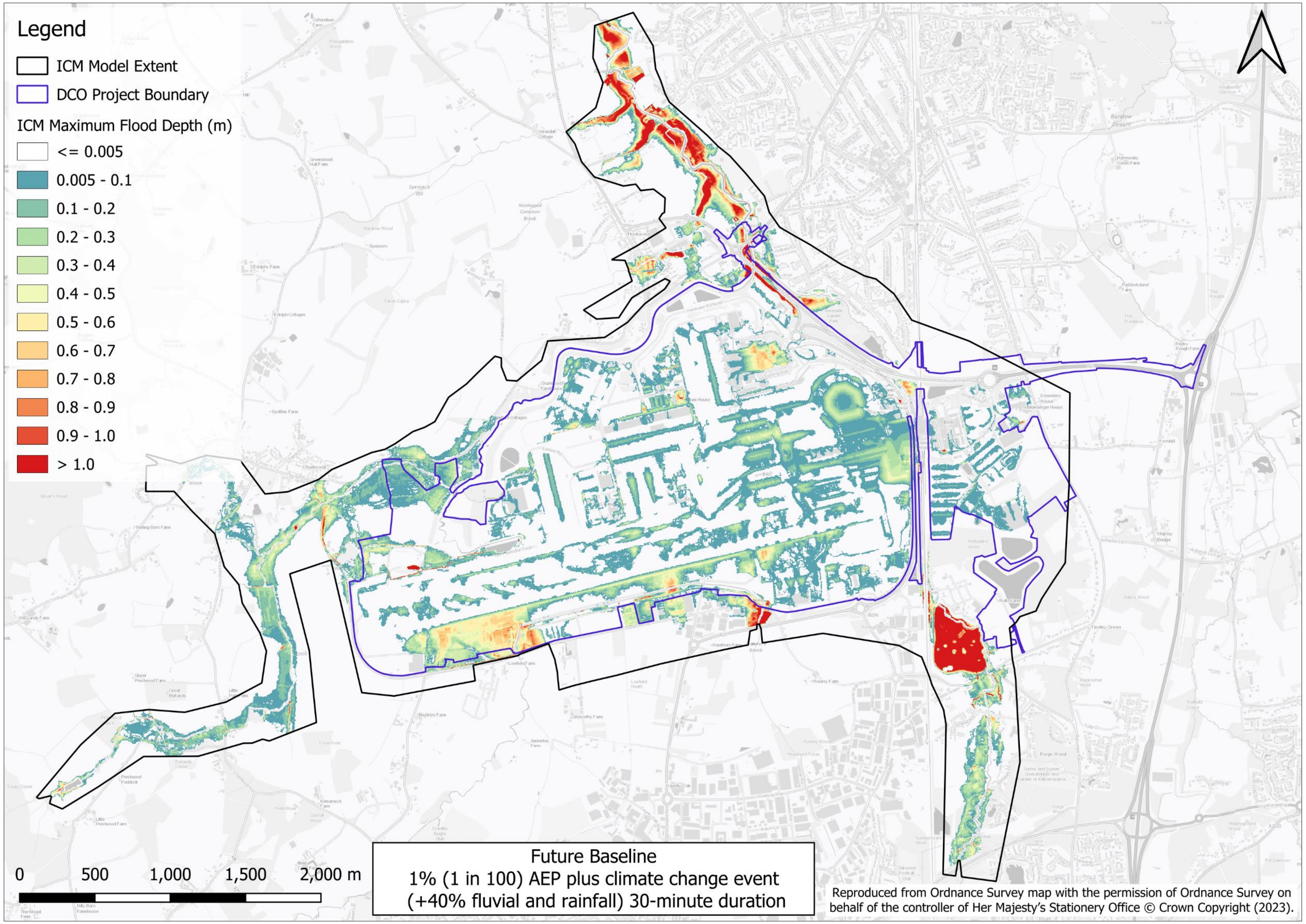


Figure 14.2.5 Future Baseline maximum flood depths for the 1% (1 in 100) AEP + 40% event 30-minute storm duration

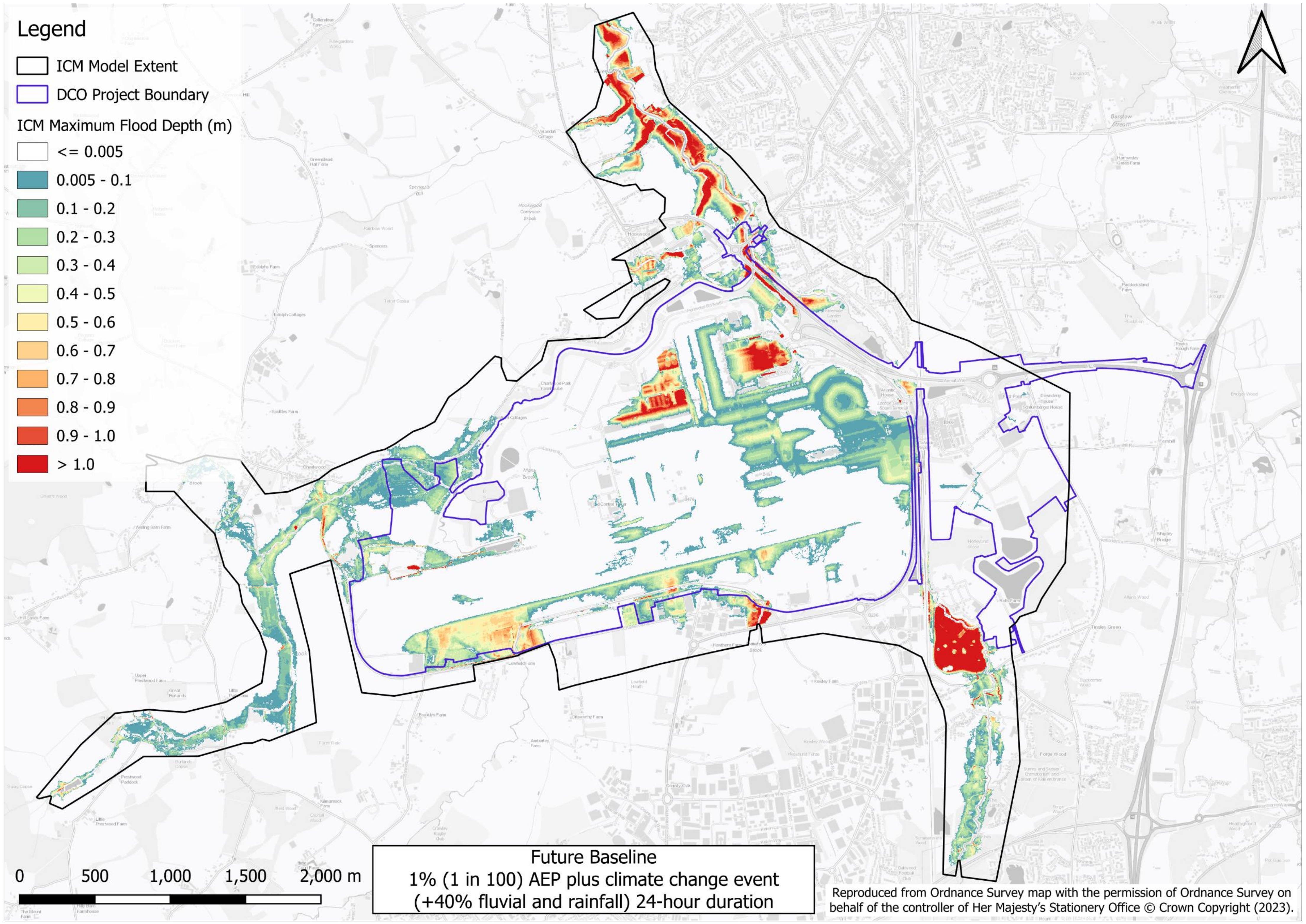


Figure 14.2.6 Future Baseline maximum flood depths for the 1% (1 in 100) AEP + 40% event 24-hour storm duration

14.3 With-Project maximum flood depths

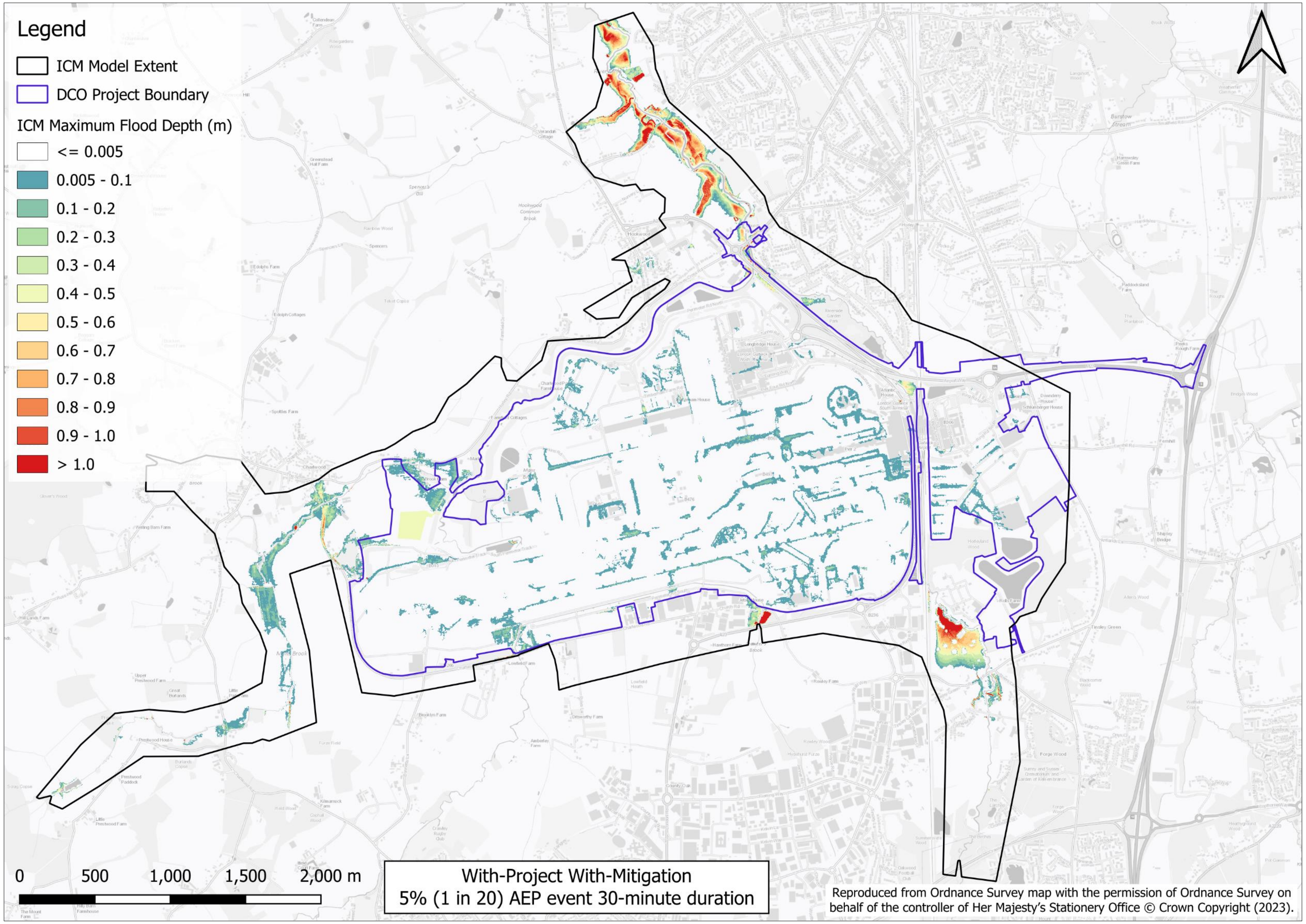


Figure 14.3.1 With-Project maximum flood depths for the 5% (1 in 20) AEP event 30-minute storm duration

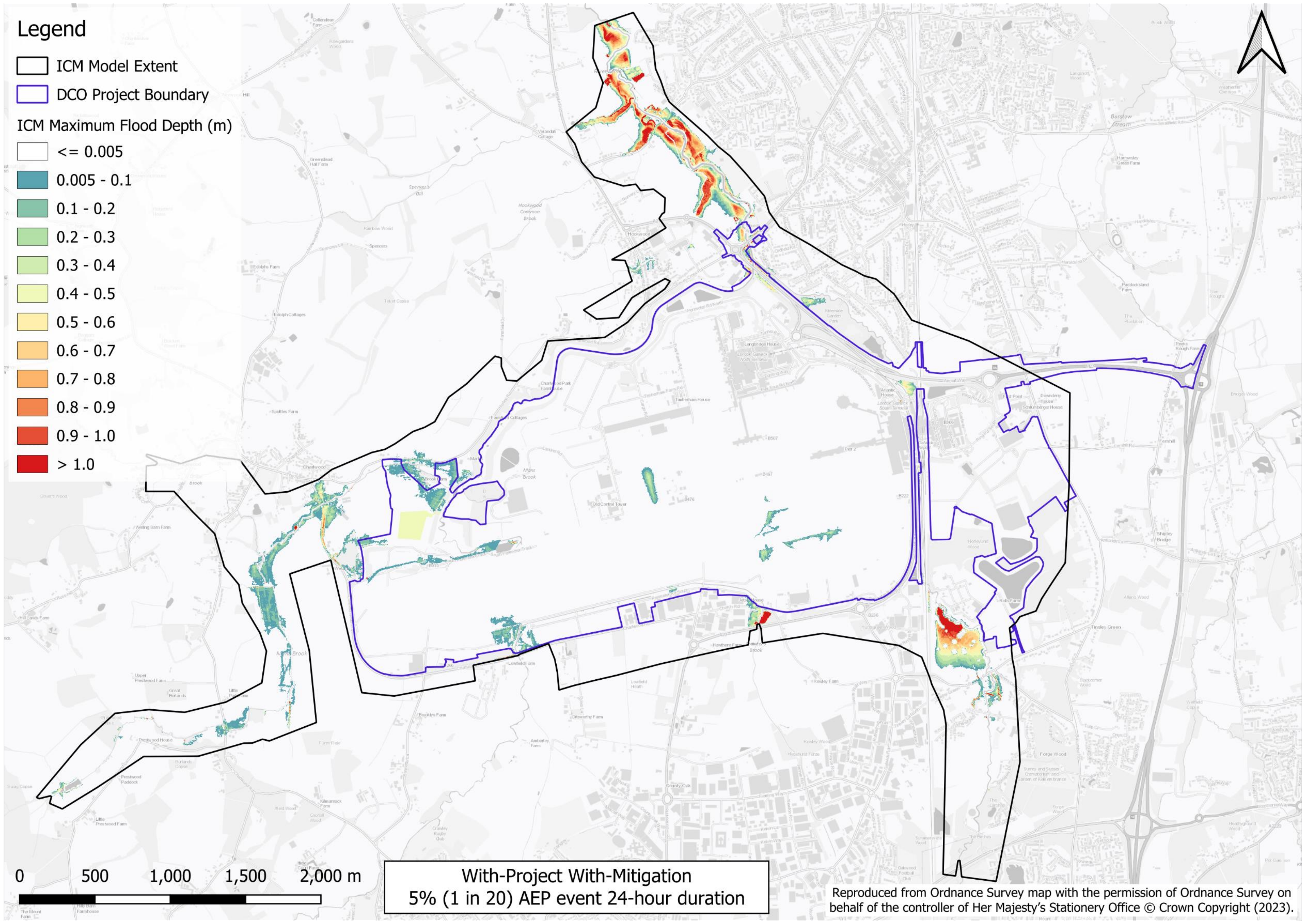


Figure 14.3.2 With-Project maximum flood depths for the 5% (1 in 20) AEP event 24-hour storm duration

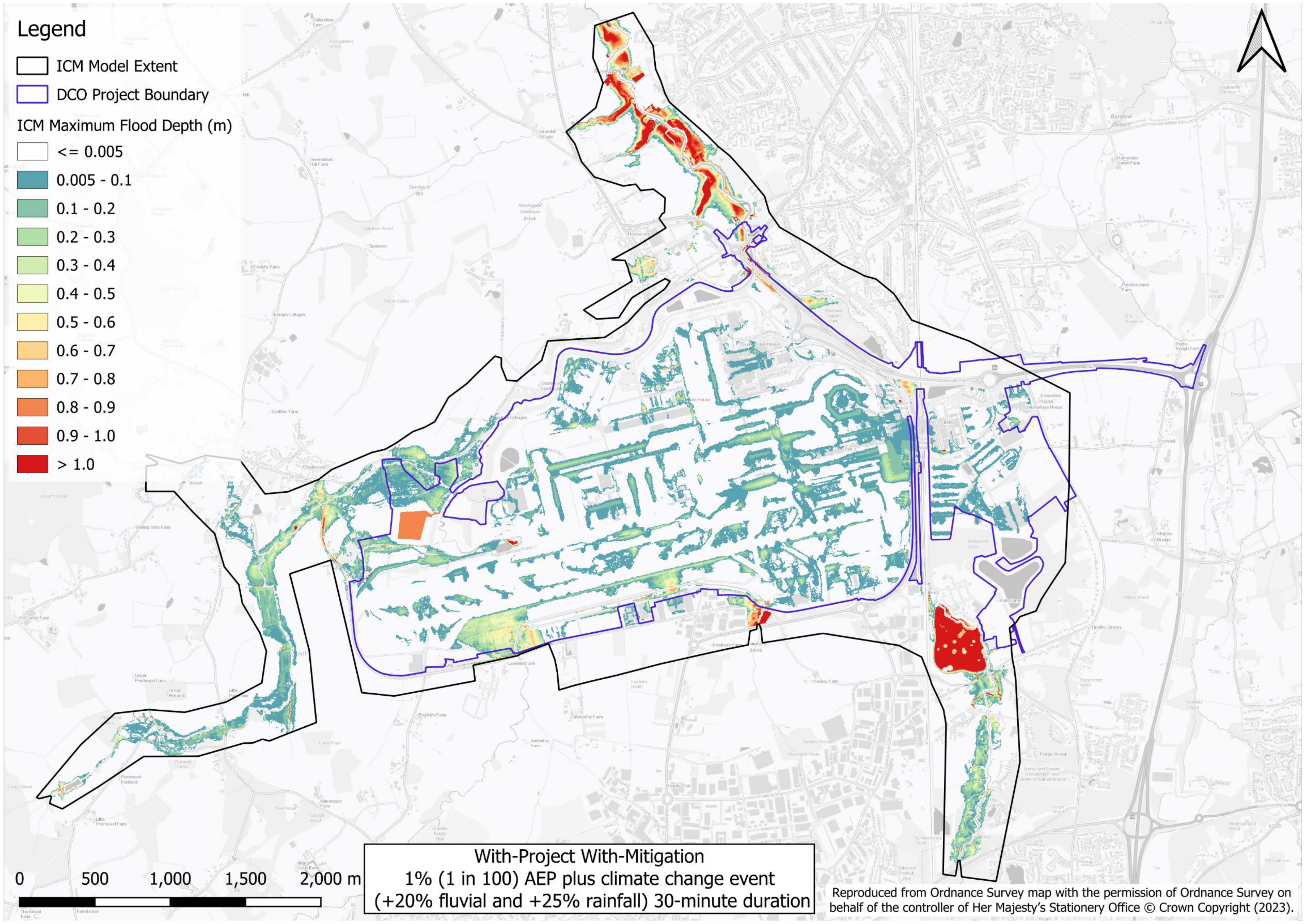


Figure 14.3.3 With-Project maximum flood depths for the 1% (1 in 100) AEP +20% fluvial and + 25% rainfall event 30-minute storm duration

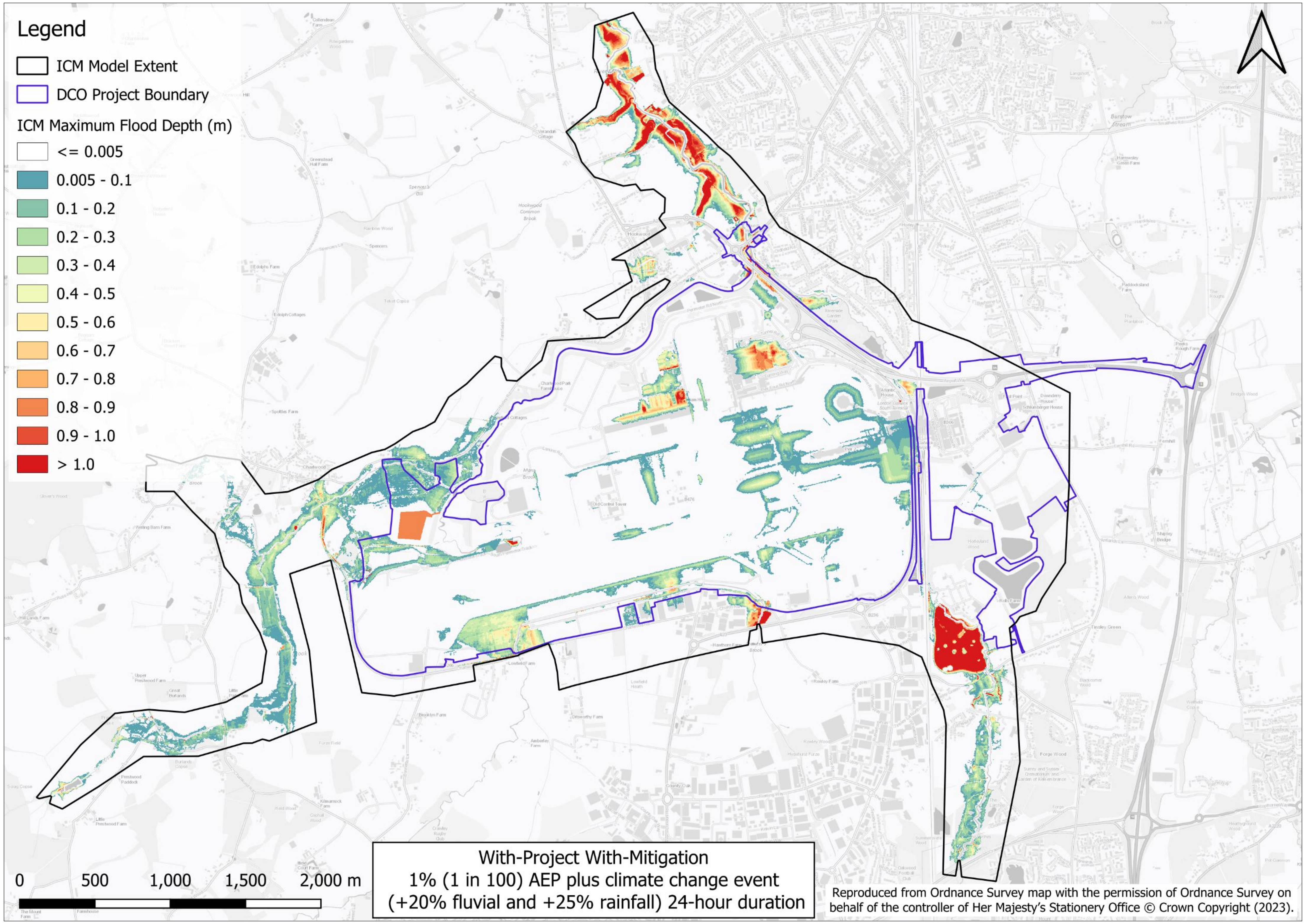


Figure 14.3.4 With-Project maximum flood depths for the 1% (1 in 100) AEP +20% fluvial and + 25% rainfall event 24-hour storm duration

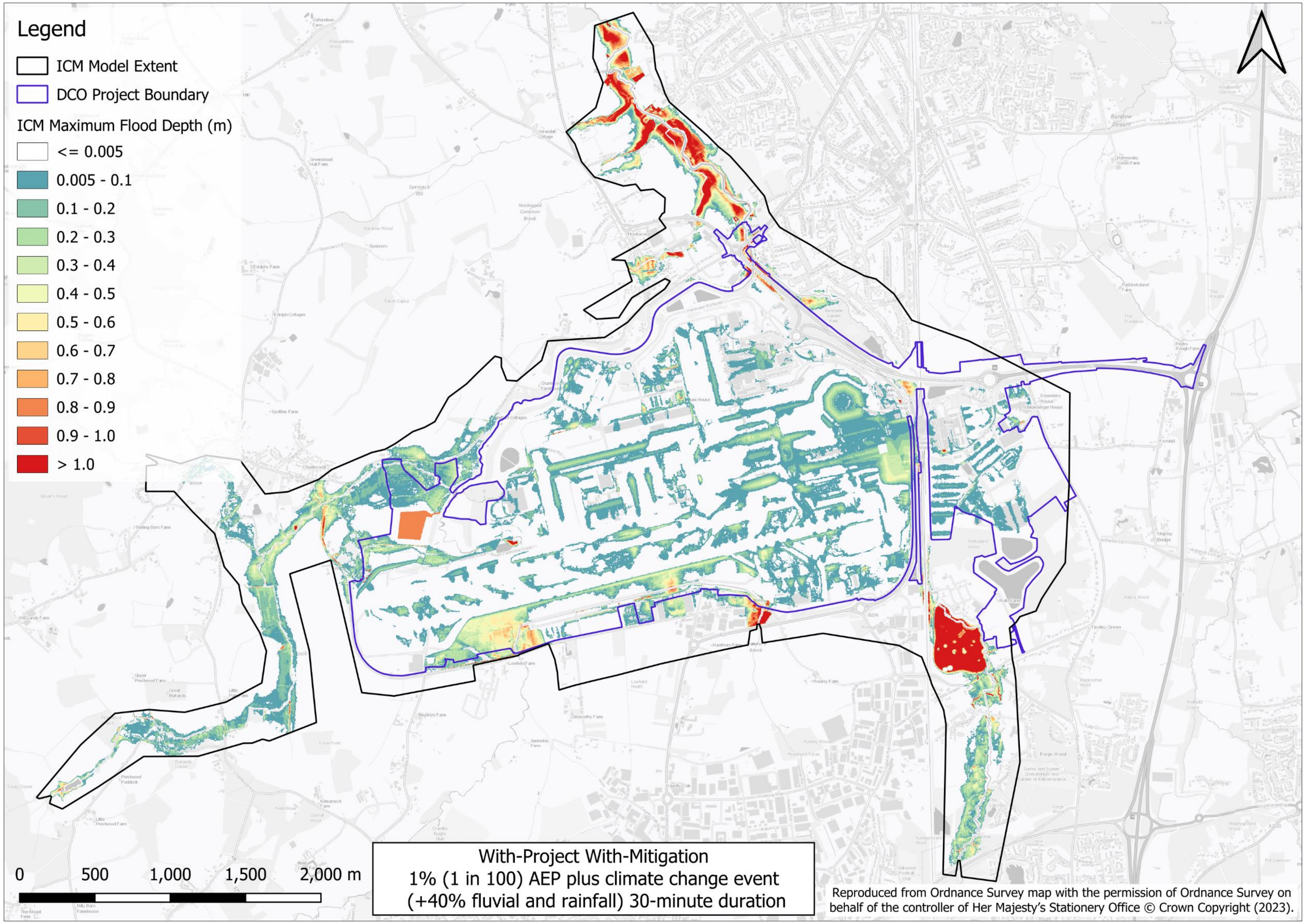


Figure 14.3.5 With-Project maximum flood depths for the 1% (1 in 100) AEP + 40% event 30-minute storm duration

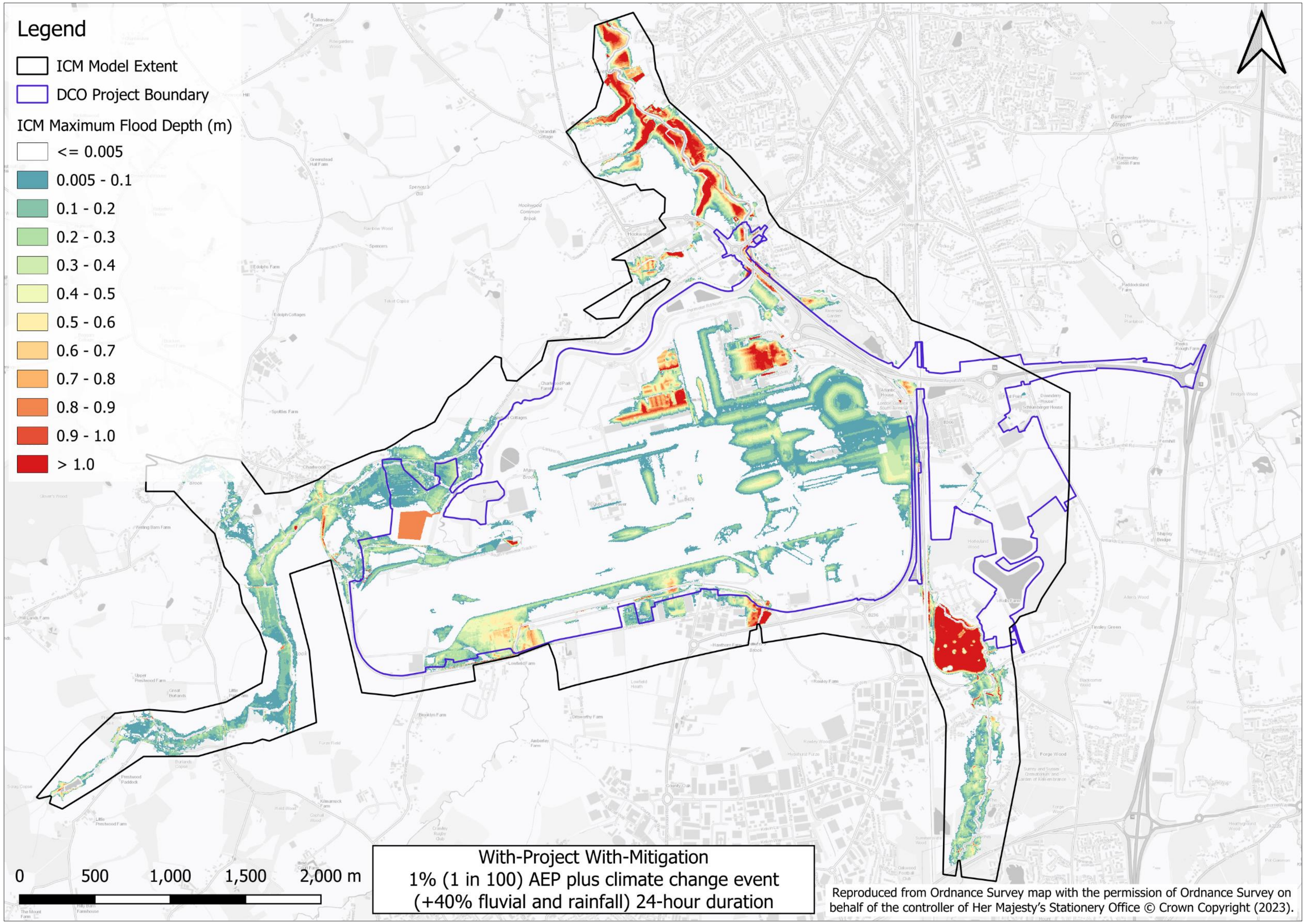


Figure 14.3.6 With-Project maximum flood depths for the 1% (1 in 100) AEP + 40% event 24-hour storm duration

14.4 With-Project vs future baseline maximum flood extents

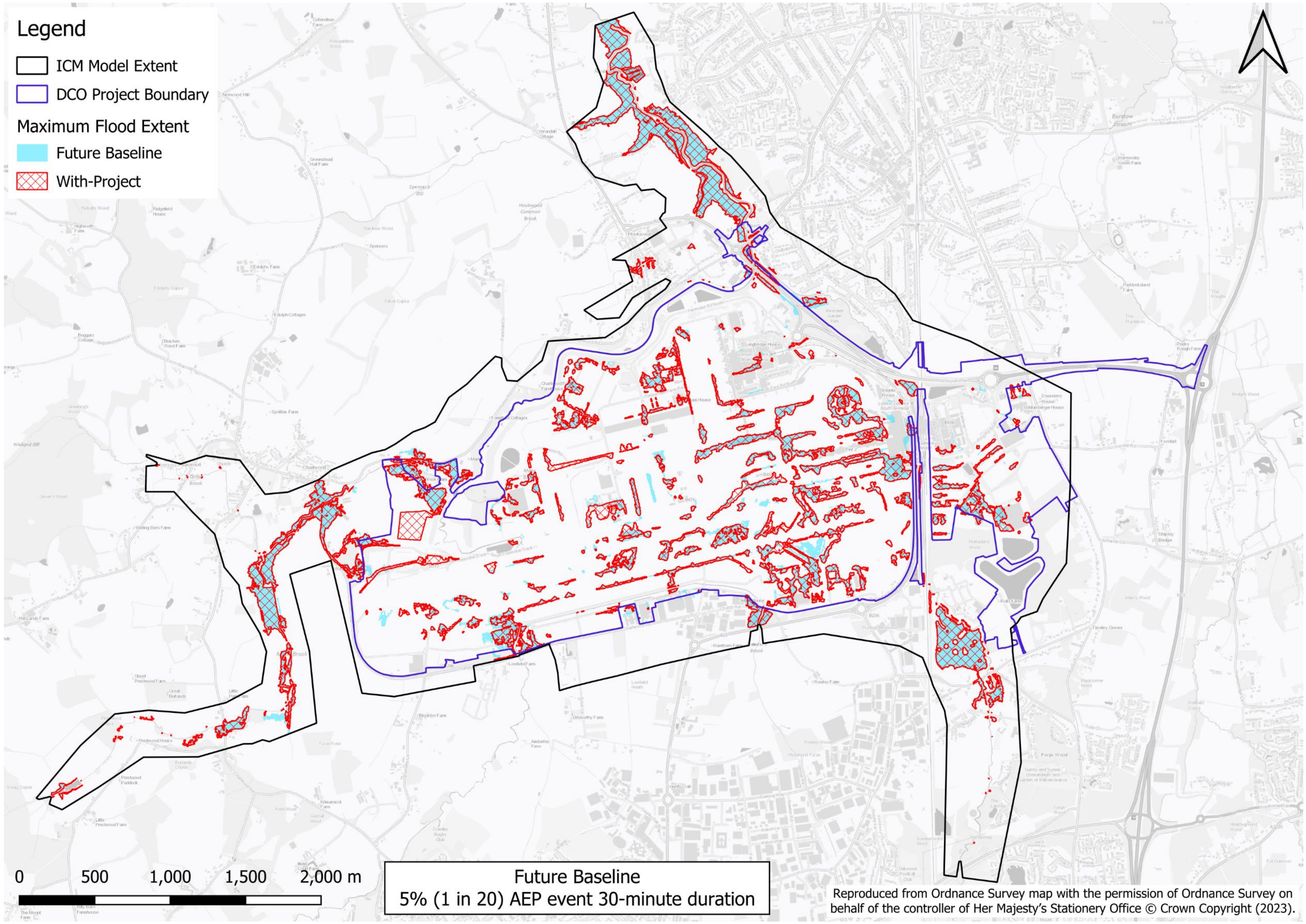


Figure 14.4.1 With-Project vs future baseline maximum flood extents for the 5% (1 in 20) AEP event 30-minute storm duration

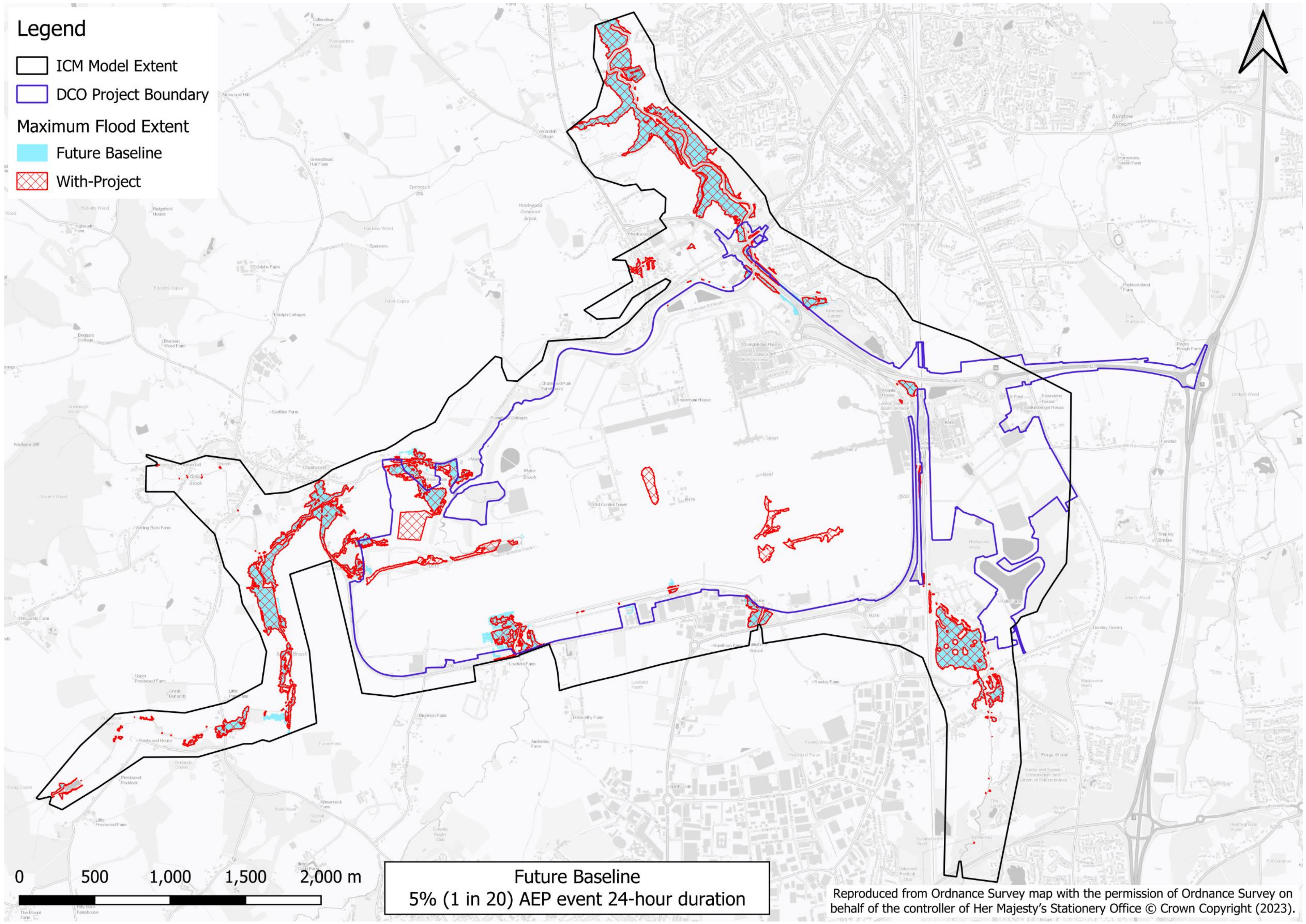


Figure 14.4.2 With-Project vs future baseline maximum flood extents for the 5% (1 in 20) AEP event 24-hour storm duration

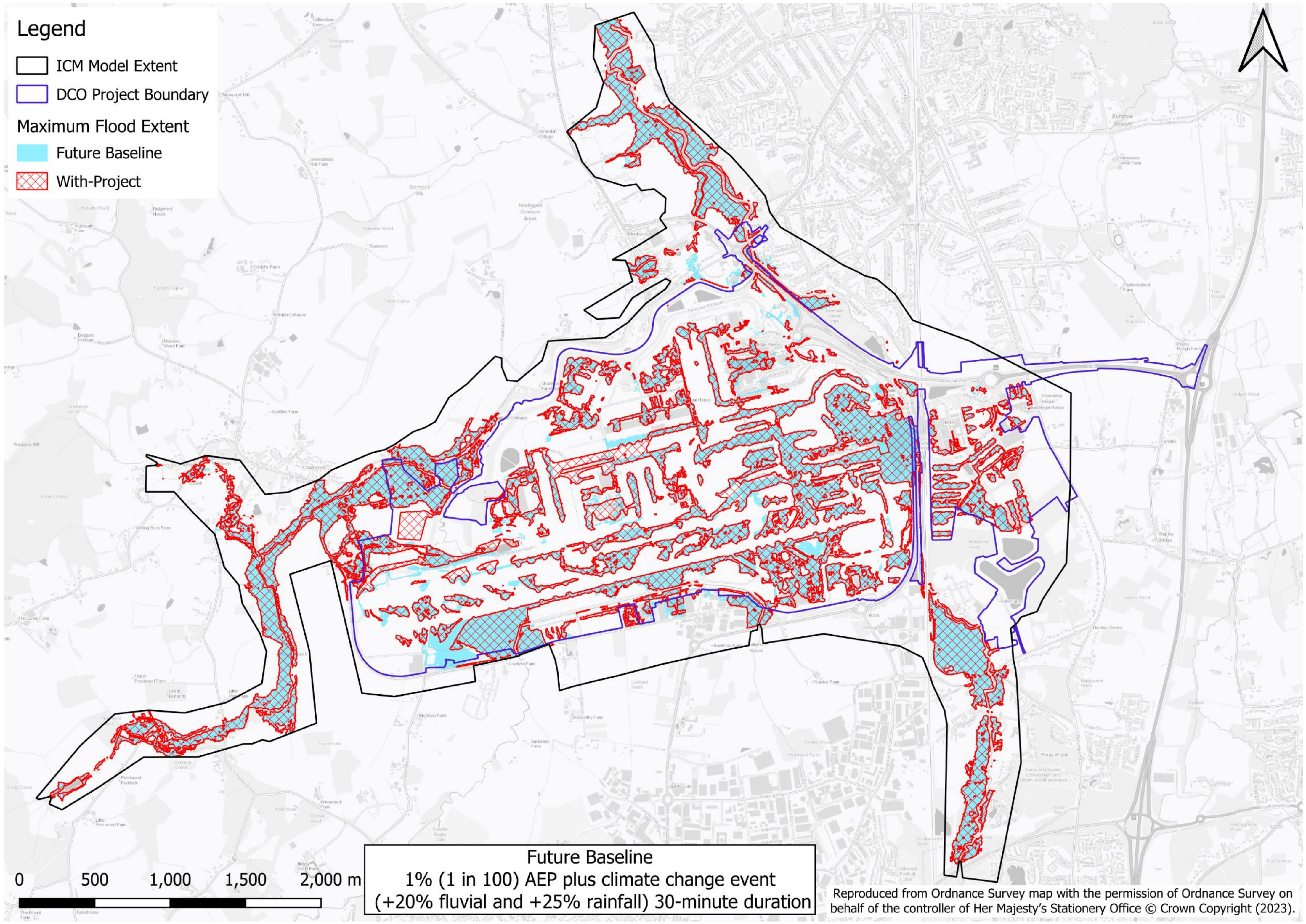


Figure 14.4.3 With-Project vs future baseline maximum flood extents for the 1% (1 in 100) AEP +20% fluvial and + 25% rainfall event 30-minute storm duration

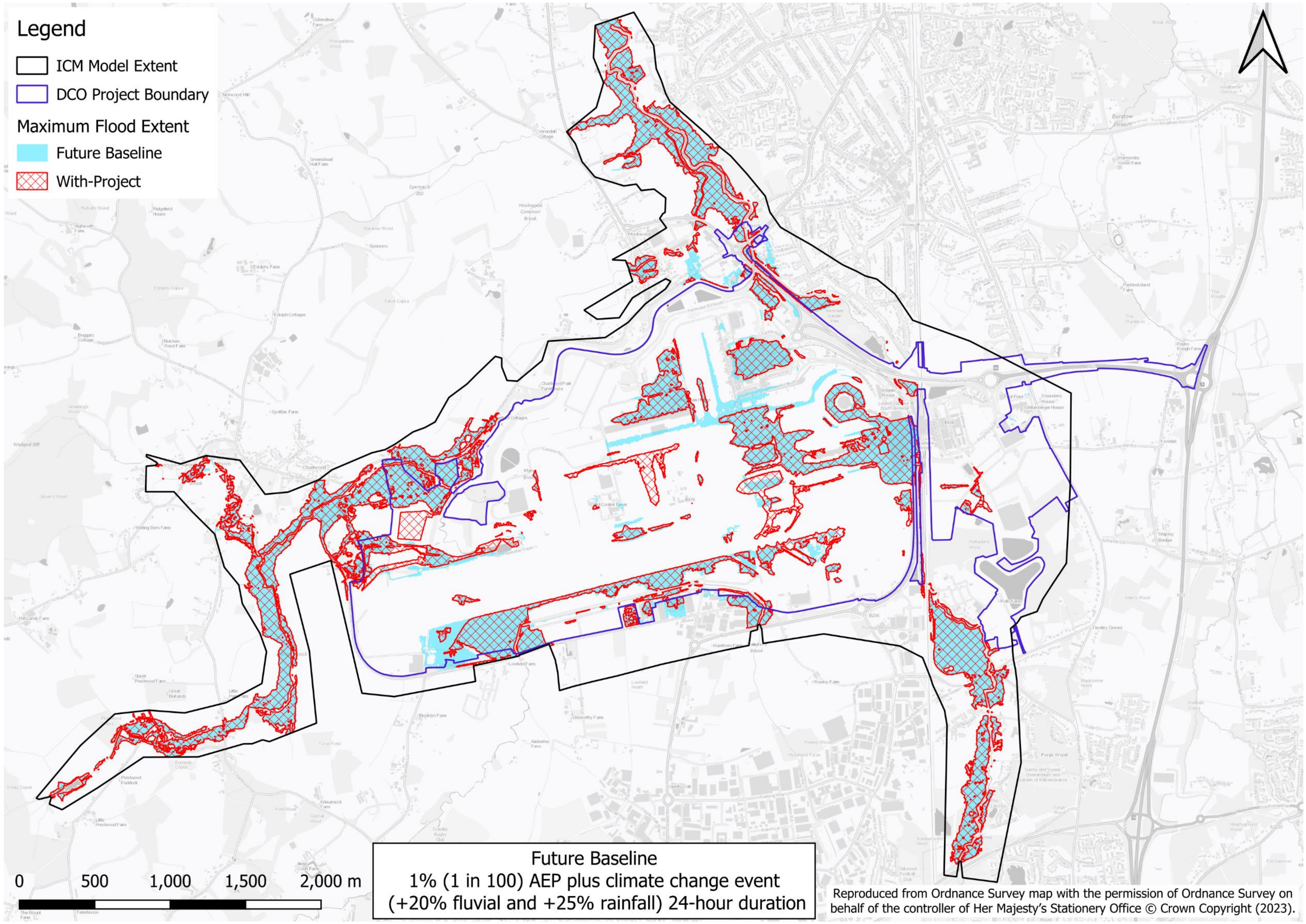


Figure 14.4.4 With-Project vs future baseline maximum flood extents for the 1% (1 in 100) AEP +20% fluvial and + 25% rainfall event 24-hour storm duration

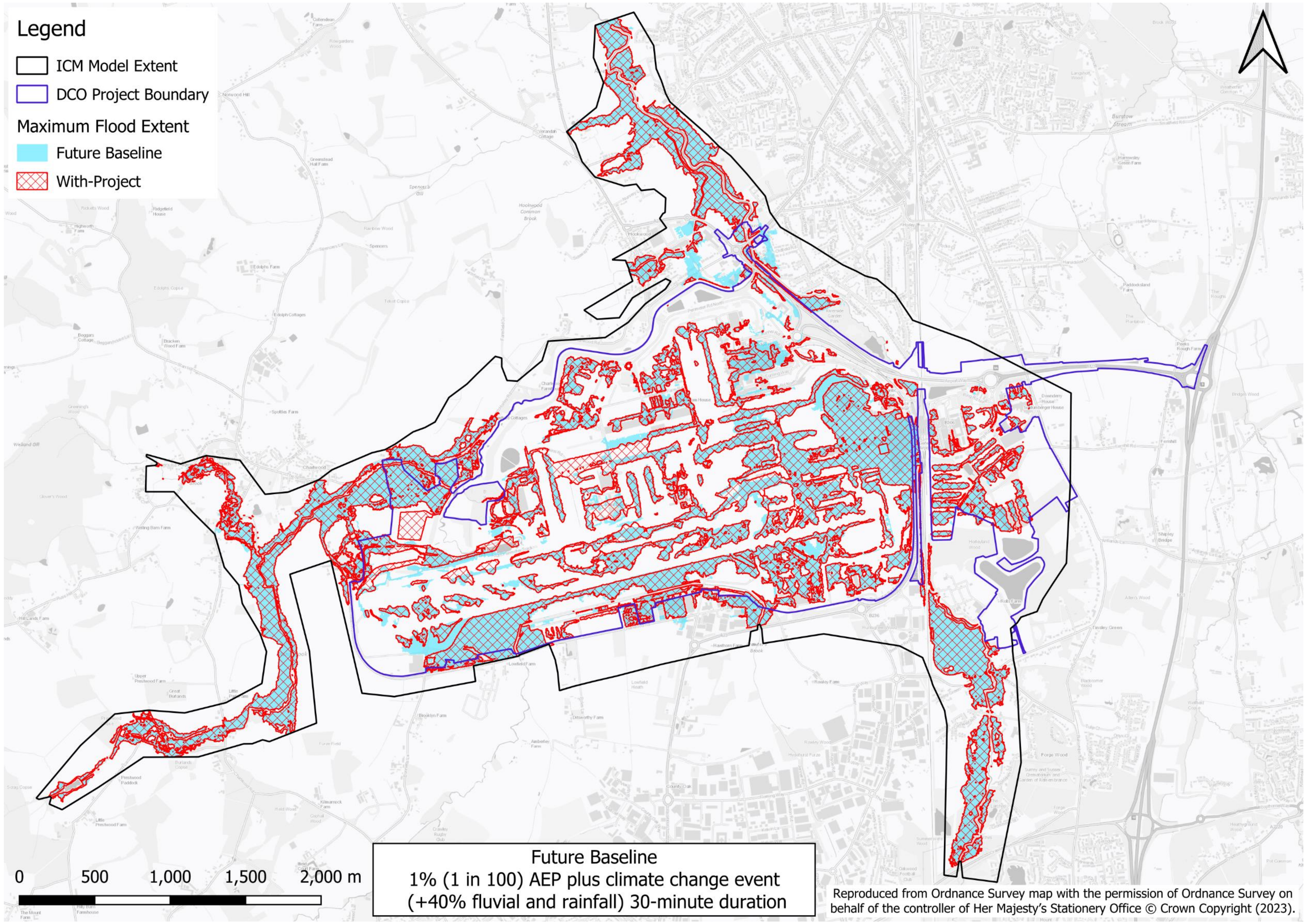


Figure 14.4.5 With-Project vs future baseline maximum flood extents for the 1% (1 in 100) AEP + 40% event 30-minute storm duration

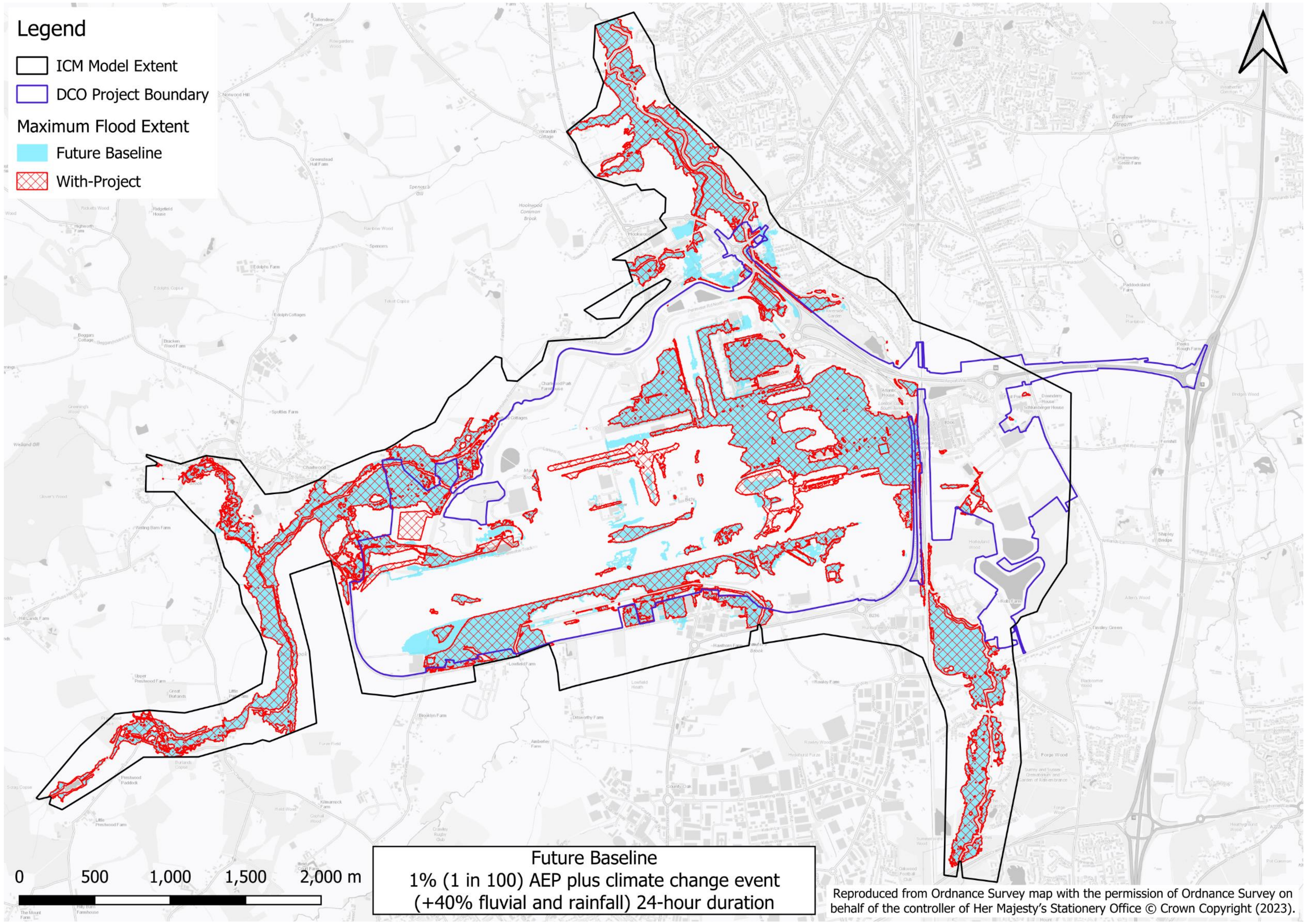


Figure 14.4.6 With-Project vs future baseline maximum flood extents for the 1% (1 in 100) AEP + 40% event 24-hour storm duration

Annex 5

Fluvial Hydraulic Model Build Report

Table of Contents

1 Introduction

1.1.1 This document is an update to the original version included in the DCO application submission to provide additional information only. This update collates information available elsewhere in the application into a single location to assist the reader's understanding of the nature of the Project and its representation in the hydraulic model. No new substantive impacts have been identified and the conclusions reported in the original report are unchanged.

1.2 Purpose of modelling

1.2.1 This document forms Annex 5 to **ES Appendix 11.9.6: Flood Risk Assessment** (FRA) [AS-078] of the Environmental Statement (ES) prepared on behalf of London Gatwick Airport (Gatwick). The ES presents the findings of the Environmental Impact Assessment (EIA) process for the proposal to make best use of Gatwick Airport's existing runways and infrastructure (referred to within this report as 'the Project'). The Project proposes alterations to the existing northern runway which, together with the lifting of the current restrictions on its use, would enable dual runway operations. The Project includes the development of a range of infrastructure and facilities which, with the alterations to the northern runway, would enable the airport passenger and aircraft operations to increase. Further details regarding the components of the Project can be found in the **ES Chapter 5: Project Description [APP-030]**.

1.2.2 This report supports **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078]. The FRA assesses the risk to and because of the Project for all sources of flooding for its lifetime including the consideration of climate change to demonstrate compliance with national planning policy. This annex documents the fluvial hydraulic modelling undertaken to inform the FRA. It details the hydraulic model schematisation of the different scenarios simulated and assumptions and limitations associated with the modelling work undertaken. Modelling results are not discussed in this report as they are reported in the FRA.

1.2.3 The principle sources of flooding to the Project are fluvial and surface water. The FRA has therefore assessed these sources and the impact of the Project on them through hydraulic modelling. Fluvial flood risk has been assessed via use of the Flood Modeller-TUFLOW River Mole fluvial model (also known as Upper Mole hydraulic model), which represents flood risk associated with out of bank flooding from the principal watercourses in the vicinity of Gatwick: Gatwick Stream, River Mole, Crawter's Brook and Man's Brook. Surface water flood risk has been considered through development of a separate InfoWorks ICM surface water drainage model which represents flood risk associated with surface water accumulation and the existing drainage network. In addition, integrated catchment modelling was undertaken to identify if there are any additional flood risks to the Project as a result of the interaction between the airfield surface water drainage network and principal watercourses.

1.2.4 Further details of the surface water drainage modelling are provided in **Annex 3** and details of the integrated catchment modelling are provided in **Annex 4** of **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].

1.2.5 The River Mole fluvial model has been produced in partnership with the Environment Agency (EA) since 2018 to allow for assessment of fluvial flood risk in the catchment. The model, which applies current best practice and makes use of quality reviewed local data, is considered to produce reliable results. The model has been calibrated based on three historic flood events (between 2000 and 2002) and an additional 2013 event has been used as the verification event.

1.2.6 The model has evolved since its original development in 2018 in order to incorporate recent changes to the airport infrastructure (including Larkins Road and Boeing Hangar) and modification of the representation in the model of structures upstream of Gatwick in Crawley by the EA.

1.2.7 The purpose of the fluvial hydraulic modelling is to assess the impact on the existing fluvial flood risk due to the Project. Then assess proposals to mitigate any increase of fluvial flood risk as a result of the Project and inform the **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].

1.3 Methodology

1.3.1 Fluvial modelling was undertaken using the Flood Modeller-TUFLOW River Mole fluvial one-dimensional (1D)- two-dimensional (2D) model of the Upper Mole catchment consisting of the Upper Mole and key tributaries such as Crawter’s Brook, Man’s Brook and Gatwick Stream.

1.3.2 The hydraulic model is based on a nested 1D/2D modelling approach whereby river reaches and in-channel structures are represented in the 1D model domain. The topography of the study area and surface features are represented within the 2D model domain which is dynamically linked to the 1D domain to allow propagation of flows onto the surrounding land when rivers overtop their banks or structures.

1.3.3 The Upper Mole model has been developed with Flood Modeller version 4.5 and 4.6 (double precision) and TUFLOW version 2018-03-AE-iDP-w64 (double precision). The model was not run in the latest software versions, to allow for comparison against 2019 EA/JBA model. A sensitivity test was run between the two models using FM v6.1 and TUFLOW 2020-10-AD where it showed negligible difference between results (in both 1D and 2D for two events and durations). Therefore a change of software version is not deemed necessary at this stage of design, as it would require model re-calibration.

1.3.4 The Baseline scenario was modified to include Project elements for the ‘with-Project’ scenario assessment. The new and amended areas of runway, buildings and highway re-alignments that would be delivered by the Project were included in the model. Details of these project elements are included **ES Chapter 5: Project Description [APP-030]**.

1.3.5 As an overview, the Project includes the following key components, also detailed below in Table 6.1 :

- repositioning of the existing northern runway 12 metres north (measured from the centreline of the existing northern runway);
- airfield works including repositioning and resurfacing of existing and constructing new taxiways, aircraft stands and an access track between the two runways;

- works to airfield support facilities including constructing a new pier, constructing and reconfiguring of aircraft stands, works to power facilities, and relocating the fire training ground and the Centre Area Recycling Enclosure (CARE) facility;
- works and extensions to the existing airport terminals (north and south);
- works to existing and construction of new hotels and offices;
- works to existing and construction of new car parks;
- surface access improvements, including active travel improvements and works to the M23 spur, the A23 London Road, Longbridge Roundabout, and the terminal roundabouts and forecourts;
- water treatment works and surface water and foul water improvements; and
- environmental mitigation works including establishing habitat enhancements.

1.3.6 Following the scenario changes made to the model, the Baseline and with-Project scenarios were simulated for the 10% (1 in 10), 3.33% (1 in 30), 1% (1 in 100) plus an allowance for Climate Change (CC) (see Section 3.2), 0.5% (1 in 200) and 0.1% (1 in 1000) Annual Exceedance Probability (AEP) events. The 0.1% (1 in 1000) AEP with-Project event has been paused due to instability.

1.3.7 Given the variability in catchment response across the contributary watercourses four critical storm durations (3, 6, 12 and 24-hour durations) were run for each event simulated In order to ensure that the worst case scenario is assessed and that the entire catchment is accounted for, the maximum flood depth across all four durations were combined into a single maximum flood extent, depth, levels etc. grids for analysis for each event. This approach was adopted to reflect the variations in catchment characteristics across the study area (e.g. difference in urbanisation, sub-catchment size and permeability) which result in variations in critical storm durations. For further details regarding the choice of critical durations an assessment was conducted in the 2018 Upper Mole Model Study.

1.3.8 The results of the with-Project scenarios were then compared to the Baseline to ascertain the un-mitigated impact of the Project. Where an increase in flood risk offsite was identified mitigation was developed and included to ensure no increase in offsite flood risk for the duration of the project incorporating the predicted effects of climate change. Any increases to flood risk onsite would be managed through Gatwick's existing flood management and response procedures as summarised in the **Flood Resilience Statement** (**ES Appendix 11.9.6: Annex 6** [APP-149]).

1.3.9 Other scenarios such as Undefended scenarios and Construction periods have been assessed as part of the fluvial modelling works and model setups are discussed in this report however the results of these scenarios are considered in the **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].

1.4 Study area

1.4.1 The study area is shown in **Figure 5-3** and focuses on the Upper Mole catchment, an area of 34.05 km^2. The model extends downstream to the west of Horley (NGR 527100 143200) in West Sussex. The study area includes a number of main rivers: the River Mole, Gatwick Stream, Crawter's Brook and Man's Brook. The principal area of interest is Gatwick Airport. The DCO site boundary shown in Figure 5-3 indicates the extents of the land owned and managed by Gatwick Airport. It is within these areas that mitigation works have been investigated to prevent any adverse impact on the existing flood risk from the Project.

1.4.2 Setup of the model extent is discussed in Section 5.1, and further information on the study area and Project is provided in **ES Chapter 4: Existing Site and Operation** [APP-029], **ES Chapter 5: Project Description** [APP-030] and **ES Chapter 11: Water Environment** [APP-036].

2 Input data

2.1.1 The data used to undertake the fluvial hydraulic modelling are summarised in Table 2.1.

Table 2.1: Input Data.

Data	Description	Source
2018 Upper Mole Hydraulic Model	Upper Mole Fluvial Flood Modelling Study (Jacobs 2018) which has been approved by the EA. This was the base model for the Project. The model is 1D/2D linked hydraulic model of the Upper Mole catchment which includes `Gatwick Airport.	London Gatwick Airport / EA
JBA/EA model updates – 24th December 2019	Model updated reference JBA document – 2017s6336-U-N002-3	JBA / EA
Upper Model updates - 2022	Upper Mole Hydraulic Model Update Impact Summary memo (GAL NR Lower Mole Model EA Update Review Memo v01.pdf, Jacobs 2021) in response to the following updates made by JBA and the EA in 2019	London Gatwick Airport
Project Elements shapefiles	The Baseline model was modified to include elements that would not significantly affect the wider catchment but are important to the local assessment of flood risk and asset criticality on the airfield, such as changes to impermeable area within airfield and noise bund locations.	London Gatwick Airport
Proposed highways realignments at Gatwick South Terminal and North Terminal roundabouts and Longridge roundabout	The 3D drawings for the proposed alignments were supplied as AutoCAD Landxml drawings from ARUP consultants which were used to create an ascii layer to represent proposed highways levels.	ARUP
Project highways construction approach	Drawings and buildability report setting out the proposed highways improvements construction approach including temporary watercourse crossings pier locations,	ARUP
2m DTM Lidar – flown in 2022	The area to the west of the airfield, north of Pond A and River Mole, which included the extensive redevelopment of Boeing Hangar, Larkins Road and Pond M was updated using Lidar DTM flown in 2022, to a resolution of 2m.	EA

3 Hydrology

3.1 Inflow hydrographs

3.1.1 As part of the original Gatwick and EA modelling, covered in Upper Mole Fluvial Flood Modelling Study (Jacobs 2018), an extensive hydrological analysis was undertaken and reported. No modifications to that hydrological input data (i.e. inflow hydrographs representative of the flood events listed in Section 1.3) to the River Mole fluvial model have been made for this study with the exception of integrating to the model minor updates made by JBA in 2019 on behalf of the EA. A full description of these updates is available in the Upper Mole Hydraulic Model Update Impact Summary memo (GAL NR Lower Mole Model EA Update Review Memo v01.pdf, Jacobs 2021) and the JBA Upper Mole model update note (2017s6336-U-N002-3, JBA 2019) as listed in Table 2.1: Input Data.

3.2 Climate Change

3.2.1 The Baseline and with-Project scenarios have been run for the 10% (1 in 10), 5% (1 in 20), 3.33% (1 in 30), 0.5% (1 in 200) and 0.1% (1 in 1000) AEP events. Further simulations have been modelled using the 1% (1 in 100) AEP event with the following uplift to peak river flows:

- +12% (higher central) increase for airfield works (2050s epoch);
- +20% (higher central) increase for the access works (2080s epoch);
- +40% (upper end) increase tested as a credible maximum scenario; and
- +16% (higher central) increase for construction scenarios (2020s epoch)

3.2.2 This incorporates the predicted impact of climate change on peak river flows based on EA guidance (Environment Agency, 2022). These allowance to be made for the predicted impact of climate change on peak river flows is subject to the river basin district, in this case identified as the Mole Management Catchment, informed by the current Flood Risk Assessments: Climate Change Allowances guidance published in February 2016, last updated in May 2022 (Environment Agency, 2022)

3.2.3 Further information is included in Section 3.7 of the **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].

4 Modelled events and scenarios

4.1.1 A summary of each scenario modelled is provided in Table 4.1. Details of each modelled scenario are provided in the subsequent sections.

Table 4.1: Model scenarios.

Scenario	Run ID	Description
Baseline	106C	Upper Mole Hydraulic Model updated to incorporate recent changes to the airport infrastructure specifically an update to Pond M, Larkins Road and Boeing Hangar ground surface as well as modification of the representation of the Gatwick FSA upstream of the DCO boundary as described in Section 5.1.
With-Project	570D	The Baseline model was updated to represent the Project surface access highways improvements and the airfield modifications. This model includes all fluvial mitigation measures listed in the Section 6.2.
Pre-Initial Construction period (2024)	611B	As a part of the construction of the Museum Field FCA, there will be a temporary haul road crossing of the River Mole during the Initial Construction Period (2024-2029) before any mitigation works. This scenario is a sensitivity test to ensure no mitigation measures are required for installation of the temporary crossing of the watercourse.
Initial Construction Period (2024 to 2029)	621B	All airfield (non-surface access) works not including: ▪ Taxiway Juliet West Spur ▪ End around taxiways ▪ Taxiways Whiskey, Victor and Zulu ▪ Exit/entrance taxiways from the main runway ▪ Temporary haul bridge installed over River Mole near Museum field ▪ Cark Park Z and Car Park Y construction compounds installed
First full year of opening period (2029 to 2032)	651B	▪ All airfield surface works complete ▪ Surface access works including Longbridge Roundabout, North Terminal, South Terminal, London Road Bridge and Brighton Road bridges ▪ Temporary utility and pedestrian bridges installed at London Road and Brighton Road Bridge works ▪ Longbridge and Car Park B compounds ▪ Temporary haul bridge over River Mole near Museum field removed
Undefended Baseline	901B	To compare like-for-like the Project's Upper Mole fluvial model against the EA published Flood Zone extents, when the presence of flood defences are ignored.
Undefended With-Project	801B	To assess the impact of the Project's effect on fluvial flood risk, assuming no mitigation would be in place. Results inform the **ES Appendix 11.9.6 Figure 6.2.1** [AS-078]. Also used to assess and understand the potential impacts to the Project should the proposed flood defences fail.

4.1.2

4.1.3 shows the modelled events and scenarios that were simulated with the River Mole fluvial model.

4.1.4 The predicted impact of climate change on peak river flow has been accounted for by simulating the 1% (1 in 100) AEP event with a +12%, +16%, +20% and +40% uplift on hydrological inflows to the model, based on EA guidance. Refer to Section 3.7 of the **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078] for a detailed reasoning of the climate change allowances adopted.

Table 4.2: Scenarios Modelled.

AEP Event*	Scenario Modelled				
	Baseline	With-Project	Construction Periods	Undefended Baseline	Undefended With-Scheme
10% (1 in 10)	✓	✓			
3.33% (1 in 30)	✓	✓			
1% (1 in 100)	✓	✓		✓	✓
1% (1 in 100) + 12% CC	✓	✓			
1% (1 in 100) + 16% CC	✓	✓	✓		
1% (1 in 100) + 20% CC	✓	✓			
1% (1 in 100) + 40% CC	✓	✓			
0.5% (1 in 200)	✓	✓			
0.1% (1 in 1000)	✓	✓(1)		✓	✓

* All scenarios run for four durations: 3hr, 6hr, 12hr and 24hr. The maximum outputs for all durations were combined and compared.
(1) 1000yr With-Project scenario currently unstable and not ready for sharing

5 Baseline model build

5.1 Baseline Model Updates

5.1.1 The Upper Mole Fluvial Flood Modelling Study (Jacobs 2018) was undertaken as a partnership between GAL and the EA (EA) and was adopted as the Baseline model for the Project. Following the Upper Mole study, the EA undertook its own updates by JBA consultants (2017s6336-U-N002-3, JBA 2019). This model was provided to Jacobs by the EA in November 2020 and the changes were incorporated into the Upper Mole hydraulic model for the Project impact assessment. The full list of EA model updates are included in Upper Mole Hydraulic Model Update Impact Summary (Jacobs, 2021). The modifications are not considered to significantly affect the wider catchment and particularly the predicted risk of flooding to Gatwick Airport but are important to the local assessment of flood risk and asset criticality on the airfield. These changes were accepted by the EA in their review of the Baseline hydraulic model in August 2023.

5.1.2 The fluvial model baseline scenario was not updated to include the Rapid Exit Taxiway Echo Romeo (RET-ER) as a part of the 'future baseline' works which would be undertaken in advance of the Project. This RET-ER is outside all modelled flood extents and therefore would not impact fluvial flood risk to the project.

North-western Airfield Representation

5.1.3 The DTM datasets used in Upper Mole Fluvial Flood Modelling Study (Jacobs 2018) were compared against the latest LiDAR data and aerial imagery. It was found that there was significant airport infrastructure development not included in the original 2015 LiDAR dataset, implemented in the 2D model. Therefore, a 'patch' was added using 2022 DTM 2m LiDAR, which covered Boeing Hangar, Larkins Road, Taxiway Lima and Pond M, see Figure 5-1.

5.1.4 No overall update to 2022 LiDAR has been made to the baseline, as a comparison of the ground surface in the model and latest LiDAR did not identify significant changes across the catchment apart from the areas updated by the 'patch'.

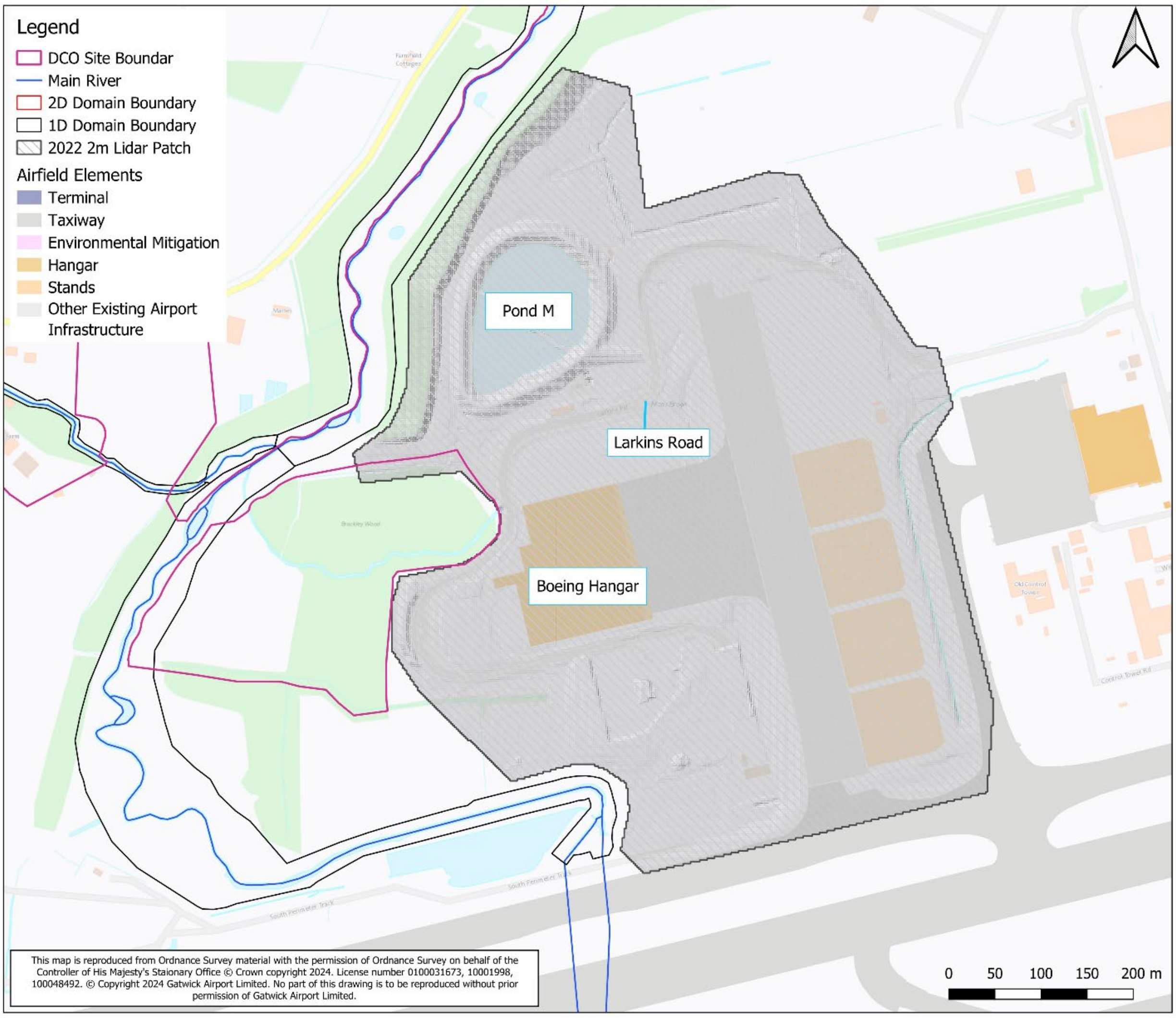


Figure 5-1: Updated 2022 LiDAR patch over Boeing Hangar and surrounding area

Schematisation of the Upper Mole Flood Alleviation Scheme (UMFAS)

5.1.5 Since the Upper Mole Fluvial Flood Modelling Study (Jacobs 2018), the Gatwick Stream Flood Alleviation Scheme (GSFAS) has been constructed. The GSFAS consists of a flood storage area (FSA) formed by a clay core impounding reservoir with a capacity of 186,000m^3, constructed to reduce the risk of flooding from the Gatwick Stream. The structure and flood storage area are located on GAL-owned land between the London to Brighton Railway line and the Thames Water Crawley Sewage Treatment Works (STW). There is a concrete structure through which the Gatwick Stream passes which contains two sluice gates (1 and 2) which automatically function to restrict flow when required based on a level gauge at South Terminal and in doing so to back the river up to the spillway (near Radford Road bridge) and fill the flood storage area, see **Figure 5-2**

5.1.6 The FSA is represented in the model using as-built topography data for Gatwick Stream (reference GAL drg 22100-XX-C-911-SUR-000001.dwg) in the 2D domain. The control rules for the sluice gates operation at the GSFA have been specified using logical rules within Flood Modeller.

5.1.7 It was found that the control rules for the operation of the FSA sluice included in the Upper Mole Fluvial Flood Modelling Study (Jacobs 2018) did not accurately reflect their operation. Therefore, new rules were derived using information available from **Gatwick Stream FAS Standard and Emergency Operation Procedure (GSFA SOP.V2, Gatwick 2022)** supplemented by water levels records (2016-2022) showing real-time operation of the gates over this period to validate the amendment based on the operation of the FSA. The amended logical rules that have been included in the latest baseline and with-scheme modelled scenarios are as follows:

- The sluice gates are located between 1D river sections 07_3124 and 07_3116. The setting point of the sluice gate operation is based on water level in the South Terminal culvert (07_2016). There are two Sluice Gates (Orf_S85_UI and Orf_S85_DI and are modelled with the following settings:
- Left and right gates weir crest elevations are set to 57.660m AOD and 57.670m AOD respectively.
- Length of weir is 1.0m, and breath of weir is 2.0m
- Height of weir crest is 0.1m upstream, and 0.19m downstream.
- The control rules of the sluice gate operation as follows:

  1. If depth of water at node 07_2016 is less than 2.586m, the gate opening is set to 1.8m.
  2. If depth at 07_2016 is between 2.586m and 2.766m then the gate opening is set to 1.4m.
  3. If depth at 07_2016 is between 2.766m and 2.876m then the gate opening is 1.15m.
  4. If depth at 07_2016 is between 2.876m and 3.006m then the gate opening is 1m.
  5. If depth at 07_2016 is greater than 3.006m then the gate opening is 1m.

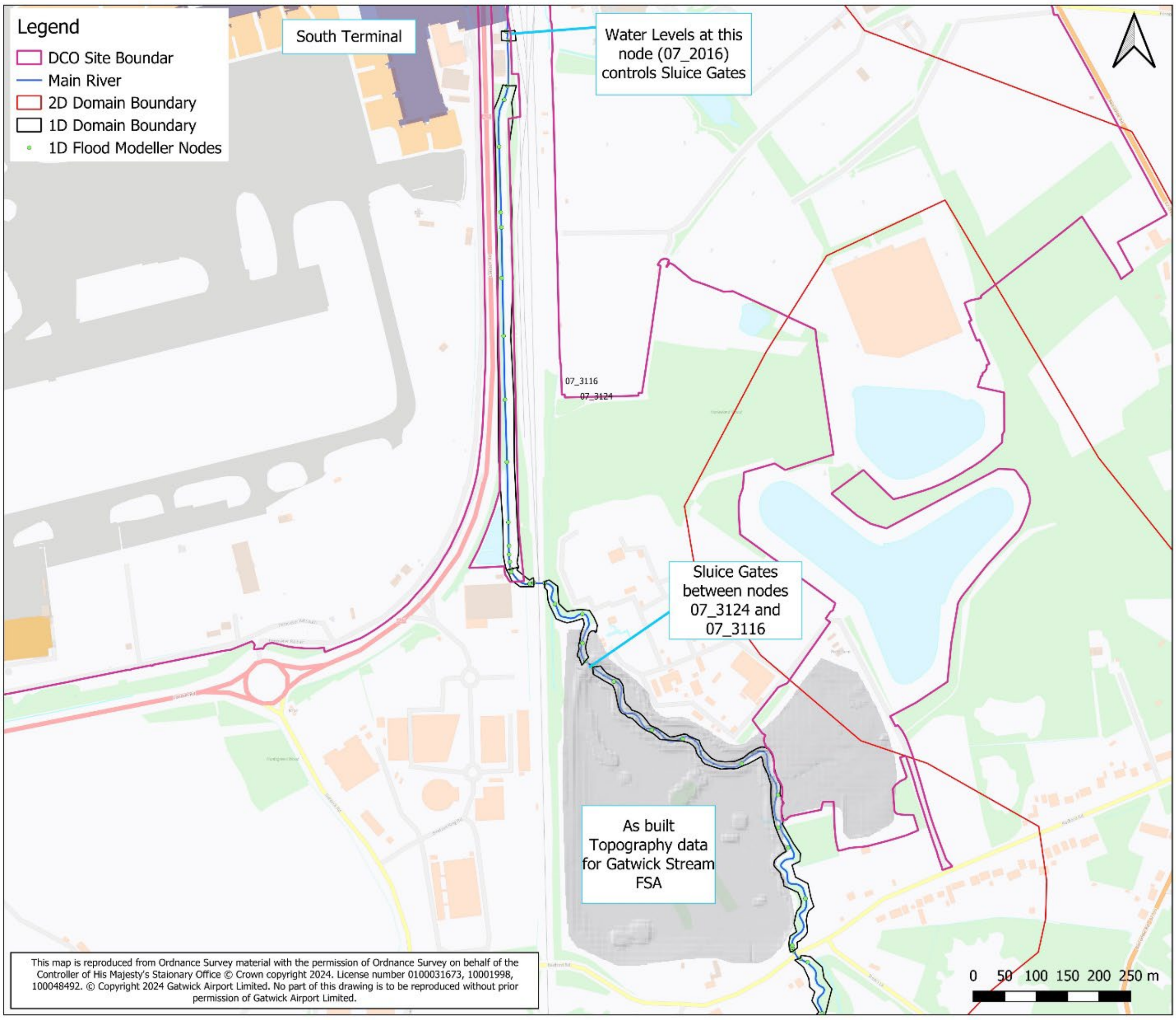


Figure 5-2: Schematisation of Gatwick Stream Flood Alleviation Scheme (GSFA)

Redistribution of Hydrological Inflows on Tilgate Brook and Crawter's Brook

5.1.8 The information on the redistribution of inflows along the Tilgate Brook and Crawter's Brook was provided by the EA following their update of the 2018 hydraulic model, as detailed in 2017s6336-U-N002-3 (JBA 2019). In previous modelling, all of the lateral inflows entered the model as a single inflow at the upstream end of the reach, upstream of the Tilgate culvert and the top reach of the Crawter's Brook.

5.1.9 The Upper Mole Hydraulic Model Update Impact Summary (Jacobs, 2021) documented that the current inflow distribution along Tilgate Brook with 3-7iae (20% of the flow) input as per a JBA recommendation however combining 3-7iab, 3-7iac and 3-7iaa_d (equal to 80% of the flow) is inputted to a single node (16_0926) downstream of the culvert. This decision is not consistent with the JBA 2019 recommendation because this amendment introduced instability into GAL's model and was outputting implausible results at the location of the airport when attempting to integrate JBA inflows distribution. This current setup was discussed with EA on 29/04/2021 and the approach was accepted as per 210429 notes of EA meeting vISSUE (002) (Jacobs 2021).

5.1.10 The re-distributed flows adopted in the Upper Mole Baseline model are detailed in Table 5.1.

Table 5.1: 1D Distribution of flows for Tilgate Brook and Crawter's Brook

Watercourse	1D Inflow Label	Lateral Inflow Node applied to	River Section applied to	Proportion of Total Flow
Tilgate Brook	3-7ia	3-7iae	16_1000r1	20%
		3-7iab	16_0926	31%
		3-7iac		19%
		3-7iaa_d		30%
Crawter's Brook	2-1	2-1iaa	03_3635	18%
		2-1iab	03_4507D	60%
		2-1iac	03_4660	5%
		2-1iad	2-1u	17%

5.1.11 The Baseline model results are reported in the **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].

5.2 Model Extent

5.2.1 The 2D model domain covers an area of 34.1km^2. The model extent has been delineated to include the floodplains of the tributaries to the River Mole including, Gatwick Stream, Crawter's Brook and Man's Brook, to their confluences with the River Mole. The model extends approximately 2.5km downstream of Longbridge Roundabout (the confluence of the Mole and the Gatwick Stream) to fully assess the impacts of the Project and risk to any third parties downstream of the Project. This study area has not been altered from original Upper Mole hydraulic model.

5.2.2 Due to the size of the model, the 2D domain was clipped to the maximum likely flood extent through iteration to reduce simulation times. A grid resolution of 5m was used due to size of model to optimise run times based on the nature of the study. The model extent is shown in Figure 5-3.

5.2.3 Five flood alleviation schemes (FAS) are located in the catchment, upstream of the airfield, as illustrated in Figure 5-3.

- Tilgate Lake, Crawley
- Worth Farm Flood Storage Area
- Clay's Lake, near Balcombe
- Ifield Reservoir
- Gatwick Stream Flood Storage Area

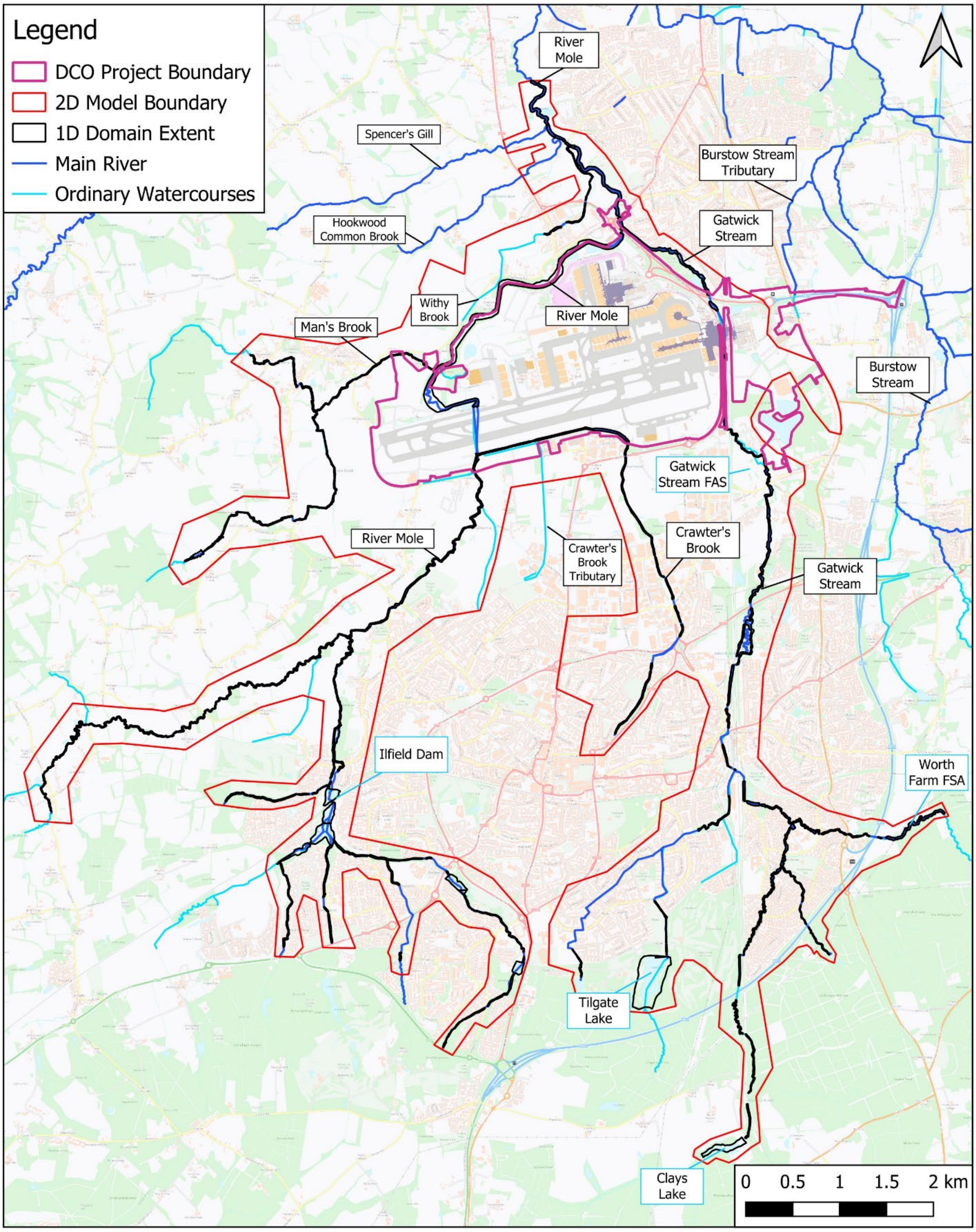


Figure 5-3: Upper Mole 2D Model Extent

5.3 Model Resolution and Topography

5.3.1 A 5m grid cell resolution was deemed appropriate due to the overall size of the model, while the channels are represented in the 1D element. The use of a 1D-2D linked model provides accurate simulation of in-channel hydraulics, coupled with detailed out-of-bank representation of flood routes, depths, flows and velocities. The combined model therefore enables robust simulation of the effect of key hydraulic features (such as bridges, culverts, flood relief areas and flood defences) both in-bank and out-of-bank.

5.3.2 The 2D ground model was constructed and linked to the 1D model domain. The accuracy of elevations derived from LiDAR were not assessed systematically, although a manual inspection of LiDAR elevations was undertaken during the development of the 2D model and during assessment of model results to confirm accuracy.

5.3.3 The model grid has been oriented to align it with key flow paths and has not been altered from the original Upper Mole hydraulic model to maintain consistency and allow for comparison against previous calibration results.

5.4 Hydraulic Friction

5.4.1 Default channel roughness factors were applied across the 1D model domain, where variations from these defaults were applied, professional judgment was used as part of the calibration process. Default 1D roughness factors are detailed in Table 5.2.

Table 5.2 1D Domain Manning's roughness values

Channel Feature	Manning's n Roughness
Channel bed	0.040
Channel bank	0.060
Floodplain	0.050

5.4.2 OS MasterMap data was used to identify land use types and inform the 2D domain in the immediate Gatwick area with different hydraulic roughness (Manning's 'n' coefficient) values. Hydraulic roughness coefficients are applied over each grid cell of the 2D domain depending on the land use taken from the MasterMap data, as shown in Table 5.3. Roughness values adopted were taken from standard guidance (Chow, 1959) and applied as seen in Figure 5-4: A general floodplain roughness factor of 0.050 was applied across the model outside the immediate vicinity of Gatwick as shown in Figure 5-4:.

5.4.3 As stated in the Upper Mole Fluvial Flood Modelling Study (Jacobs 2018), there is a history of model instability due to manning's roughness values. The 2018 study undertook a sensitivity test where the model was re-run with MasterMap data covering the full extent of the model and the outputs compared. It was determined that there are no significant differences in the flood extents and that there is no systematic increase or decrease in flood depths. Therefore the global Manning's 'n' of 0.05 in the original (2018) model was retained.

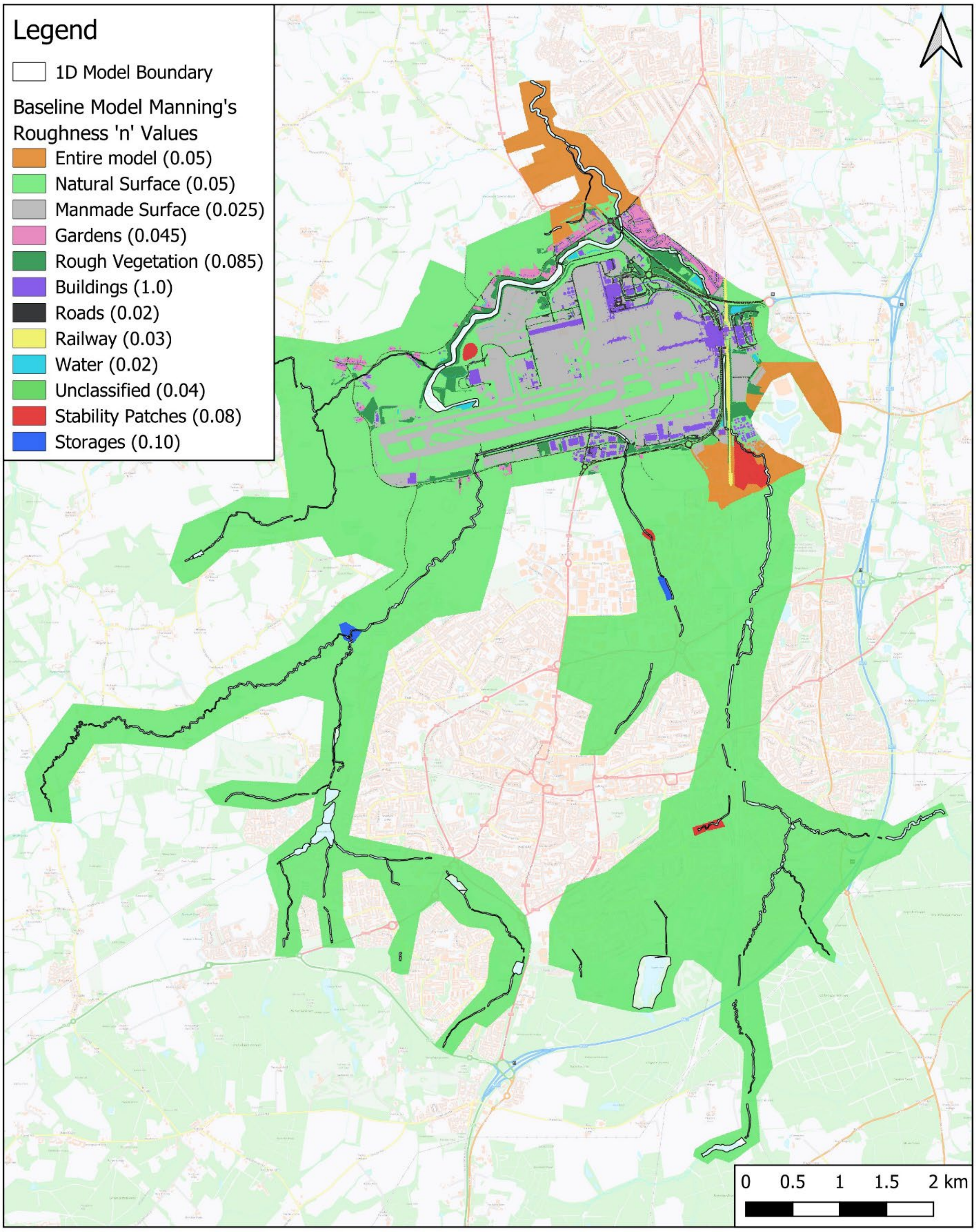


Figure 5-4: Manning's Roughness Values Adopted in the 2D Model Domain.

Table 5.3 2D Domain Manning's Roughness Values

OS MasterMap feature	Manning's n Roughness
General	0.05
Natural Surface	0.05
Manmade Surface	0.025
Garden	0.045
Rough Vegetation	0.085
Building	1.0
Road	0.02
Railway	0.03
Water	0.02
Unclassified	0.04
Banks	0.085
Stability Patches	0.08
Storage	0.1

5.4.4 Stability patches with a Manning's n value of 0.08 were used in the following areas; the Gatwick FAS, Pond M and large floodplain areas in Rowley Wood, Waterlea Meadows. These can be seen by the red areas in Figure 5-4.

5.4.5 Buildings have been modelled with a Manning's value of 1.0 due to sensitive nature of the buildings at the airfield, new airfield buildings are designed or protected so that water cannot enter them. It is a conservative approach and assumes no water ingress to the building with maximum displacement impacts. This assumption has been adopted for all buildings in the 2D domain.

6 With-Project Model Build

6.1 Updates made to Baseline Scenario

The Baseline model was updated to represent the Project, the following sections set out how these elements have been incorporated and the location of changes made as shown in Table 6.1, as sourced from in **ES Chapter 5: Project Description** [APP-030].

Table 6.1: Modification made to the Baseline model for the With-Project model build.

Project Element	Included in With-Project Model	Model modifications	Reference
Indicative Construction Sequencing between 2024 to 2029			
Repositioning of Existing Northern Runway, Reconfiguration of Taxiways	Repositioned Northern Runway Taxiway Juliet West and Juliet West Spur Taxiway Juliet East (Code C and E), Taxiway Lima and Taxiway Tango End around taxiway east and west Runway exits	Airfield Works represented by 3D ascii layer Added to 2D domain using materials roughness layers – “man-made surface”	TEMP-XX-C-193-M3-200001.dwg. Roughness values updated using Project Description Figures [APP-053]
Works to Aircraft Stand	Reconfiguration of existing remote stands for Taxiway Lima New stands north of Lima Remote aircraft stands north of Taxiway Juliet New Code C stand north of Virgin hangar	Stands added to 2D domain using materials roughness layers	Roughness values updated using Project Description Figures [APP-053]
Reconfiguration of Airport Facilities	Replacement ground maintenance and airfield surface transport facilities; fire training ground; CARE facility ; motor transport facilities. Replacement Rendezvous Point North Satellite airport fire service facility Removal and replacement of the western noise mitigation	Added to 2D domain using materials roughness layers – “man-made” Noise mitigation replaced by 2d_zsh wall	Roughness values updated using Project Description Figures [APP-053] Figure 14-3:.
Internal Access Routes	Realignment of Larkins Road (Phase 2) Runway Access Track Mans Brooks Farm Bridges	Added to 2D domain using materials roughness layers – “roads”	Roughness values updated using Project Description Figures [APP-053]]

Project Element	Included in With-Project Model	Model modifications	Reference
		Approach ramps added to 2D domain using 2d_zsh	
Terminal Extensions	South Terminal and North Terminal IDL extension North Terminal baggage reclaim extension Additional coaching gates South Terminal and North Terminal Forecourt	Added to 2D domain using materials roughness layers – "buildings"	
Hotels	South Terminal hotel at car park H	Added to 2D domain using materials roughness layers – "buildings"	
Car Parking	Removal of existing Purple Parking, North Terminal Long Stay Multi Storey and Car Park J, X and H	Added to 2D domain using materials roughness layers – "man-made surface"	
Water Management, Foul Water and Substations	Diversion and extension to the River Mole Removal of Pond A Flood Compensation Area at Museum Field Flood storage – Car Park X	1D Domain alteration to channel extent and cross-sections Pond A raised using 2d_zsh to existing ground level Museum Field and CPX FCAs lowered using 2d_zsh to design levels	Figure 14-2: Assumed existing ground levels Figure 14-4: and Figure 14-6:
Landscaping and Ecological Planting	Land to the west of the River Mole (including Museum Field)	Added to 2D domain using materials roughness layers – "natural surface"	Roughness values updated using Project Description Figures [APP-053]
Indicative Construction Sequencing between 2029 Onwards			

Project Element	Included in With-Project Model	Model modifications	Reference
Surface Access	South Terminal, North Terminal and Longbridge Roundabout junction improvements	Highways Surface works represented by 3D ascii layer Added to 2D domain using materials roughness layers – “roads” and “man-made surface”	41700-XX-C-HGN-CM-200003 -3D combined highways model DWG.dwg Roughness values updated using Project Description Figures [APP-053]
Reconfiguration of Taxiways	Taxiway Juliet West Spur Taxiways Whiskey, Victor and Zulu	Airfield Works represented by 3D ascii layer Added to 2D domain using materials roughness layers – “man-made surface”	TEMP-XX-C-193-M3-200001.dwg. Roughness values updated using Project Description Figures [APP-053]
Pier and Stand Amendments	Pier 7 and associated stands Conversion stands west of Pier 3 to 8 Code C	Added to 2D domain using materials roughness layers – “man-made surface”	
Aircraft Holding Area	Charlie Box		
Car Parking	Car park Y and Car park H		
Reconfiguration of Airport Facilities	Aircraft Hangar	Added to 2D domain using materials roughness layers – “buildings”	
Internal Access	South Terminal and North Terminal autonomous vehicle stations		
Offices and Hotels	South Terminal Office (on existing car park H) South Terminal Hotel		
Terminal Extensions	North Terminal baggage hall extension and South Terminal baggage reclaim and borders	Not implemented in Upper Mole fluvial model	
Water and Substations	New end of runway pumping station and New substation north of Pier 7		

Project Element	Included in With-Project Model	Model modifications	Reference
Landscaping and Ecological Planting	New footpath from Riverside Garden Park Ecological enhancements for the area to the north east of the Longbridge roundabout		
Other			
Construction Compounds	Main contractor MA1, Airfield satellite, Car park Z, Car park Y, Water Treatment Works, South Terminal roundabout, Longbridge roundabout and Car park B compounds	Not implemented in Upper Mole fluvial model, as guidance has been provided to sign up to flood warnings and locate compound areas away from Flood Zones and elevate on stilts as per **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].	

6.1.1 The following sections set out how these elements have been incorporated and the location of changes made by the Project is shown in Figure 6-1. The principal modification pertinent to fluvial flood risk was the inclusion of the proposed highway alignments and airfield modifications including works to the northern runway.

6.1.2 The model was not amended to include the Church Meadows Footbridge, a pedestrian footbridge from Church Meadows to the east of the River Mole and associated publicly accessible land at Museum Field and Brook Farm. This is due to the left bank abutment works would be smaller than model's 5m grid cell size and the right bank abutment is outside all modelled flood extents. It is anticipated the structure will be of such a size not to influence flood flows or remove a significant volume of floodplain

6.1.3 In addition, minor extensions were made to the 2D domain to the south-east of Crawley STW to incorporate and assess the widening of the A23 as part of the surface access improvement works, see Figure 6-1.

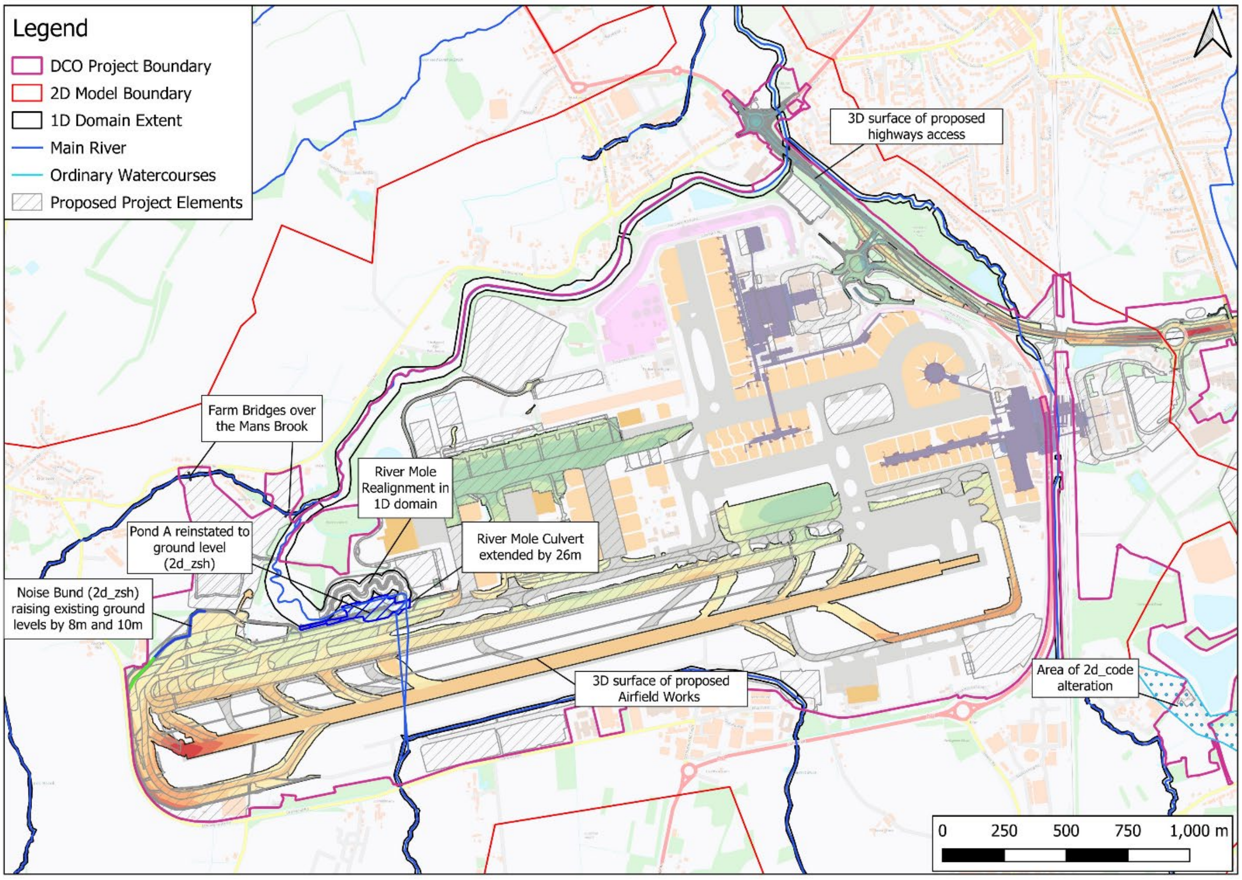


Figure 6-1: Location of With-Project Elements Interacting with Water Environment

Airfield Works

6.1.4 The following key works components of the Project's airfield works are as followings, and the description of how these are implemented in the With-Project scenario are included in the following paragraphs:

- amendments to the existing northern runway including repositioning its centreline 12 metres further north to enable dual runway operations;
- reconfiguration of taxiways;
- Juliet;
- Lima and Tango;
- Whiskey, Victor and Zulu;
- exit/entrance taxiways and
- end-around taxiways.
- runway access tracks between main runway and northern runway;
- modification to airfield road networks (including extension of Larkins Road)
- pier and stand alterations (including a proposed new pier and new aircraft holding areas);
- airfield support facilities; central area recycling enclosure (CARE) facility;
- motor transport, grounds maintenance and airfield surface transport facilities;
- emergency air traffic control tower and TCR Snowbase Building;
- cargo facilities;
- provision for aircraft engine ground running areas;
- fire training ground and satellite airport fire service provision;
- hangars;
- western noise mitigation feature (provisionally a combination of a wall and earth bund); and
- internal access routes.
- extensions to the existing airport terminals (north and south);
- provision of additional hotel and office space;
- provision of reconfigured car parking, including new car parks

6.1.5 The Project runway separation increase plus modifications to taxiways, runway exits, end around taxiways, airfield roads, aircraft stands and RETs have been represented in the 2D domain with the elevations of airfield development stamped onto model grid using a 3D drawing (source: TEMP-XX-C-193-M3-200001.dwg). Extent of the 3D surface is shown in Figure 6-2.

6.1.6 Alterations to the 2D roughness layers were used to represent the Northern Runway works, taxiways, runway exits, end around taxiways, airfield roads and RETs as well as the Pier, Terminals, Stands and Gates and all associated works shown in Figure 6-3 and listed in paragraph 6.1.4.

6.1.7 The proposed noise mitigation feature located to the west of the airfield was represented in the model as a 2d_zsh line type, raised to 8 and 10m using the “ADD” function, as seen by preliminary design included in Figure 14-3:.

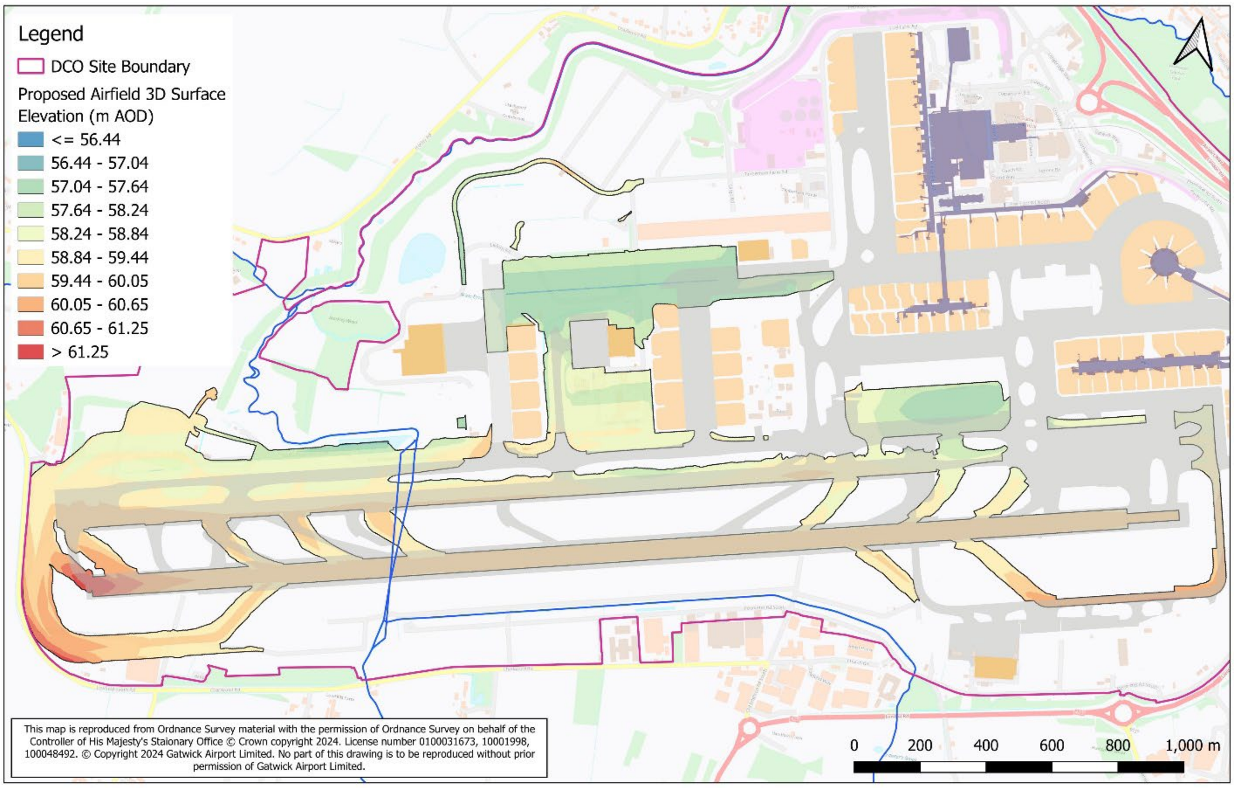


Figure 6-2: 3D surface ascii of airfield development.

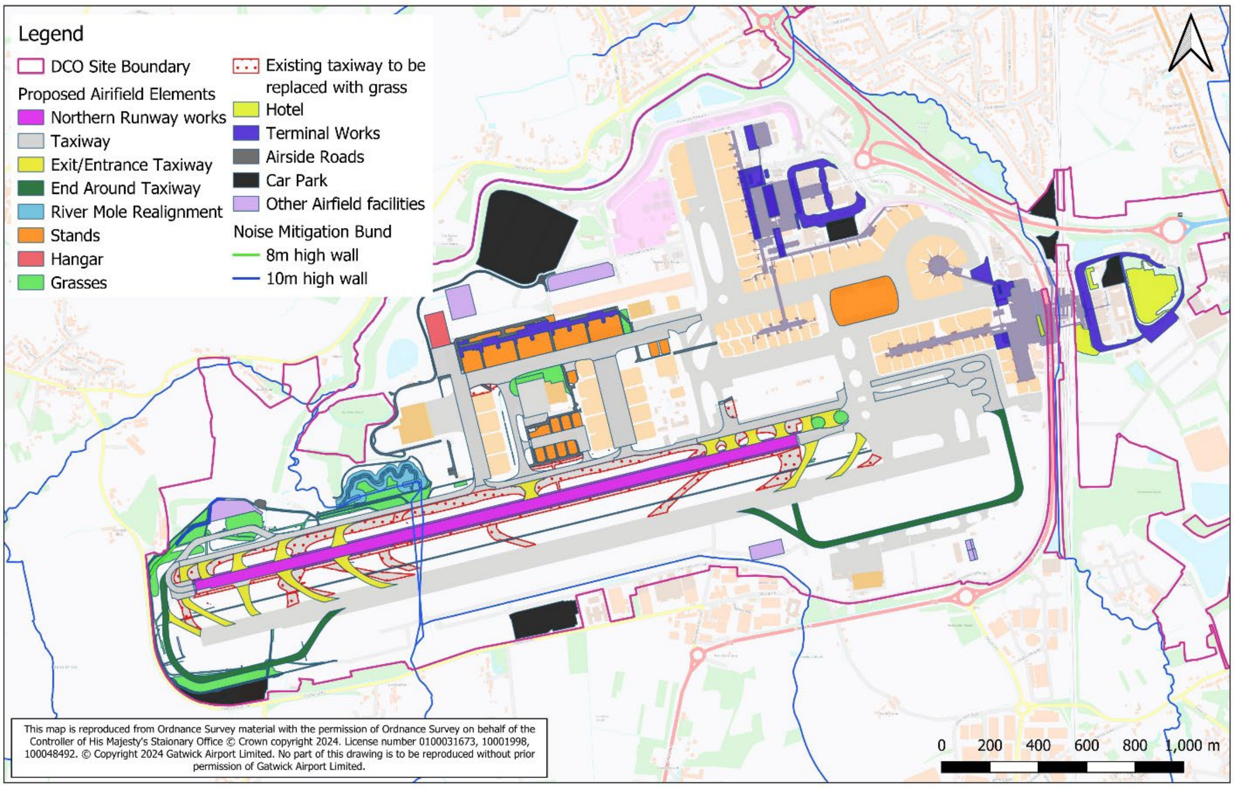


Figure 6-3: Proposed airfield developments which inform 2D Manning's roughness updates.

River Mole Culvert Extension and Pond A Removal

6.1.8 The River Mole is conveyed beneath the airfield in a northerly direction via twin box culverts. These are augmented by a syphon that conveys higher flows. Reconfiguration of the airfield as part of the Project will interact with the Mole and these structures on the northern side of the airfield (their outlets). The existing Taxiway Juliet would require an increased separation distance from the repositioned northern runway to allow aircraft to use this taxiway independently of northern runway operations, therefore the western part of Taxiway Juliet (Taxiway Juliet West) would be repositioned approximately 26 metres to the north of its existing position. As a result of this taxiway reconfiguration the following works are necessary:

- The River Mole would be diverted and extended to the north of its current course to take a more sinuous course than the current alignment and provide approximately a 300 metre length of new renaturalised river valley;
- The river channel at the exit to the existing culvert would be extended. The channel that the River Mole runs in from the exit of the existing culvert would be extended northwards by 26 metres to enter the new section of river valley;
- The River Mole syphon (which activates only in high flow conditions) would be extended in a new section of box culvert of approximately 36 metres in length to connect to the new section of river valley; and
- Pond A would be removed and infilled.

6.1.9 Preliminary design drawings developed in 2022 for the River Mole renaturalisation are included as Figure 14-1: and Figure 14-2:.

6.1.10 The following modifications were made to the baseline model to represent the renaturalisation of the River Mole (see Figure 6-4:):

- The 26m River Mole culvert extension was included by adding a node (19_001r/l) to each end of barrel (19_0000cvR*D* and 19_0000cvL*D*). Extension sections have the same dimensions as existing, and the distance to next conduit is 26.0m. The gradient of the extended section is the same as the existing culvert slope, therefore the culvert outlet has a level of 54.750m AOD;
- The extension of 40m to the syphon was inserted by increasing distance to next conduit to 610m of Node RMOF_45S; and
- The removal of Pond A consisted of modifications made in the 2D model involving the reinstatement of ground levels using 2d_zsh polygon and the “No Merge” option. The Pond A levels was raised using existing ground level elevations surrounding the pond, and the use of -9999 to infill areas where Pond A was located.

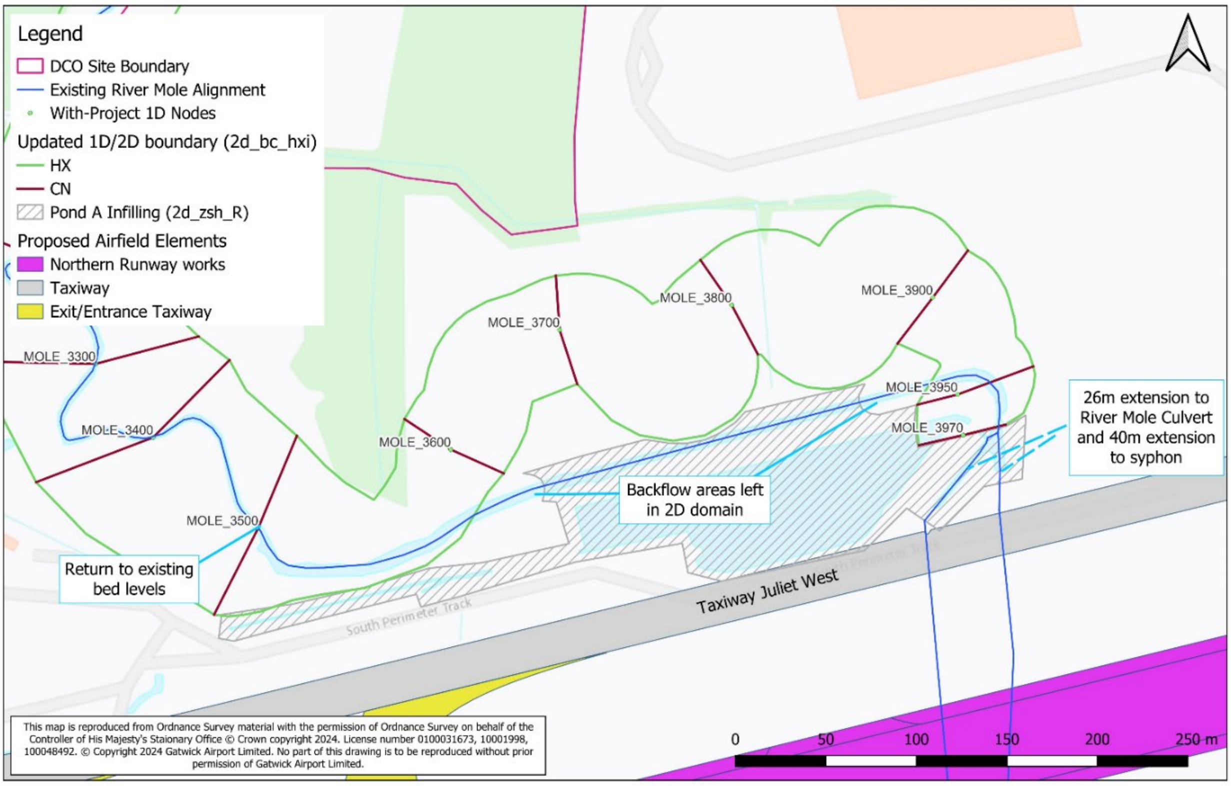


Figure 6-4: River Mole realignment.

River Mole Re-naturalisation

6.1.11 Due to the Taxiway Juliet works and extension of the River Mole culvert, the River Mole would be diverted and extended to the north of its current course to take a more sinuous course than the current alignment and provide approximately a 300m length of new river valley. This diversion would provide opportunities for ecological mitigation and flood storage.

6.1.12 The preliminary design of the new two-stage channel in the realigned section of the River Mole is included in **Figure 14-2**:. An indicative cross-section design and its representation in FloodModeller is shown in Figure 6-5. The new realigned section links the new River Mole (runway) culvert outfall invert of 54.696m AOD to the existing bed level of 54.55m AOD at MOLE_3500.

6.1.13 The following 1D Manning's roughness values have been applied to the new re-aligned channel: 0.03 (low flow channel), 0.035 stepped channel and 0.06 (side slopes). The rougher value of 0.06 has been applied to the second stage section due to the planting and re-naturalisation currently planned for this element of the new section of channel.

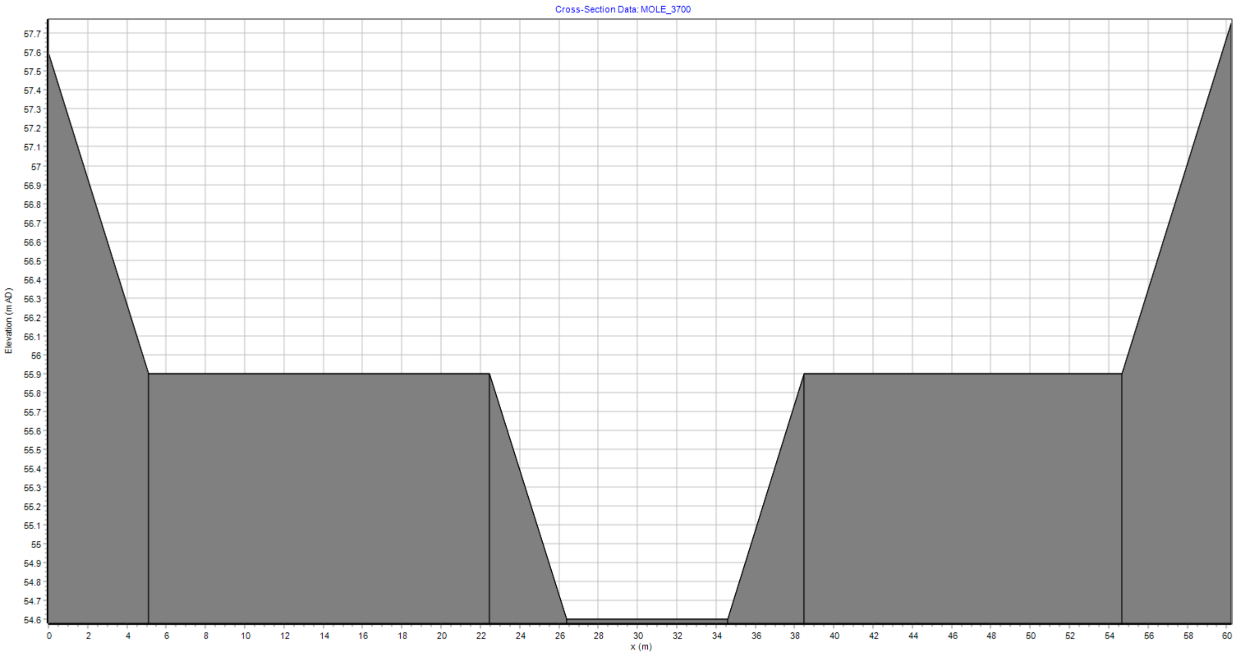


Figure 6-5: Indicative River Mole realigned channel cross-section (MOLE_3700).

Highways Surface Access Works

6.1.14 Improvements are proposed to the surface access (highways) and active travel routes that provide access to both terminals at the airport. A full list of proposed works are in **ES Chapter 5: Project Description** [APP-030]. The following surface access works are proposed as part of the Project and included within the With-Project model scenario:

- South Terminal: new junction layout providing full grade separation;
- North Terminal: new junction layout including partial grade-separation, improving traffic flow;
- The Airport Way eastbound connection from North Terminal roundabout would be removed with eastbound traffic to travel via a new signal-controlled junction on the A23 London Road and an enhanced eastbound diverge connection onto Airport Way;
- Enhancement of the eastbound M23 Spur as part of the South Terminal roundabout improvements;
- Improvements to Longbridge Roundabout where the A23 meets the A217; and
- New and enhanced active travel routes providing safe connections from surrounding areas.

6.1.15 The following amendments to existing watercourse crossings are proposed as part of the Project:

- A23 London Road Culvert – 13_1448brU1 length increased to 28.62m in 1D Domain
- A23 Brighton Road Culvert - 13_1272brU1 length increased to 25.0m in 1D Domain

6.1.16 Inverts of these bridge/culverts are assumed to be same as existing at this stage and will be re-assessed in Detailed Design. The 1D Nodes and HXI layers connection to the 2D has also been updated accordingly as shown in Figure 6-6Error! Reference source not found..

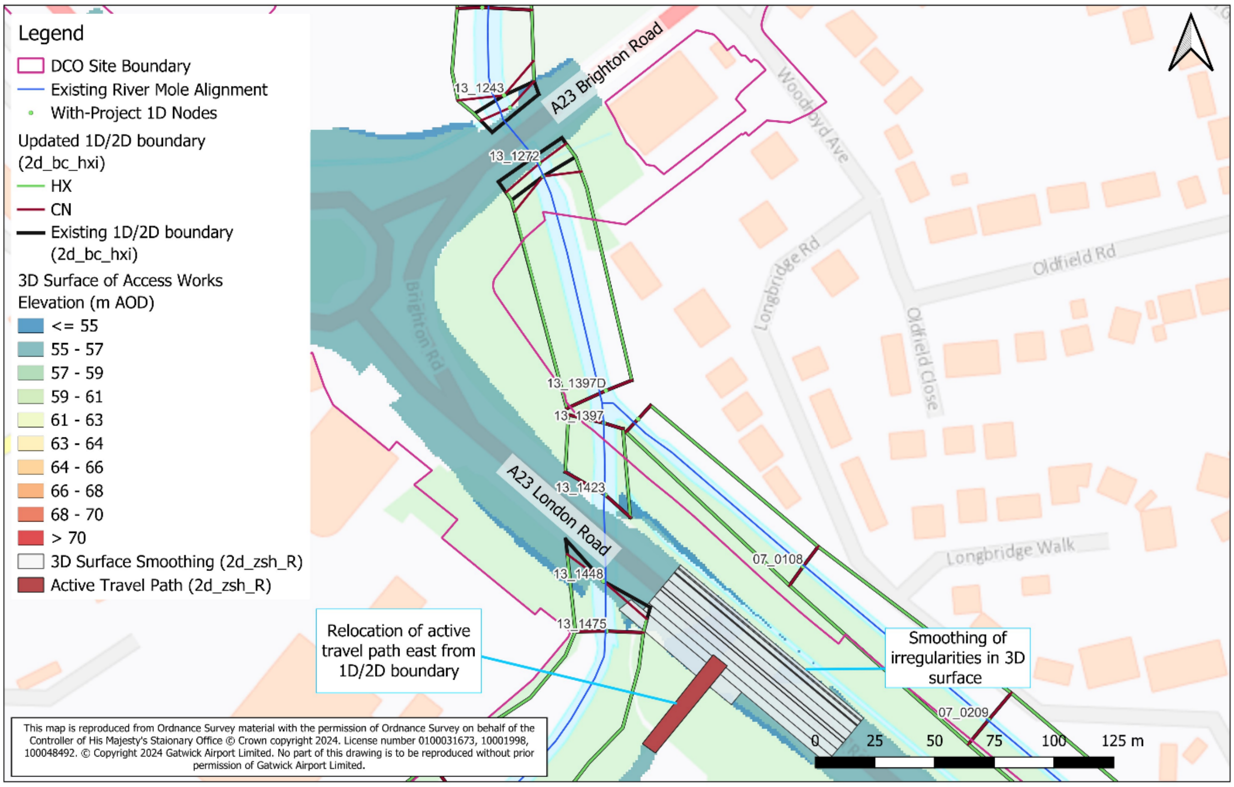


Figure 6-6: Longbridge Roundabout 2D domain alterations.

6.1.17 The new road surface, which incorporates all of the proposed surface access works, was stamped onto the model grid using 3D drawing produced from LandXML provided by ARUP's Drainage designers (Drawing: 41700-XX-C-HGN-CM-20003) to represent the with-Project scenario within the TUFLOW 2D domain. Where the LandXML did not render correctly, 2d_zsh's were using the smooth irregular sections as shown below in Figure 6-7:.

6.1.18 The positioning of the Active Travel Path adjacent to Car Park Y and the River Mole has been represented separately using 2d_zsh files with elevations from the 3D surface (see paragraph 6.1.14). This is to rotate the path away from the 1D/2D boundary (2d_bc_hxi). The exact location of this active travel path and location of flood relief culverts will be confirmed via detailed design.

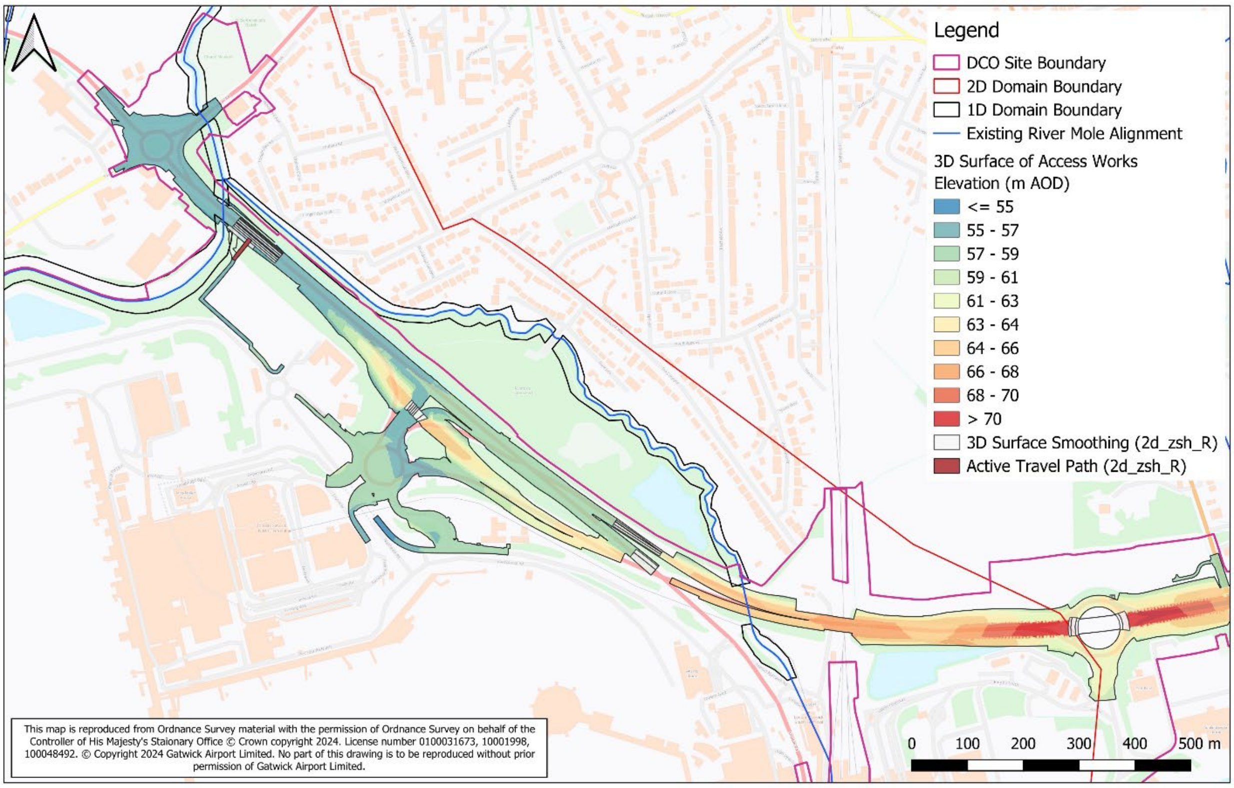


Figure 6-7: 3D Surface ascii of Highways Access works.

Man’s Brook Farm Bridges

6.1.19 The Project includes the construction of two bridges over the Man’s Brook to facilitate access by the farmer south of the watercourse.

6.1.20 The approach ramps were added only to the 2D domain, with the level of bridge to be set above the 1%AEP+20%CC peak water level plus freeboard. The Western Farm Bridge deck level was set to 59.4 m AOD, while the eastern bridge is set to 58.6m AOD. The approach ramps have been set as 8m wide and 10m in length rectangles using 2d_zsh files, raising from existing ground level to the peak water level as shown in Figure 6-8:.

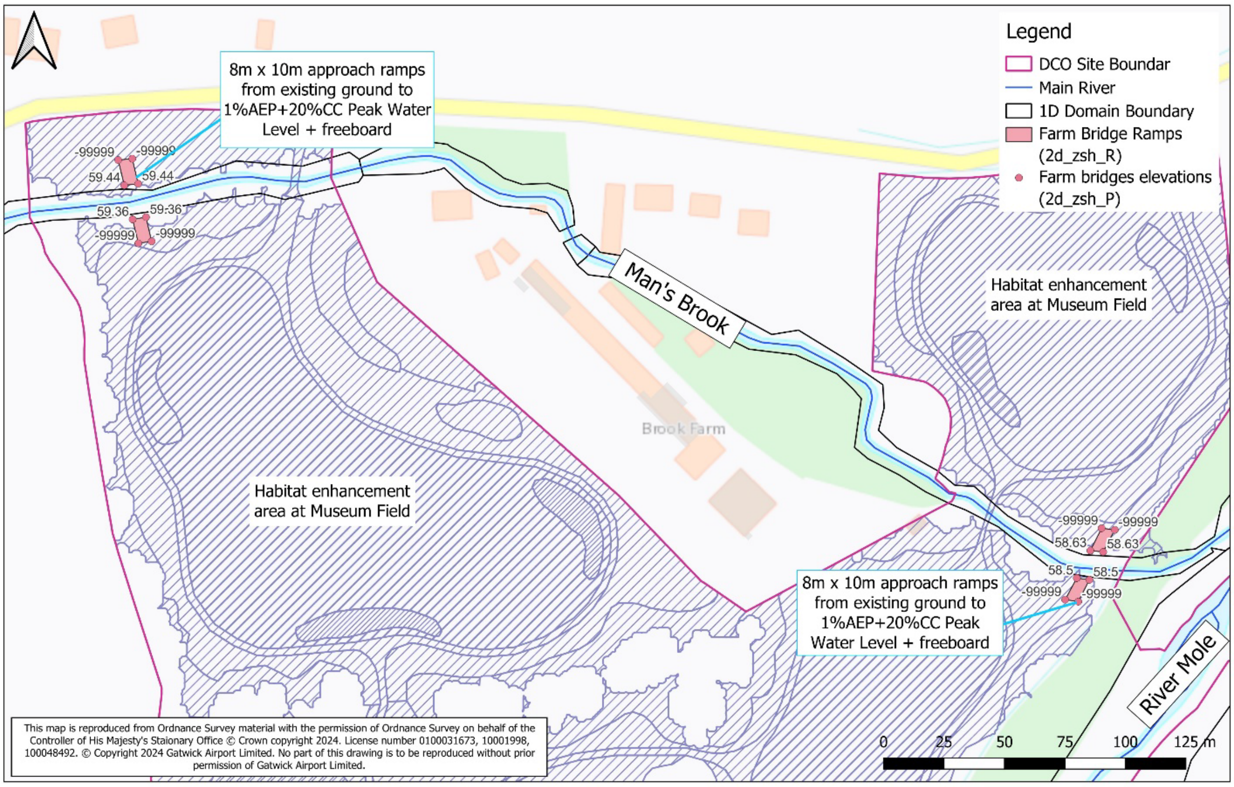


Figure 6-8: Farm Bridge setup in the 2D Domain.

6.2 Mitigation Requirements

6.2.1 Several measures are included in the Project to mitigate its impact on fluvial flood risk which are shown in Figure 6-13: Schematisation of Car Park X FCA

6.2.2 and described in detail below with a description of how they were included in the hydraulic model. Detailed descriptions of the mitigation options related to the surface water model and integrated catchment model (but not of relevance to the fluvial flood risk assessment) are provided in **ES Appendix 11.9.6: Annex 3** and **4** [APP-149] respectively.

6.2.3 The model results associated with the with-Project scenario are reported in the **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].

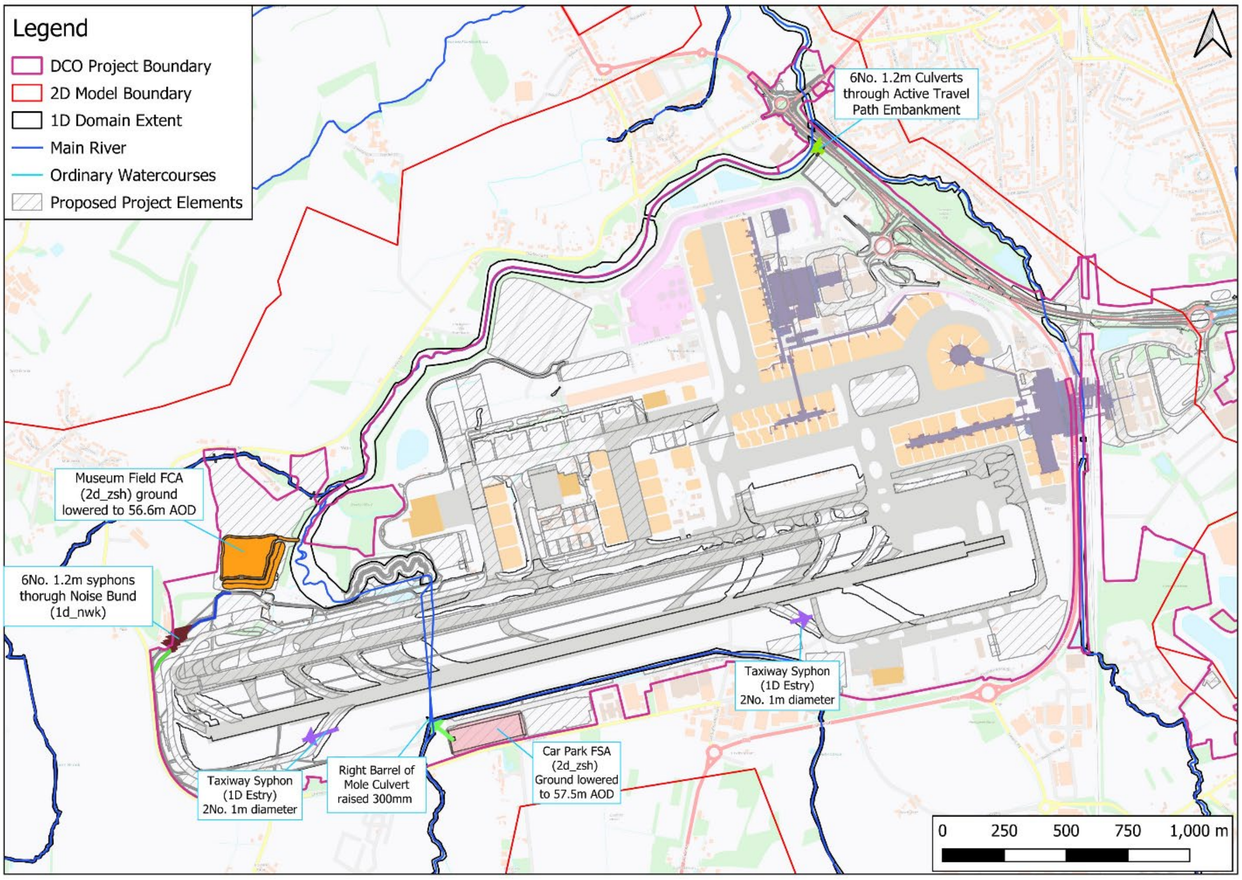


Figure 6-9: Proposed Mitigation measures due to With-Project developments.

Museum Field FCA

6.2.4 Museum Field FCA is an offline excavated storage area which fills freely via a spillway (swale) when River Mole levels reach 56.6m AOD. It is envisaged that the spillway would consist of an earth-lined, grassed trapezoidal swale feature 12m wide, the need for erosion protection would be determined through detailed design, see Figure 6-10:.

6.2.5 The FCA is approximately 165m by 185m and located north of the Project's relocated fire training ground and west of the River Mole. Excavations depths below existing ground level are between 2.6 and 3.4m,

6.2.6 Museum Field is modelled using 2d_zsh, as shown in Figure 6-10:, with levels and location of basin informed by preliminary designs provided in Figure 14-4: and Figure 14-5:. It should be noted that the bund set to 65.2m AOD in Figure 6-10: south of the basin is a noise mitigation bund and does not retain any water.

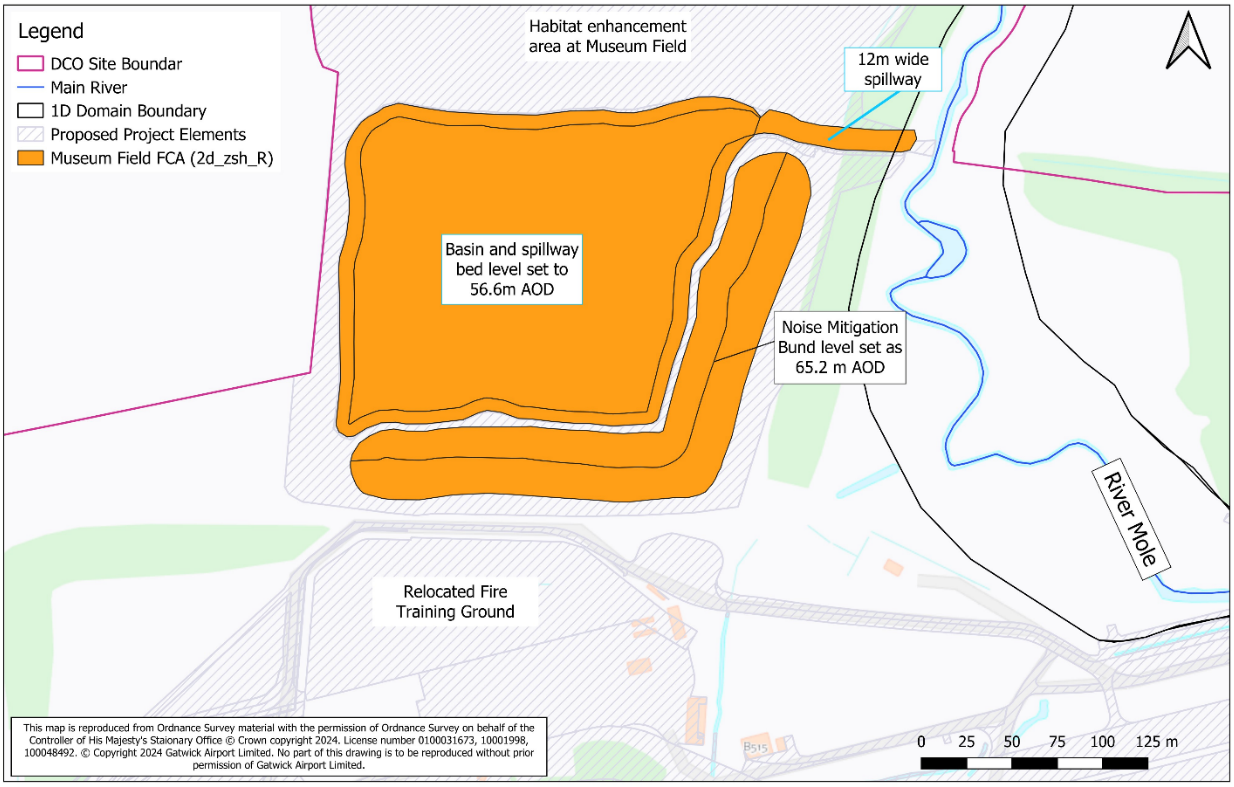


Figure 6-10: Schematisation of Museum Field FCA

6.2.7 Museum Field FCA fills exclusively when the River Mole water level rises to 56.6m AOD and the spillway is engaged. There are no surface water interactions via overland flow. The critical duration for the Museum Field is the 24-hour duration, and the following parameter for Museum Field FCA in Table 6.2 has been based off this duration.

6.2.8 Figure 6-11: shows only a slight reduction in peak flows downstream of the Museum Field FCA in the 3.3%AEP event, as well as all events shown in Table 6.2.

Table 6.2: Museum Field FCA peak operation

Parameter	AEP Event			
	10%	3.33%	1%	1%AEP+20%CC
Peak Water Depth (m)	0.50	0.70	0.86	0.97
Peak Water Level (m AOD)	57.10	57.31	57.46	57.58
Volume Stored (m^3)	14,800	21,050	25,650	29,250
Fill time (hr)	5	5	6	12
Drawn down time (hr)	28	34	36	36
Peak Flows in River Mole (MOLE_3000) (m^3/s)				
Baseline (106C) (m^3/s)	22.8	27.3	31.15	36.93
With-Project (570D) (m^3/s)	22.1	26.7	30.6	35.75
Reduction in peak flow in River Mole (m^3/s)	-0.7	-0.6	-0.55	-1.18

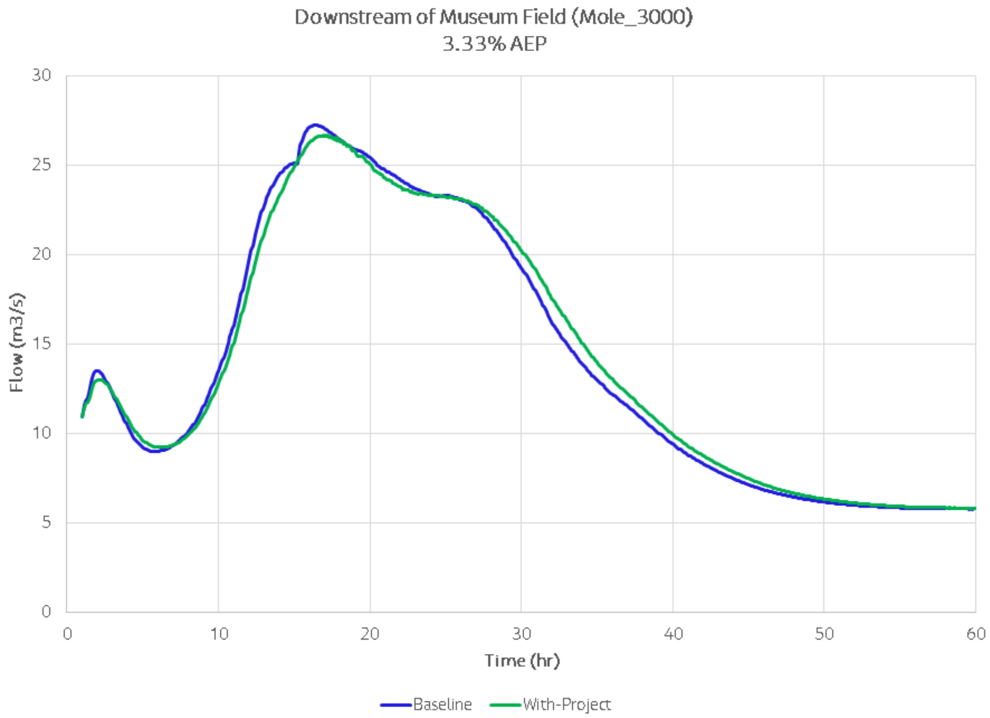


Figure 6-11: Reduction in peak flow in the River Mole due to Museum Field FCA – 3.33% (24 hours storm duration)

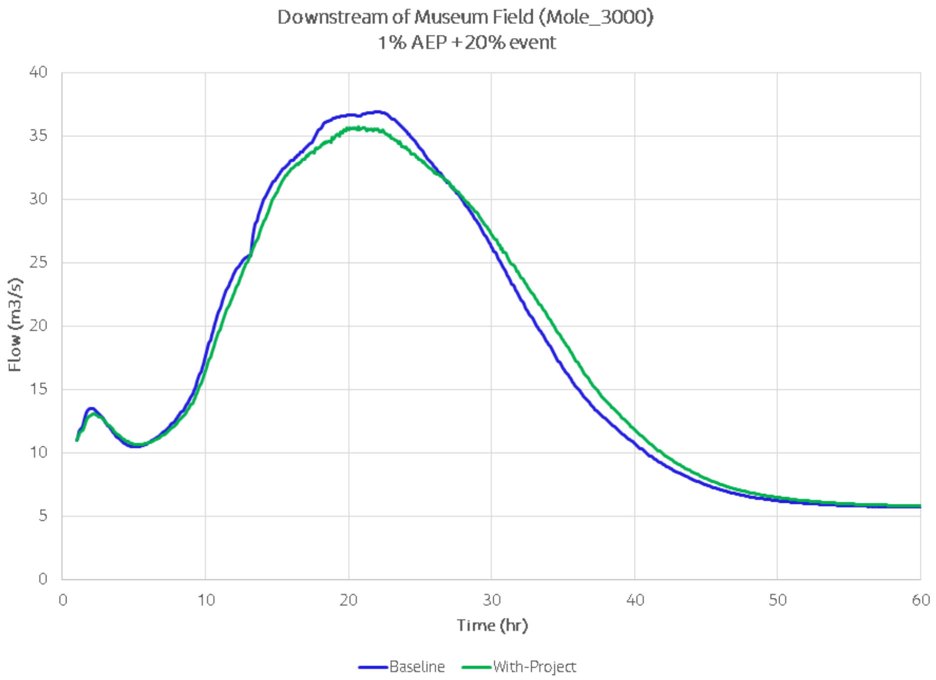


Figure 6-12: Reduction in peak flow in the River Mole due to Museum Field FCA – 1% AEP +20% (24 hours storm duration)

Car Park X FCA

6.2.9 Car Park X (CPX) FCA is an approximately 300m in length and 90m wide rectangular storage basin, located south of the main runway and the Crawter's Brook. Excavation depths are between 0.9 and 2.3m.

6.2.10 Car Park X FCA fills in the event of the River Mole flooding upstream of Charlwood Road and flowing north-east overland and over-spilling into the FCA within Car Park X. No flows enter the FCA from Crawter's Brook. The detailed design will need to consider water quality aspects (because of its use as a car park) of the operation of the FCA to prevent any impacts to the River Mole.

6.2.11 Car Park X FSA was represented used 2d_zsh elements as seen in Figure 6-13, with design informed with preliminary design drawings (Figure 14-6:). The basin is drained via a 1.0 m diameter circular culvert, 120 m in length, which outfalls into the River Mole upstream of its confluence with Crawter's Brook. Via dropped sump, added as 1D Estry elements. Inverts and diameters are assumed and will be refined as part of the detailed design.

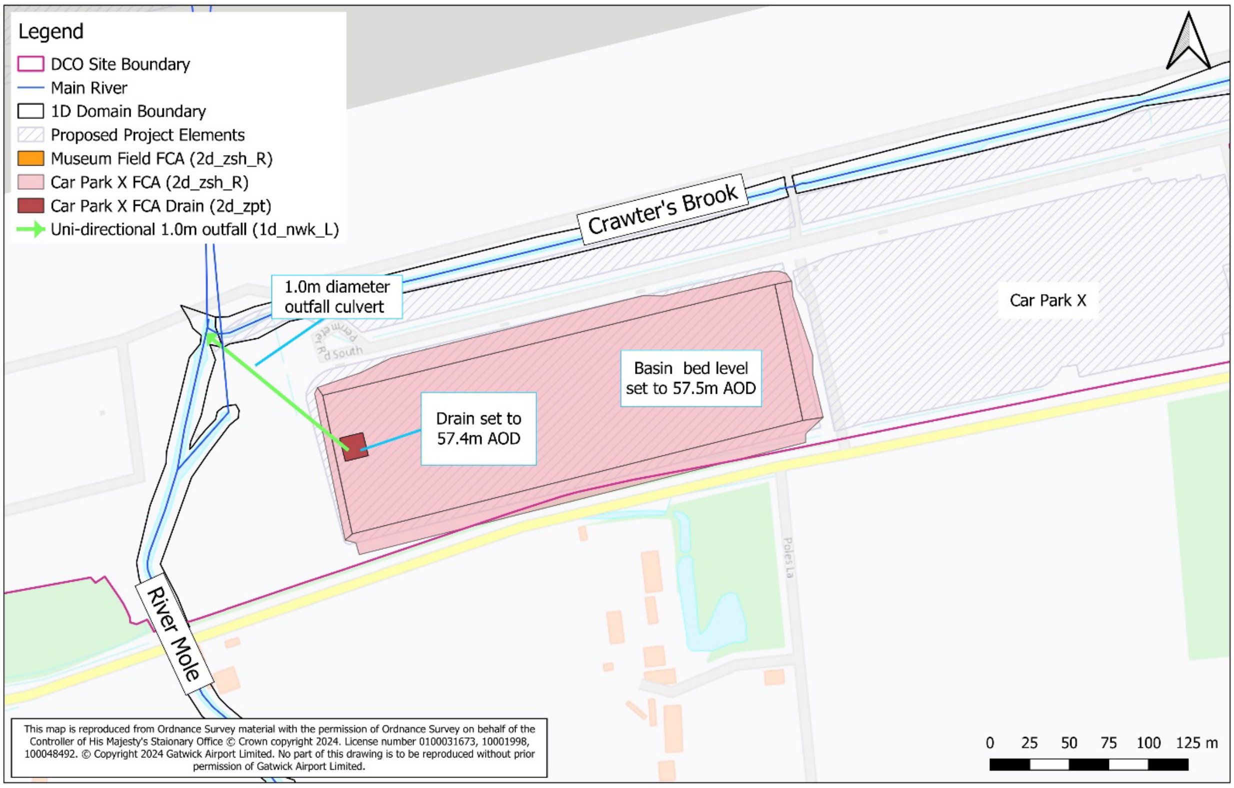


Figure 6-13: Schematisation of Car Park X FCA

6.2.12 The critical duration for the Museum Field FCA is the 12-hour duration, and the following parameter for CPX FCA in Table 6.3 has been based off this duration.

6.2.13 The peak flows downstream of CPX FCA increase with the project, this is likely due to the attenuation of the FCA to allow for the River Mole culvert to flow more efficiently, resulting in the increase in flows seen in Table 6.3. However, as indicates in Table 6.2 this could not extend further downstream beyond the Museum Field FCA and would not affect other parties as part of the holistic mitigation strategy for the whole Project.

Table 6.3: CPX FCA operation stat

Parameter	AEP Event			
	10%	3.33%	1%	1%AEP+20%CC
Peak Water Depth (m)	0	0.65	1.13	1.59
Peak Water Level (m AOD)	-	58.15	58.63	59.08
Volume Stored (m^3)	-	17,650	32,250	47,300
Fill time (hr)	-	3	3	3
Drawn down time (hr)	-	29	30	32
Peak Flows in River Mole (19_0000) (m^3/s)				
Baseline (106C) (m^3/s)	17.44	20.11	22.07	23.27
With-Project (570D) (m^3/s)	17.76	20.8	22.7	24.22
Increase in peak flow into River Mole Culvert (m^3/s)	+0.32	+0.7	+0.59	+0.95

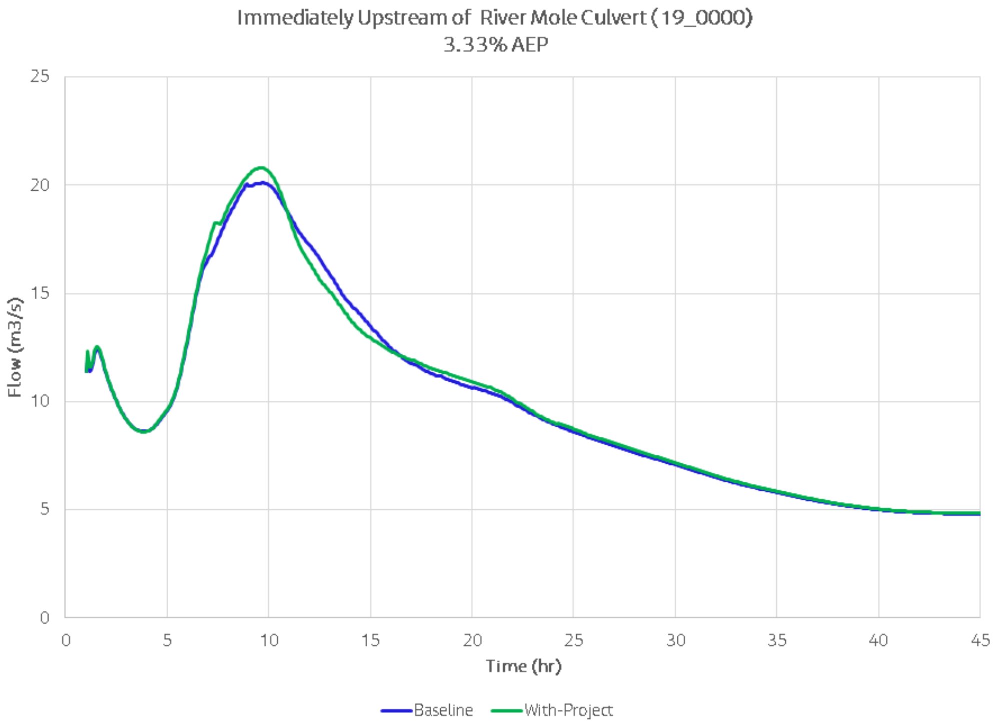


Figure 6-14: Change in peak flow in River Mole culvert due to Car Park X FCA – 3.33% AEP (12 hours storm duration)

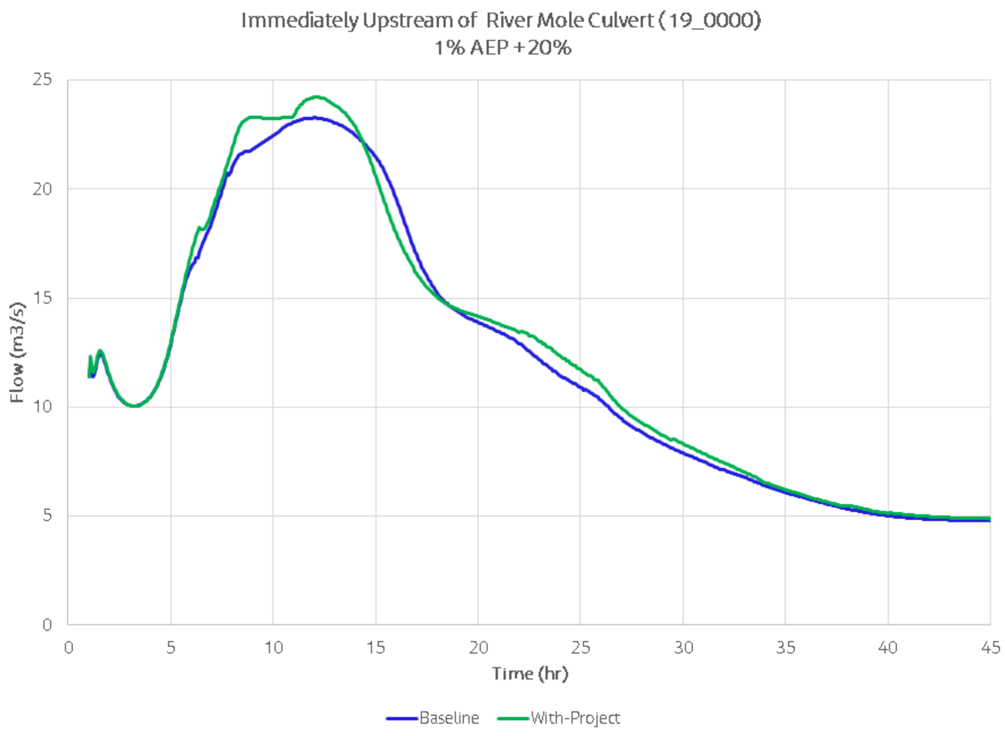


Figure 6-15: Change in peak flow in River Mole culvert due to Car Park X FCA - 1% AEP +20 % climate change (12 hours storm duration).

Syphons under Noise Mitigation Feature and Taxiways

6.2.14 Syphons are included in the construction of the north-west noise mitigation feature to maintain floodplain connectivity of a fluvial overland flow path that flows southwards from the Man's Brook to prevent increases to flood risk beyond Gatwick's boundary. Six 1.2m diameter syphons were incorporated into the structure of the noise bund as 1D Estry elements.

6.2.15 These syphons were inserted into the ground from between 0.3 and 0.8m to allow for capture of shallow sheet flows. These were sumped using a 2d_zsh Thick Line (Shape-width set to 10), at the pit location. In addition, these culverts have a raised manning's value of 0.025 and nodal storage on three of the syphons to help with stability issues occurring at these syphons. Inverts and diameters are assumed and will be re-assessed in detailed design.

6.2.16 Syphons have been added beneath the two end-around taxiways (east and west), to retain floodplain connectivity on the airfields (see Figure 6-17: End Around Taxiway West and End Around Taxiway East (Yankee) Syphons.).

6.2.17 The syphons are modelled as two groups of two circular culverts of 1.0m diameter using 1D Estry Elements (source: G20000-00-B-800-SE-000002 RET Syphons.pdf).

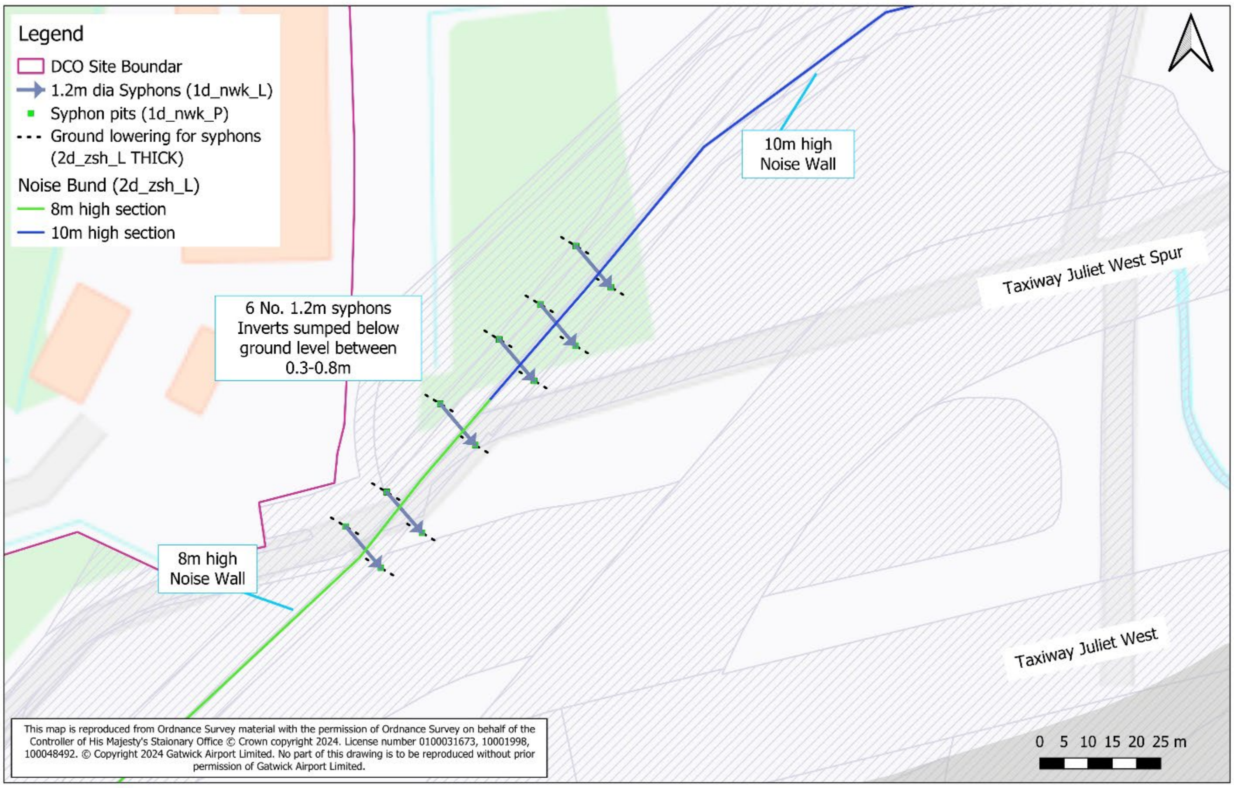


Figure 6-16: North West Noise Mitigation Feature Syphons.

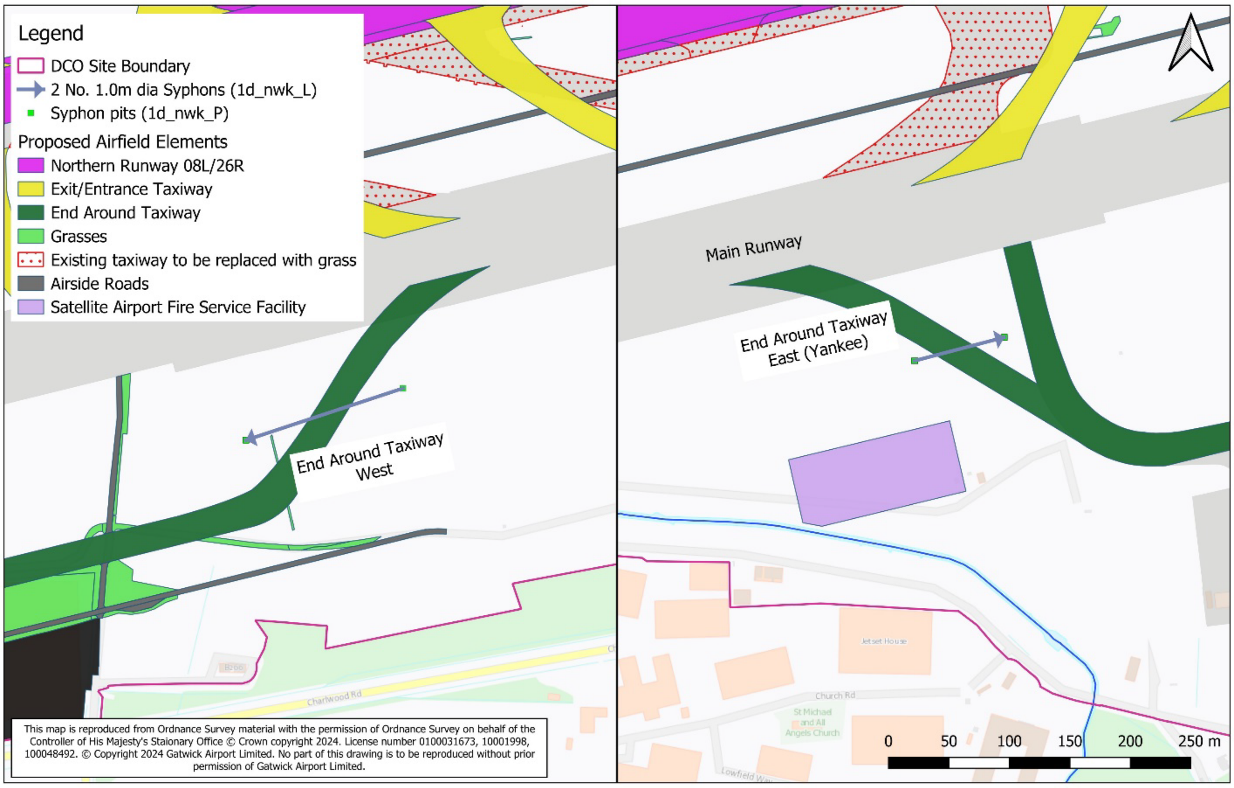


Figure 6-17: End Around Taxiway West and End Around Taxiway East (Yankee) Syphons.

Active Travel Path Culverts

6.2.18 To improve active travel routes between Longbridge Roundabout and North Terminal, a new proposed shared pedestrian and cyclist ramp to the south-east of A23 London Road River Mole bridge would provide enhanced connectivity to and from Riverside park for pedestrians and cyclists. The active travel path ramp up to the A23 London Road River Mole bridge cuts off an area of active floodplain between Car Park Y and the A23 Road embankment.

6.2.19 As described in paragraph 6.1.18, the location of the active travel path embankment has been relocated eastwards to reduce loss of River Mole floodplain. In addition 6No. 1.2m diameter culverts have been included beneath the active travel path (added as 1D Estry elements) to maintain floodplain connectivity in this section of floodplain between A23 London Road and Car Park Y. The culvert inverts and diameters are assumed and will be refined during detailed design.

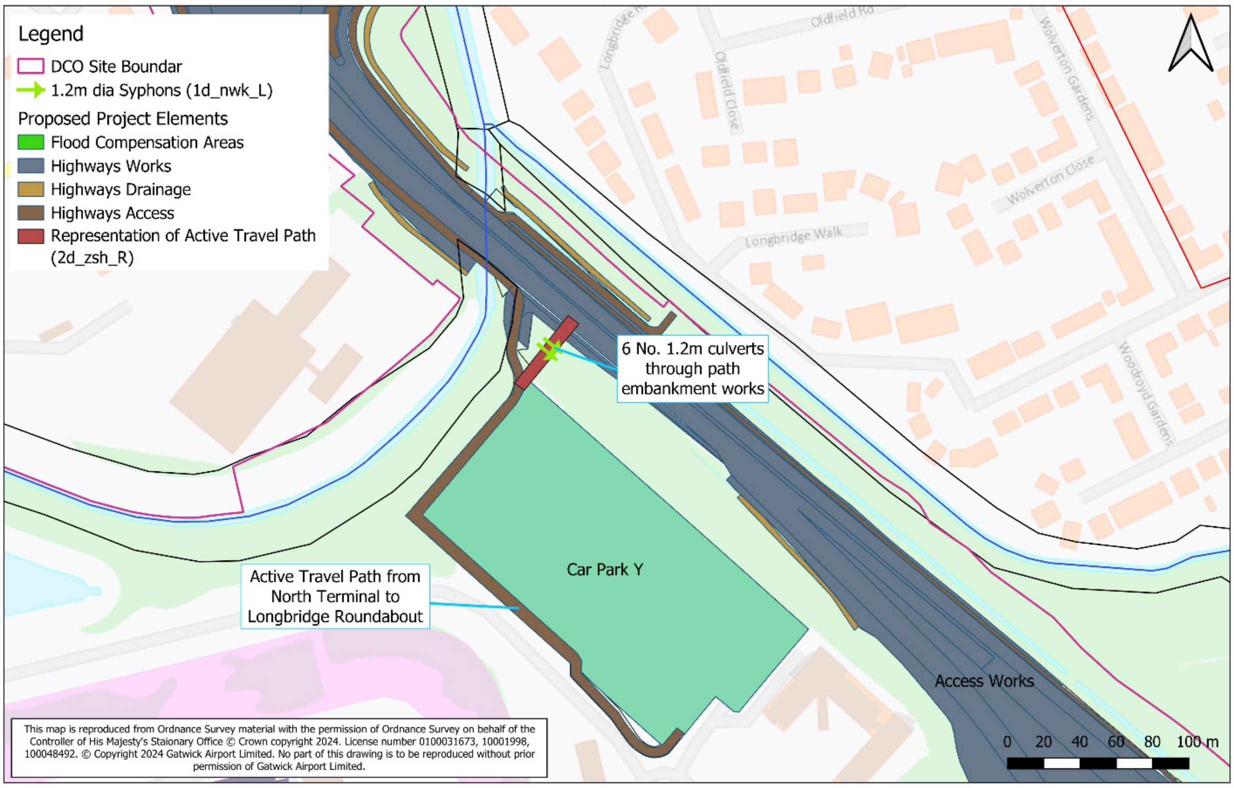


Figure 6-18: Active Travel Path route from North Terminal to Longbridge Roundabout.

River Mole Runway Culvert Inlet Weir

6.2.20 A small weir (300mm high) is proposed to the River Mole to improve fish passage by concentrating flows into a single box of the twin-box culvert during periods of low-flow. The new weir will be installed across the southern face of the east box of the culvert that conveys the river beneath the runways. The intention would be to increase low-flow water depths to facilitate fish passage through the culvert under the airfield during these periods.

6.2.21 In the 1D domain, a Weir has been added as a spill unit (19_0000cvRU) between 19_0000 and 19_0000cvRU1 which has an elevation of 55.690mAOD, 300mm higher than the 19_0000cvRU1 invert of 55.360mAOD.

7 Construction Scenario Model Build

7.1 Construction Sequencing

7.1.1 Construction scenarios were considered with the River Mole fluvial modelling to assess their respective impact on fluvial flood risk. The following three periods of construction were modelled:

1. Pre-Initial Construction Period (2024): beginning of construction prior to any mitigation measures;
2. Initial Construction Period (2024 up to 2029): to completion of airfield works; and
3. First Full Year of Opening (2029 up to 2032): to completion of surface access works.

7.1.2 For each period of the construction works, a model version was developed incorporating the elements of the Project as described in the following sections and in Table 7.1, Table 7.2 and Table 7.3, in accordance with the indicative construction sequencing detailed in Figure 14-8: and Figure 14-9. In addition, Table 6.1 detailed each of the Project elements that have been implemented in the With-Project model build, and their construction sequencing.

7.1.3 Construction activities would continue until 2038 and completion of all works associated with the Project. However works between the Interim Assessment Year (2032) and the Design Year (2038) would not affect fluvial flood risk because they are either inside buildings or outside the floodplain. The 2047 assessment year is principally required by National Highways and is focussed on traffic numbers, therefore the With-Project scenario was used to assess both of these construction periods, as all construction is completed by this date and is in effect in full operation by 2032.

7.1.4 The temporary compounds were not represented in the 2D domain within each construction scenario. Where compounds are inundated in the 1%AEP+16%CC flood event, the climate change allowance for the 2020s epoch as detailed in Section 3.2, the compound would be subject to operational mitigation measures as set out in the **ES Appendix 5.3.2: Code of Construction Practice Annex 1 - Water Management Plan** [APP-083] to ensure no increase to flood risk, including signing up to flood warnings and locating all buildings outside the construction scenario flood extent where practicable or elevating them above the 1%AEP+16%CC peak water level.

7.1.5 The model results associated with these construction period scenarios are reported in the **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].

7.2 Pre-Initial Construction Period (2024)

7.2.1 A sensitivity test was run to assess the impact of the proposed temporary haul road crossing of the River Mole approximately 370m to the west (downstream) of its exit from the runway culvert, required to provide access for the construction of the Museum Field FCA and would be in place before and during the construction of the compensatory flood storage. This crossing would create an access/haul road from Museum Field to Pentagon Field to transport the excess excavated material through Gatwick Campus to avoid the need to use local public roads. The proposed location of this haul road, and it’s approach ramps, are located within the EA Flood Zone 3b, therefore resulting in this sensitivity check.

7.2.2 As the design of the temporary crossing is at outline stage, a 1%AEP+16%CC event standard is proposed to be used to set the soffit of the crossing structure, therefore no structure was added to the 1D domain.

7.2.3 It is assumed the crossing would be clear span with footings set back a minimum of 5m from top of the riverbank, approach ramps have been modelled as solid objects in the 2D domain using 2d_zsh files, set to 20m in length and 8m wide. The level of the bridge deck has been set to 58.9 and 59.0m AOD on the southern and northern sides of the River Mole respectively.

Table 7.1: Modification made to the Baseline model for the Pre- Initial Construction Period scenario.

Project Element	Description	Model Modifications
Museum Field Haul Road Watercourse Crossing	8m wide, 20m in length solid approach ramps to deck level above the 1%+16%CC peak water level.	Ramps added to 2D domain using 2d_zsh raising from existing ground level to the 1%+16%CC peak water level as seen in No changes made to theFigure 7-1:. 1D domain at this stage as soffit level of bridge will be set at later design stages based on the peak design water level

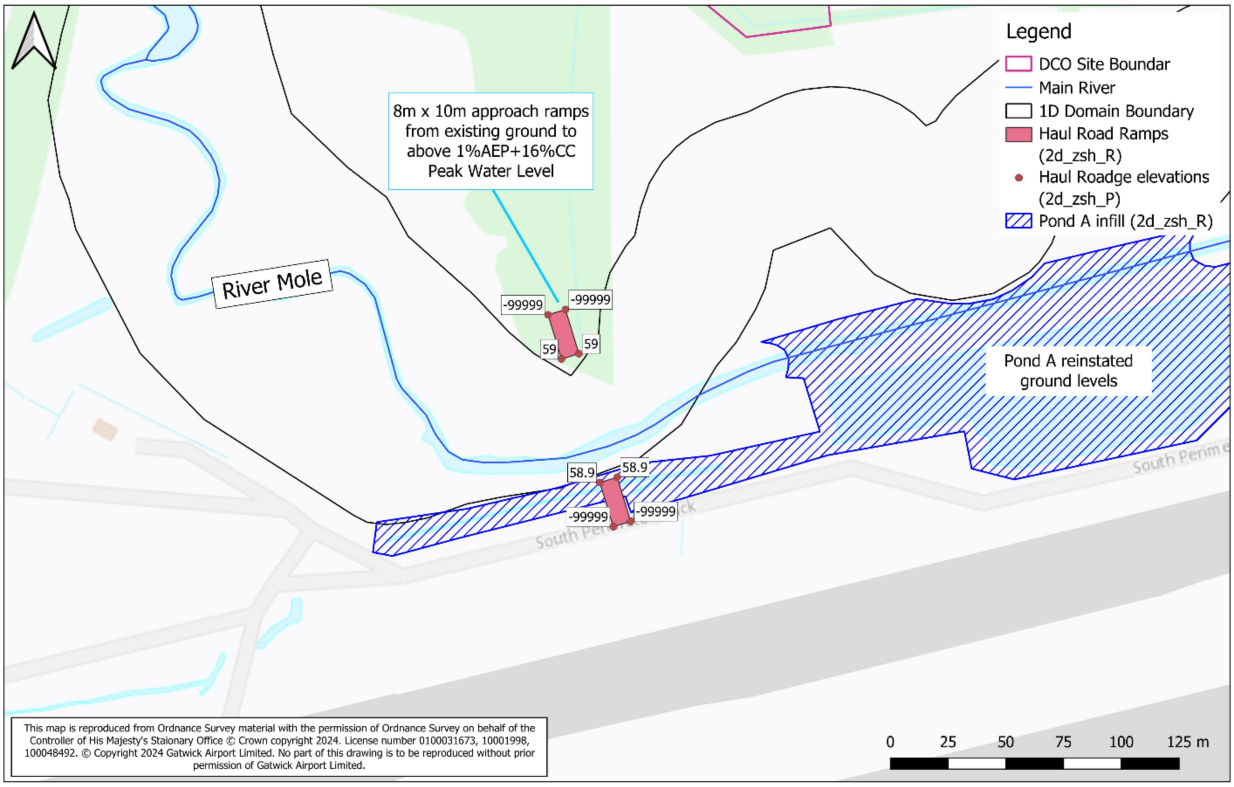


Figure 7-1: Temporary Haul Road Bridge over the River Mole setup in the 2D Domain.

7.3 Initial Construction Period (2024 – 2029)

7.3.1 During the Initial Construction Period (2024-2029) the following elements of the Project, described in Sections 6.1 and 7.2, would be constructed:

- River Mole re-alignment and associated Pond A earthworks
- Airfield Surface works (only elements completed in this construction period)
- Museum Field FCA
- Car Park X FCA
- Northwest Noise Bund including its flood mitigation syphons.

7.3.2 The temporary Museum Field Haul Road over the River Mole would still be in place during the entirety of the Initial Construction Period, as per Table 7.1.

7.3.3 Construction of the new airfield surface will commence during the Initial Construction Period (2024-2029); however these works will not be complete until the First Full Year of Opening (2029-2032) as set out in Figure 14-8. Therefore the 3D airfield surface ascii described in Section 6, has been clipped to include only those works completed by 2029, which excludes Taxiway Juliet West Spur and Taxiways Whiskey, Victor and Zulu which can be seen in Figure 7-2.

7.3.4 Works to Longbridge Roundabout will commence in 2028, as stated Figure 14-9**Figure 14-9**, however, as the work elements interacting with the floodplain such as bridge works will begin in 2029, works to Longbridge Roundabout have not been included in hydraulic modelling for the Initial Construction Period (2024-2029) but in the First Full Year of Opening (2029-2032).

Table 7.2: Modifications specific to the Initial Construction Period (2024-2029) scenario

Project Element	Description	Model Modifications
Airfield Surface	Airfield works : ▪ Taxiway Juliet East (Code C and E) ▪ Taxiway Lima west extension ▪ Taxiway Tango cut-through ▪ Runway exits – northern runway to Taxiway Juliet ▪ Repositioned Northern Runway ▪ Taxiway Juliet West ▪ Runway Exits – main runway to northern runway ▪ End around taxiway east	Asc layer used in With-Project model build has been clipped to only include those elements completed in the Initial Construction Period
Other Airfield Works	Stand Amendments, Reconfiguration of Airport Facilities, Internal Access Routes, Terminal Extensions, Hotels, Car Parking and Landscaping and Ecological Planting as detailed in Figure 14-8	2D roughness updated in With-Project TUFLOW material layer roughness zone

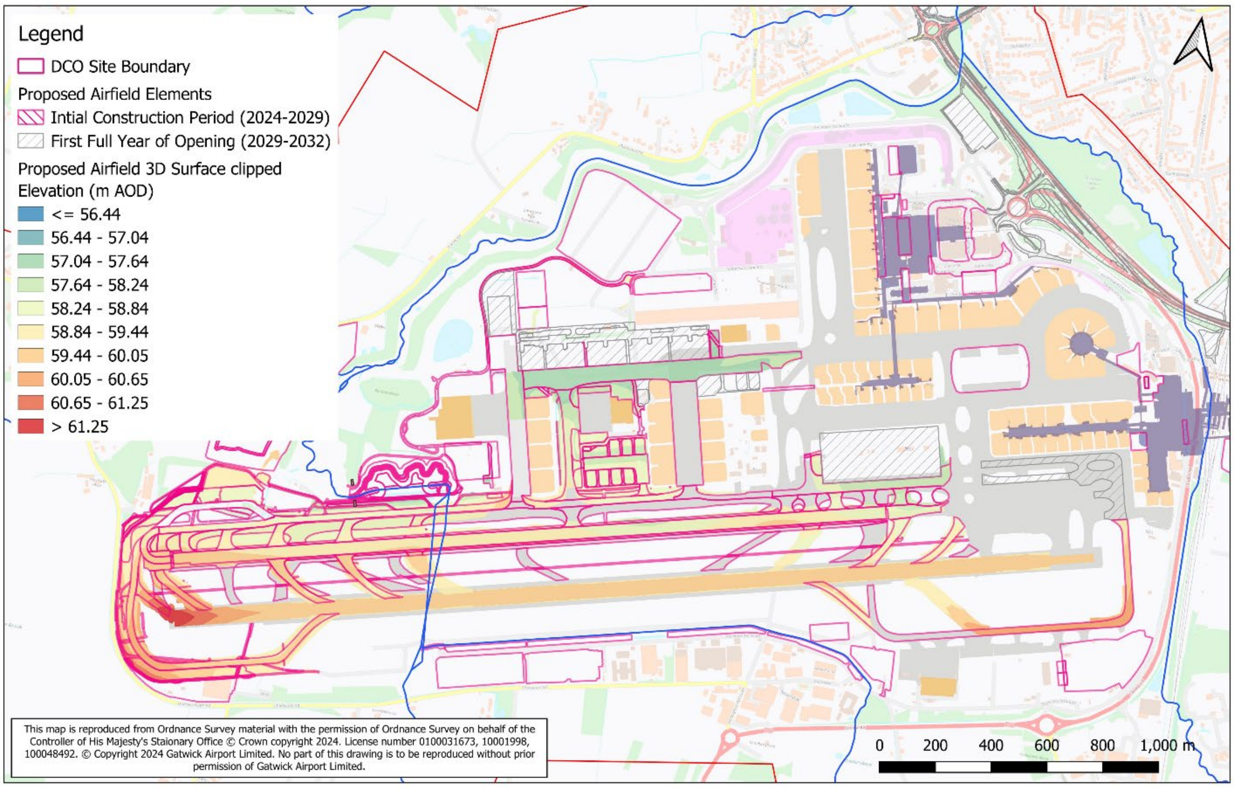


Figure 7-2: Initial Construction Period (2024 – 2029) 3D surface addition and airfield developments.

7.4 First Full Year of Opening (2029-2032)

7.4.1 During the First Full Year of Opening period (2029-2032), the following elements of the Project would be constructed:

- Completion of the new airfield surface
- Taxiways Whiskey, Victor and Zulu
- Access works including:
- Longbridge roundabout works
- North Terminal roundabout works
- South Terminal roundabout works
- Mitigation culverts through the active travel path at Car Park Y
- Temporary pedestrian and utilities bridges over River Mole at London Road and Brighton Road (both upstream and downstream) at Longbridge roundabout works

7.4.2 Location of the piers of the temporary bridges at both London Road and Brighton Road bridges can be seen in Figure 7-3:, and were provided by the Project Constructability team (source: GSA-Brighton Road -Temp-footings.dwg and GSA-London Road -Temp-footings.dwg).

Table 7.3: Modifications specific to the First Full Year of Opening (2029-2032) scenario

Project Element	Description	Model Modifications
Temporary pedestrian and utilities bridges	Temporary pedestrian and utilities bridges over River Mole at London Road and Brighton Road (both upstream and downstream) at Longbridge roundabout works	Location of piers were as raising 5m x 5m grid cell up to a assumed value of 60m AOD above the 1%AEP+16%CC peak water level. Flow constrictions were also applied to ensure adequate representation in the 2D domain.

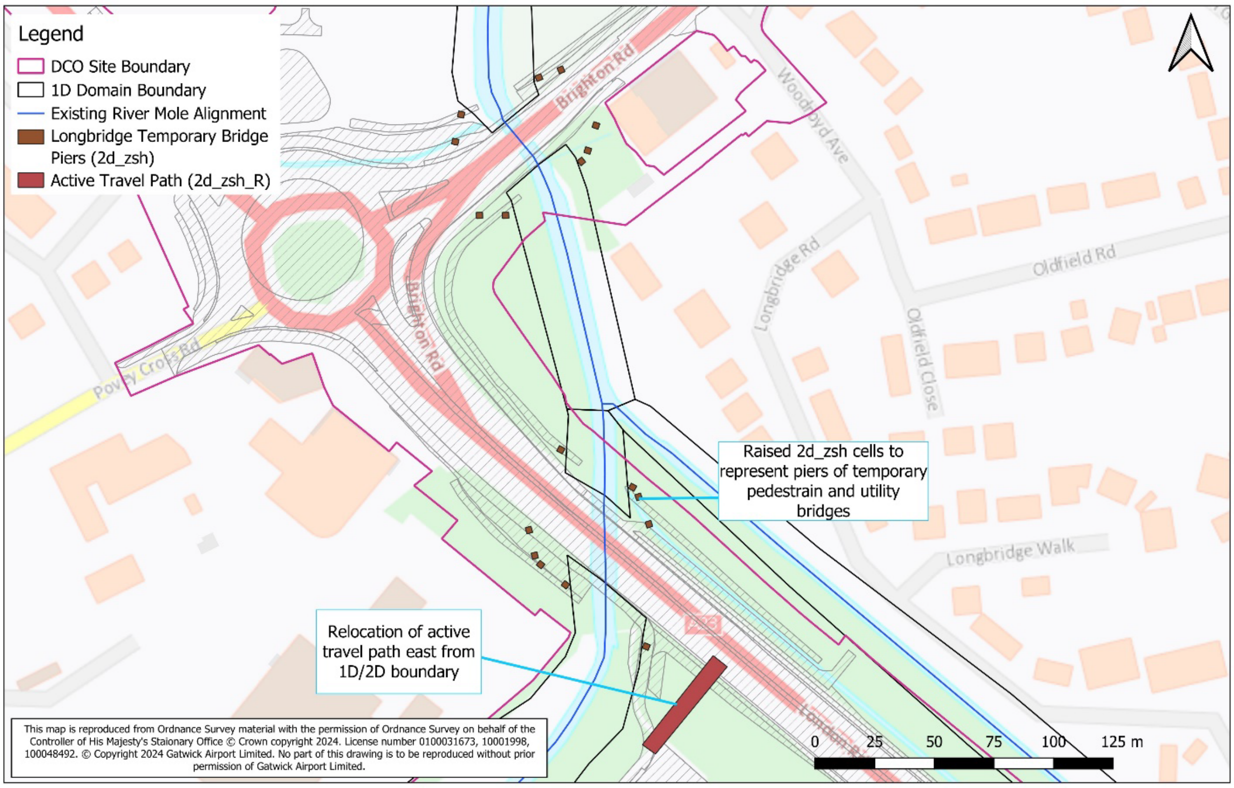


Figure 7-3: First Full Year of Opening (2029-2032) temporary bridge pier locations.

8 Undefended Model Build

8.1 Undefended Baseline

8.1.1 The Upper Mole Fluvial Flood Modelling Study (Jacobs, 2018) details all defence assets included within the Baseline model.As part of this study, an undefended scenario has been run with the Baseline model to provide a basis for comparison to the published EA Flood Zones. The undefended scenario consists of the removal of EA flood defences and Flood Storage Areas (FSAs) across the Upper Mole catchment, and the Undefended With-Project scenario combines their removal with the Project elements. To replicate this the components listed in Table 8.1 were removed from the with-Project model:

Table 8.1: List of flood defences modified for Undefended Baseline scenario.

Flood Defence	Description	Undefended Baseline Modifications[1]
Gatwick UMFAS	Online 1D sluice structure and 2D offline storage on the Gatwick Stream immediately upstream of the DCO boundary	Removed asc layer covering Gatwick FSA storage area, and 2d_zln which reinforced bank and embankment levels.
Worth Farm FSA	Online 1D structure and 2D storage area	Removed asc layer which was informed by Worth Farm FSA.
Clays Lake	Spillway	2d_zln reinforcing spillway was removed
Ifield Mill Pond	Online structure and storage area	2d_zln removed which stamped dam crest and Upper spillway levels onto 2d domain
Tilgate Reservoir	1D online structure and storage area	Sluice gate and weir removed in the 1D and spillway removed from 2D domain

Notes (1) This is the baseline scenario, assuming conditions as surveyed before the UMFAS schemes and Gatwick Stream FAS.

8.1.2 The model results associated with the Baseline Undefended scenario are reported in the **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].

8.2 Undefended With-Project

8.2.1 The undefended With-Project scenario has been used to assess and understand the potential impacts to the Project should the proposed flood defences fail. Assuming that any of the proposed Project mitigations would not engage or fail during a storm event, the Undefended With-Project scenario is the equivalent of the With-Project No-Mitigation scenario.

8.2.2 The following mitigation measures were removed from the 2D Domain:

- Museum Field FCA; 2d_zsh layers including ground lowering for the basin and spillway
- Car Park X FCA; 2d_zsh layers including ground lowering for the basin, as well as 1d_nwk FCA outfall pipe and associated drain lowering 2d_zsh
- Noise Bund and Taxiway syphons
- Travel Path Culverts

8.2.3 The model results associated with the With-Project Undefended scenario are reported in the **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].

9 Model Proving

9.1 Introduction

9.1.1 This section sets out the numerical performance of both 1D Flood Modeller and 2D TUFLOW model components .

9.2 1D Flood Modeller Model Performance

9.2.1 Model run performance has been monitored during each simulation undertaken to ensure that suitable model convergence was achieved. Convergence refers to the ability of the modelling software to arrive at a solution that is close to the exact solution within a pre-specified error tolerance. The concept of an acceptable error range has been adopted by the developers of the software, as numerical errors occur due to the quality of the data used, limitations of the software and underlying equation solving processes.

9.2.2 The 1D model mass balance error as both a percentage of the peak system volume and a percentage of boundary inflow volume is output by Flood Modeller. The overall mass error for all calculations is less than 1% in all events and modelled scenarios. These percentages are therefore considered acceptable based on modelling best practice.

9.2.3 Figure 14-10 to Figure 14-13 show the convergence plots for the Baseline scenario 1% (1 in 100) AEP+20%CC 3-hr, 6-hr, 12-hr and 24-hr duration events. Model convergence issues are similar to the Upper Mole Fluvial Flood Modelling Study (Jacobs 2018) and are deemed acceptable.

9.2.4 Figure 14-14 to Figure 14-17 show the convergence plots for the With-Project scenario 1% (1 in 100) AEP+20%CC 3-hr, 6-hr, 12-hr and 24-hr duration events.

9.3 2D TUFLOW model performance

9.3.1 TUFLOW hydraulic modelling software provides run performance guidance along with acceptable error ranges that should be achieved during each model run. The accepted tolerance range recommended by the software manual is +/- 1% mass balance error.

9.3.2 For all simulations carried out for this study mass error outputs are all within this tolerance as shown for example for the 1% (1 in 100) AEP+ 20%CC 3-hr, 6-hr, 12-hr and 24-hr events - Baseline scenario in Figure 14-14 to Figure 14-17. The change in volume throughout the model simulation has also been checked and has been found to vary relatively smoothly which is another indicator of good convergence of the 2D model component.

9.4 Calibration and verification/validation

9.4.1 No further calibration/verification has been carried out beyond what was undertaken with the EA model in 2018.

10 Model Assumptions and Limitations

10.1.1 The accuracy and validity of the hydraulic model results is heavily dependent on the accuracy of the hydrological and topographic data included in the Upper Mole Fluvial Flood Modelling Study (Jacobs 2018), which provided further details are provided.

10.1.2 The Project design is currently at outline stage, with detailed design to follow the DCO consent application process. Therefore the model and subsequent impact assessment are based on a relatively high-level of design, but one which is commensurate with planning applications. The draft DCO incudes control measures to set the parameters of the detailed design and works within the floodplain would be subject to the usual Flood Risk Activity Permit (FRAP) process.

10.1.3 The Project design is subject to Limits of Deviation to provide a degree of flexibility for detailed design and construction. However as stated in paragraph 10.1.2 the evolution of the design would be subject to design controls and consenting via the FRAP process.

11 Conclusion

11.1.1 The purpose of the fluvial hydraulic modelling is to assess the impact of the Project on the existing fluvial flood risk to inform the project FRA, incorporating the predicted impacts of climate change into the assessment. Subsequently the model has then used to develop mitigation measures (if required) to ensure compliance with national planning policy: to mitigate any increase in fluvial flood risk as a result of the Project.

11.1.2 The main sources of flooding to the Project are fluvial and surface water. The FRA has therefore assessed these sources through hydraulic modelling. Fluvial flood risk has been assessed via the use of the Flood Modeller-TUFLOW River Mole fluvial model (also known as Upper Mole hydraulic model) that was originally developed collaboratively by the EA and GAL in 2018. The model represents flood risk associated with out of bank flooding from watercourses in the vicinity of the airport: Gatwick Stream, River Mole, Crawter's Brook and Man's Brook).

11.1.3 The baseline model has been further developed since 2018 in order to incorporate recent changes such as:

- 2022 LiDAR patch covering Pond M, Larkins Road and the Boeing Hangar to the west of the airfield.
- Updating operational control rules of the Gatwick UMFAS
- Redistribution of hydroloigical flows upstream of Gatwick (plus other amendments made by the EA to the model for consistency)

11.1.4 The model was run for the 10% (1 in 10), 3.33% (1 in 30), 1% (1 in 100) and, 0.5% (1 in 200) and 0.1% (1 in 1000) Annual Exceedance Probability (AEP) events plus the multiple allowances for Climate Change (CC) as detailed in Section 3.2.

11.1.5 For each event simulated, given the variability in catchment response across the contributary watercourses, each scenario was run for four critical storm durations: 3, 6, 12 and 24-hours, their results amalgamated into a worst-case flood extent, depth etc (see paragraph 1.3.7).

11.1.6 The following seven scenarios were run to ensure compliance with national planning policy, as well as to ensure mitigation measures prevent any increase in fluvial flood risk as a result of the Project during all various stages of the Project:

- Baseline (106C)
- With-Scheme (570D)
- Pre-Initial Construction Period (2024) (611B)

- Initial Construction Period (2024-2029) (621B)
- First Full Year of Opening (2026-2032) (651B)
- Baseline Undefended (901A)
- With-Project Undefended (or No-Mitigation) (801B)

11.1.7 The model results associated with these scenarios are reported in the **ES Appendix 11.9.6: Flood Risk Assessment** [AS-078].

12 References

Jacobs (2022) Upper Mole Baseline Fluvial Hydraulic Model Build Report - GALCTC25-JAC-EWE-SCHW-RP-LE-0001

Environment Agency (2022) Flood Risk Assessments: Climate Change Allowances. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

13 Glossary

13.1 Glossary of terms

Table 13.1: Glossary of terms

Term	Description
AEP	Annual Exceedance Event
CC	Climate Change
ES	Environmental Statement
DTM	Digital Terrain Model
FAS	Flood Alleviation Scheme
FCA	Flood Compensation Area
Flood Modeller	Flood Modeller 1D modelling software
FRA	Flood Risk Assessment
FRAP	Flood Risk Activity Permit
FSA	Flood Storage Area
ICM	InfoWorks Integrated Catchment Modelling software
LiDAR	Light Detection and Ranging A remote sensing technique to map the earth's surface
TUFLOW	TUFLOW 2D modelling software

14 Figures

14.1 Design Drawings informing With-Project Build

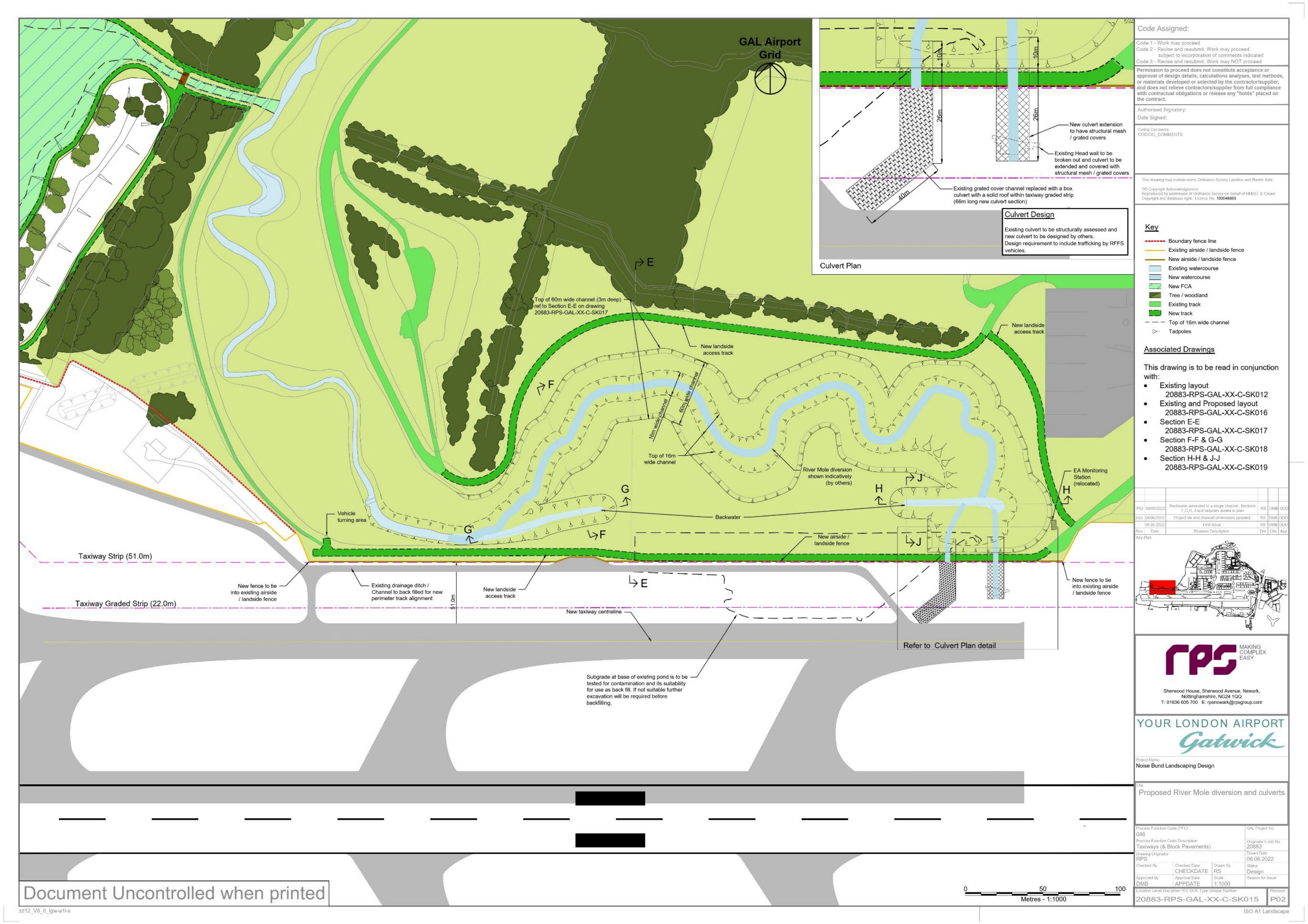


Figure 14-1: Realigned River Mole Preliminary Design.

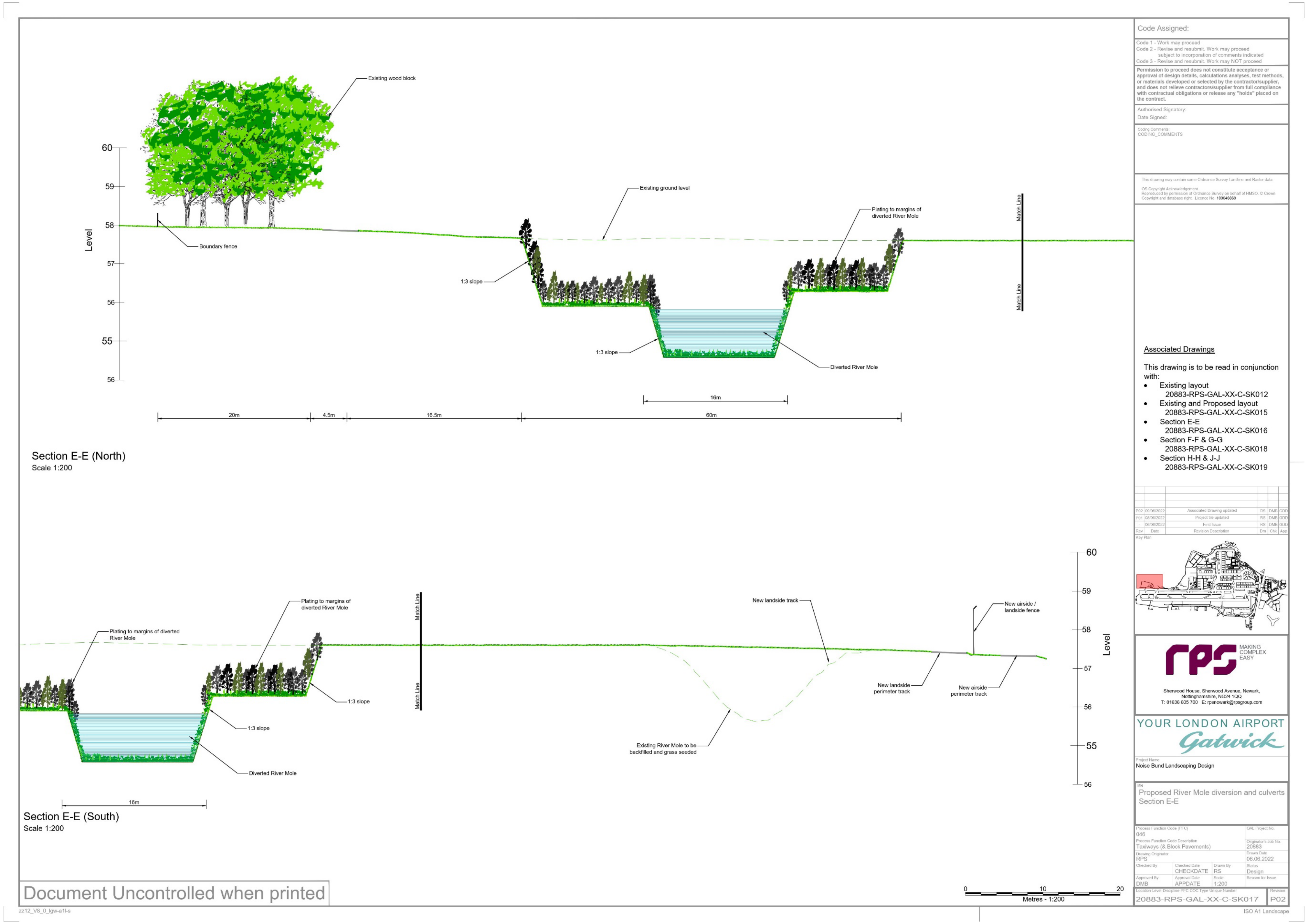


Figure 14-2: Preliminary Realigned River Mole Two-stage Sections.

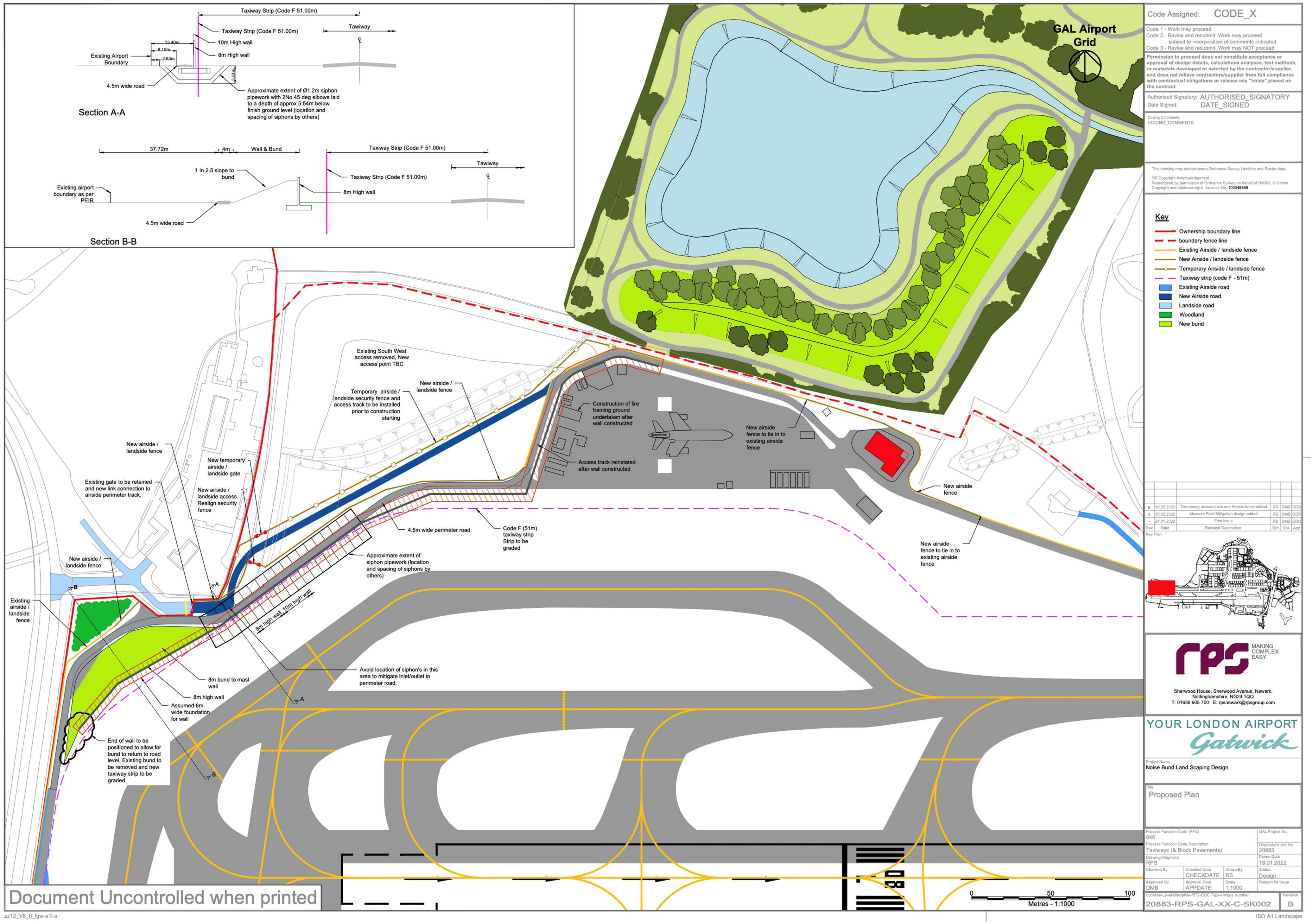


Figure 14-3: Western Noise Bund Design.

Figure 14-4: Preliminary Museum Field FCA Design.

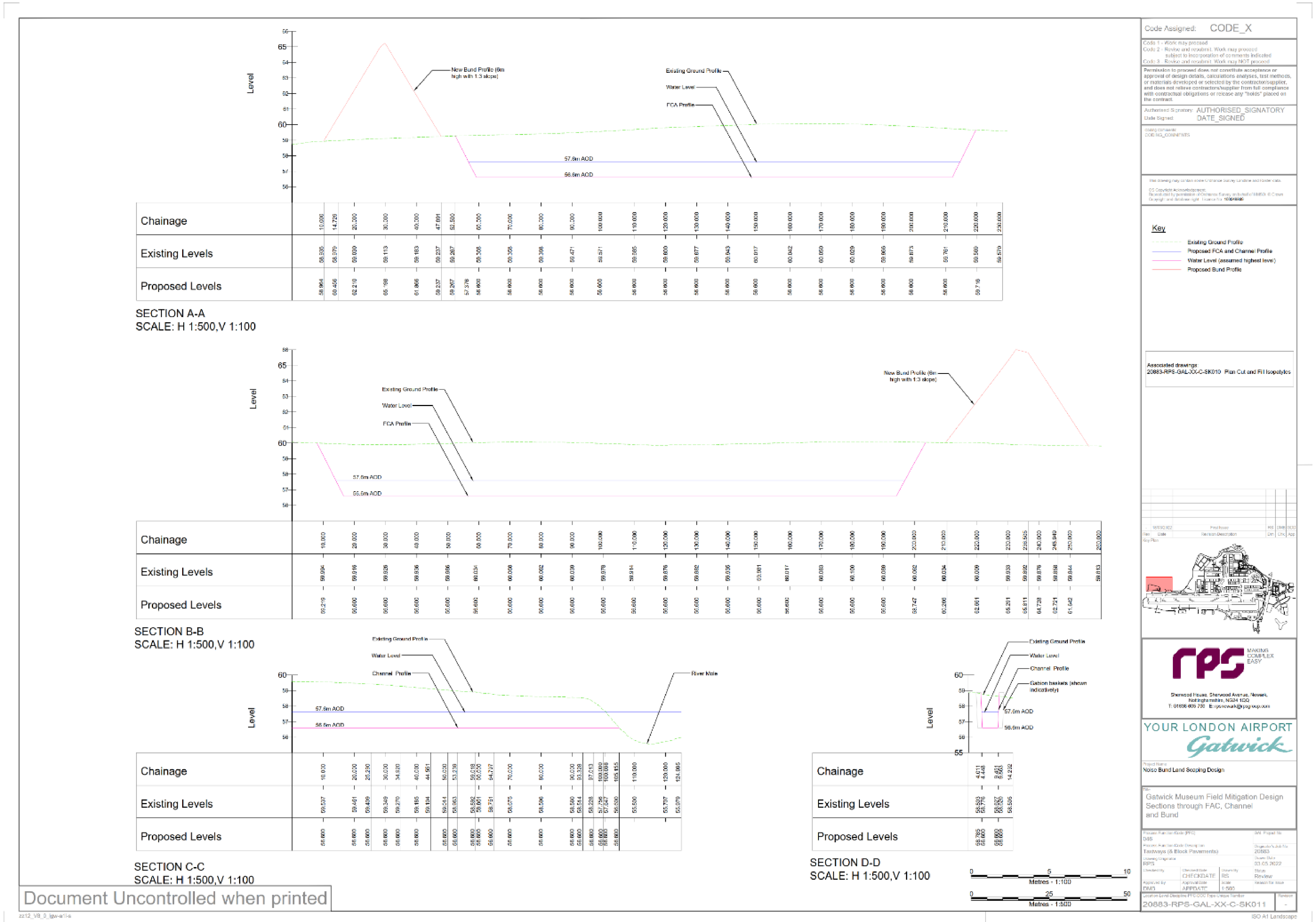


Figure 14-5: Preliminary Design Museum Field FCA Section.

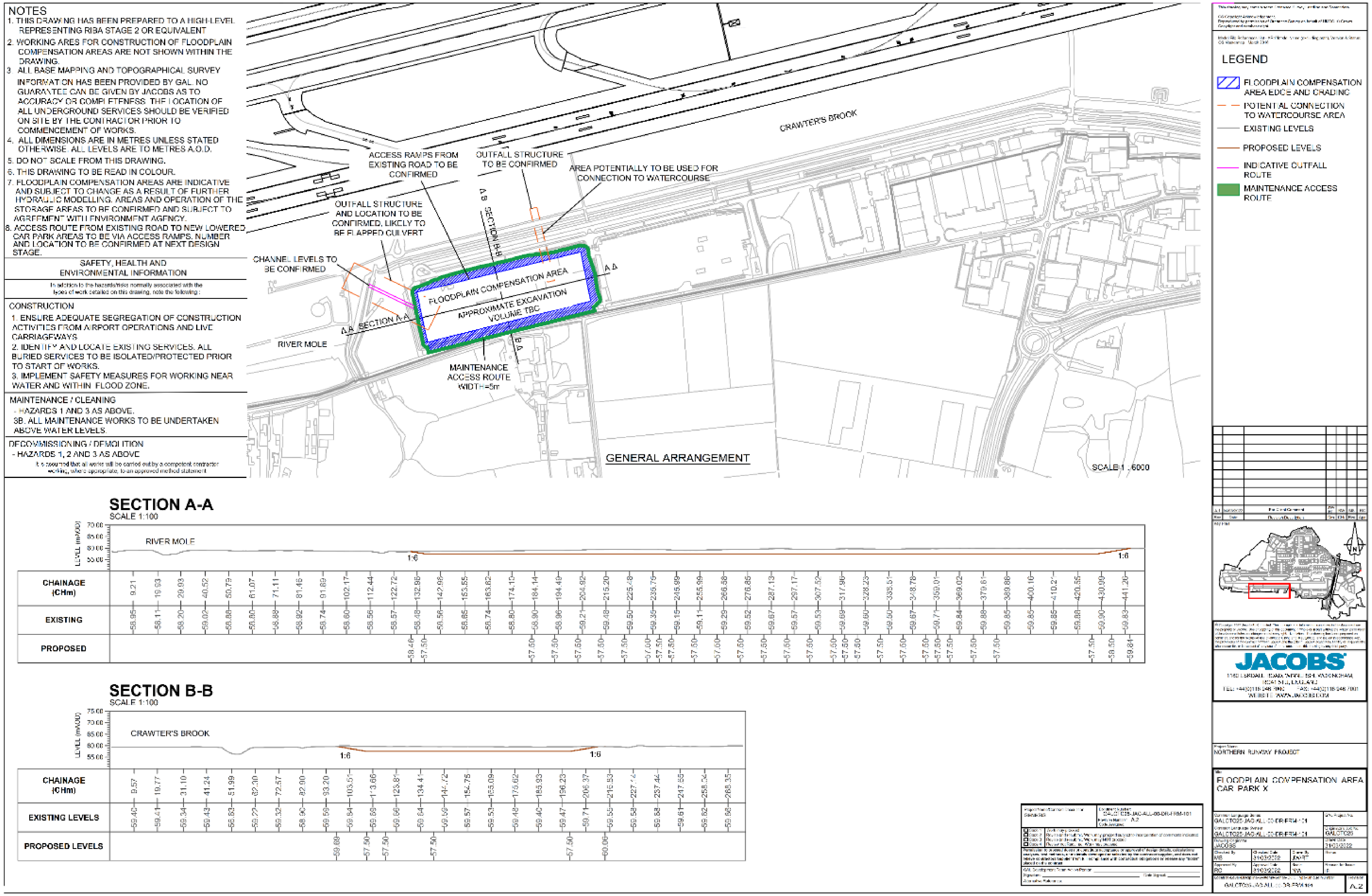


Figure 14-6: Preliminary Design Car Park X FCA.

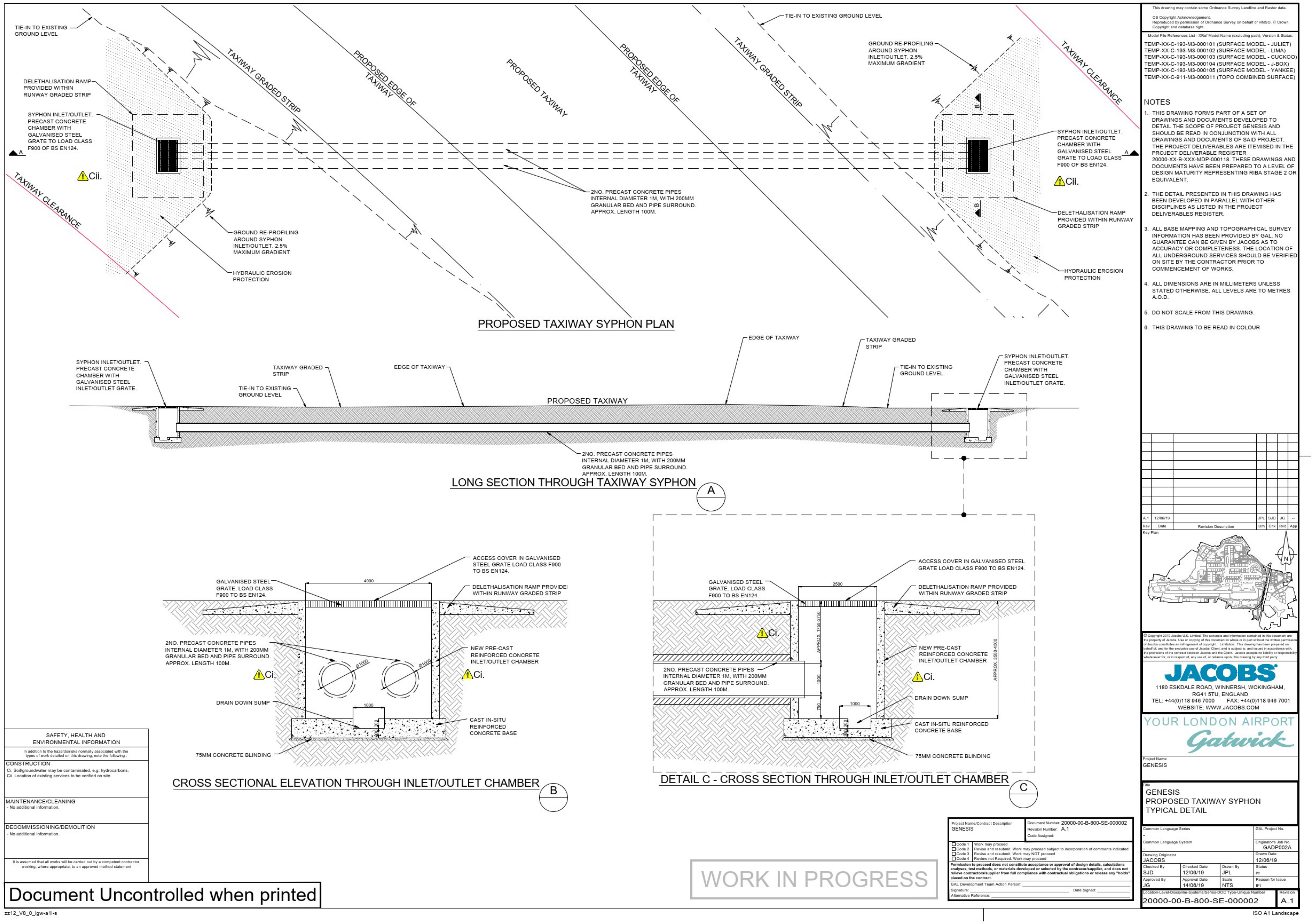


Figure 14-7: Taxiway Syphon typical detail design.

14.2 Indicative Construction Sequencing

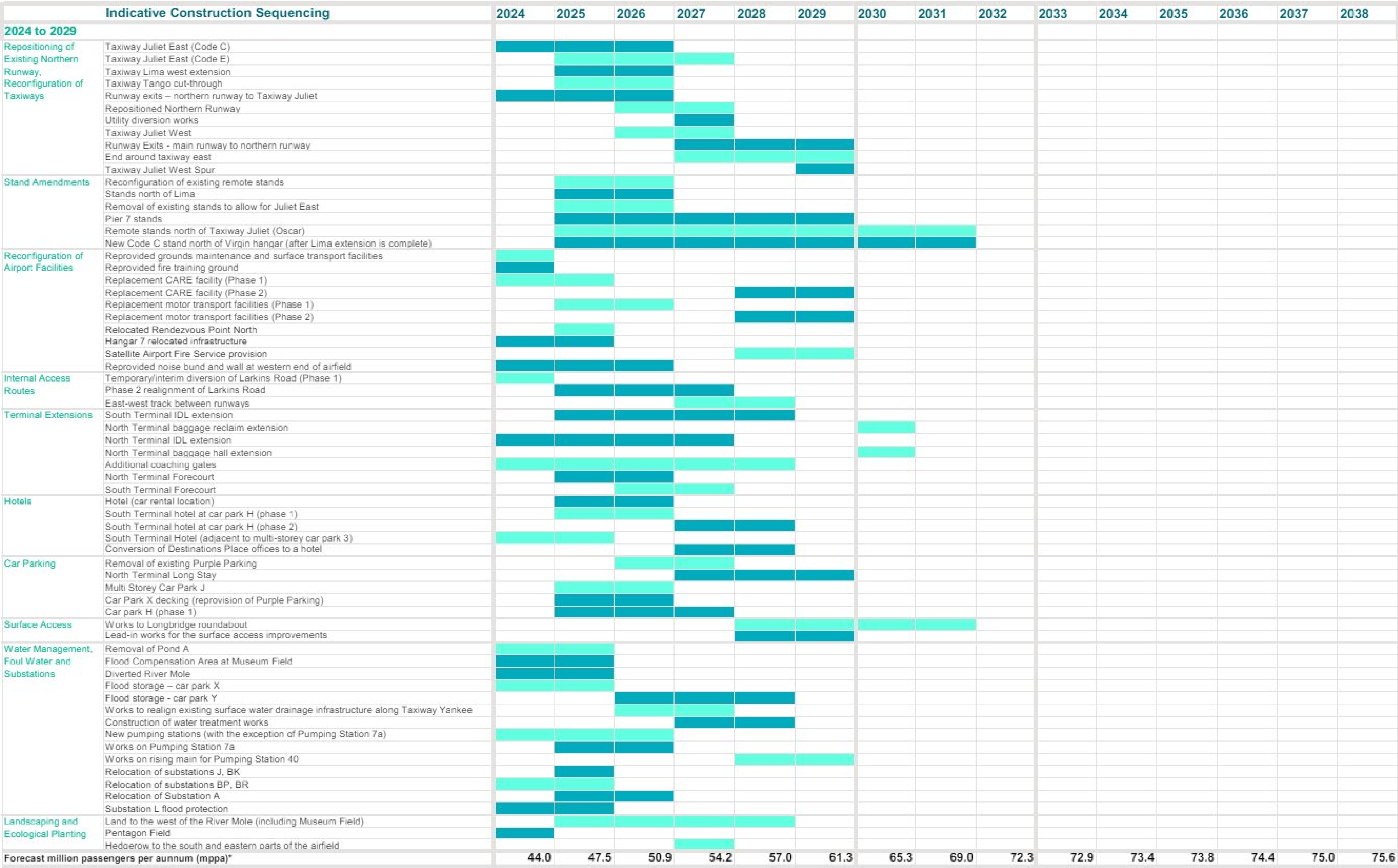
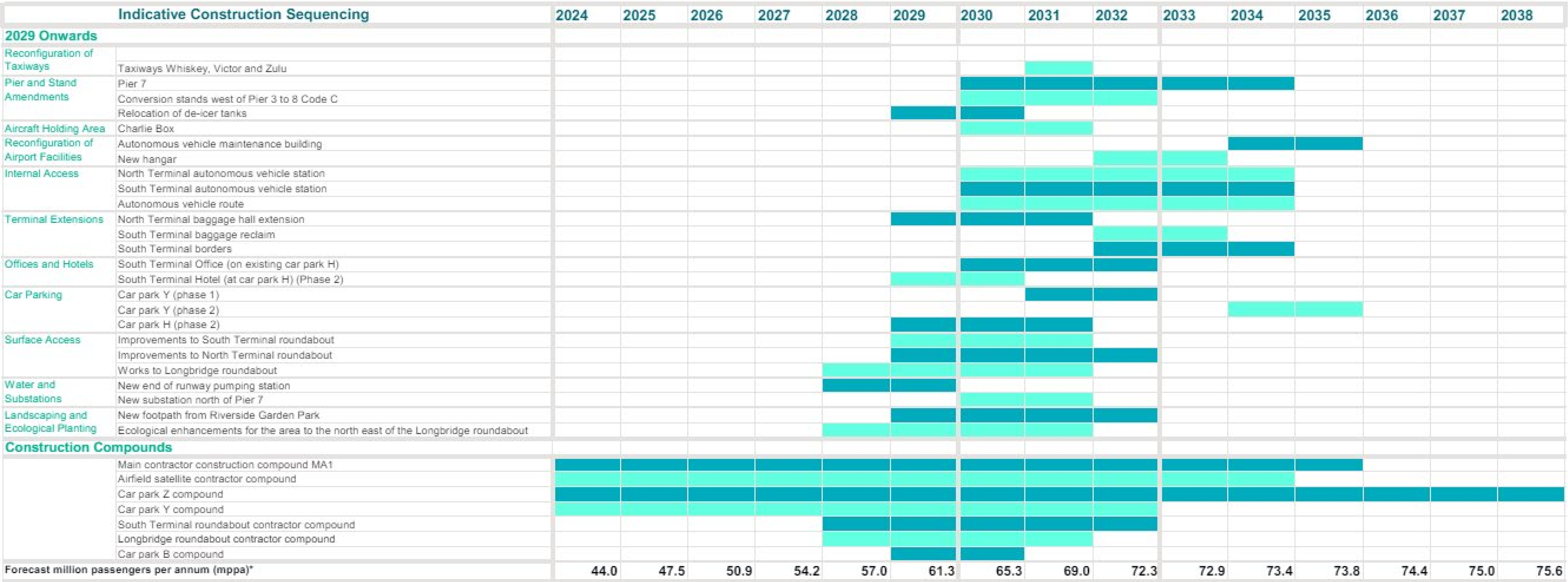


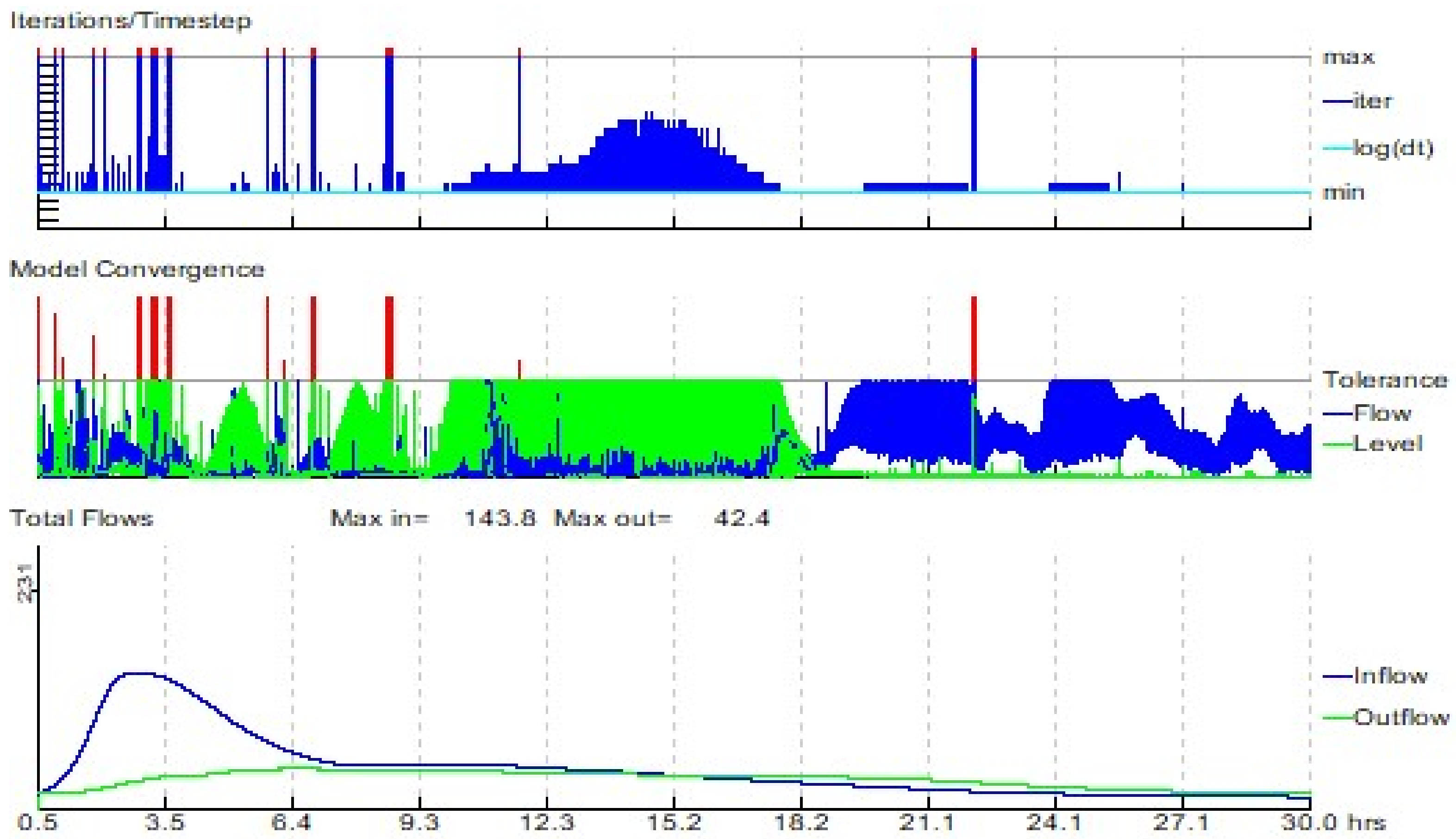
Figure 14-8: 2024 to 2029 Indicative Construction Sequencing (source: Appendix 5.3.3 – Indicative Construction Sequencing [APP-088]).



*Forecast passenger figures have been calculated based on financial year, rather than calendar year. For example, the figure quoted for 2024 represents forecasts for the financial year 2024/2025 (12 months to March 2025).

Figure 14-9: 2029 Onwards Indicative Construction Sequencing -(source: Appendix 5.3.3 – Indicative Construction Sequencing [APP-088]).

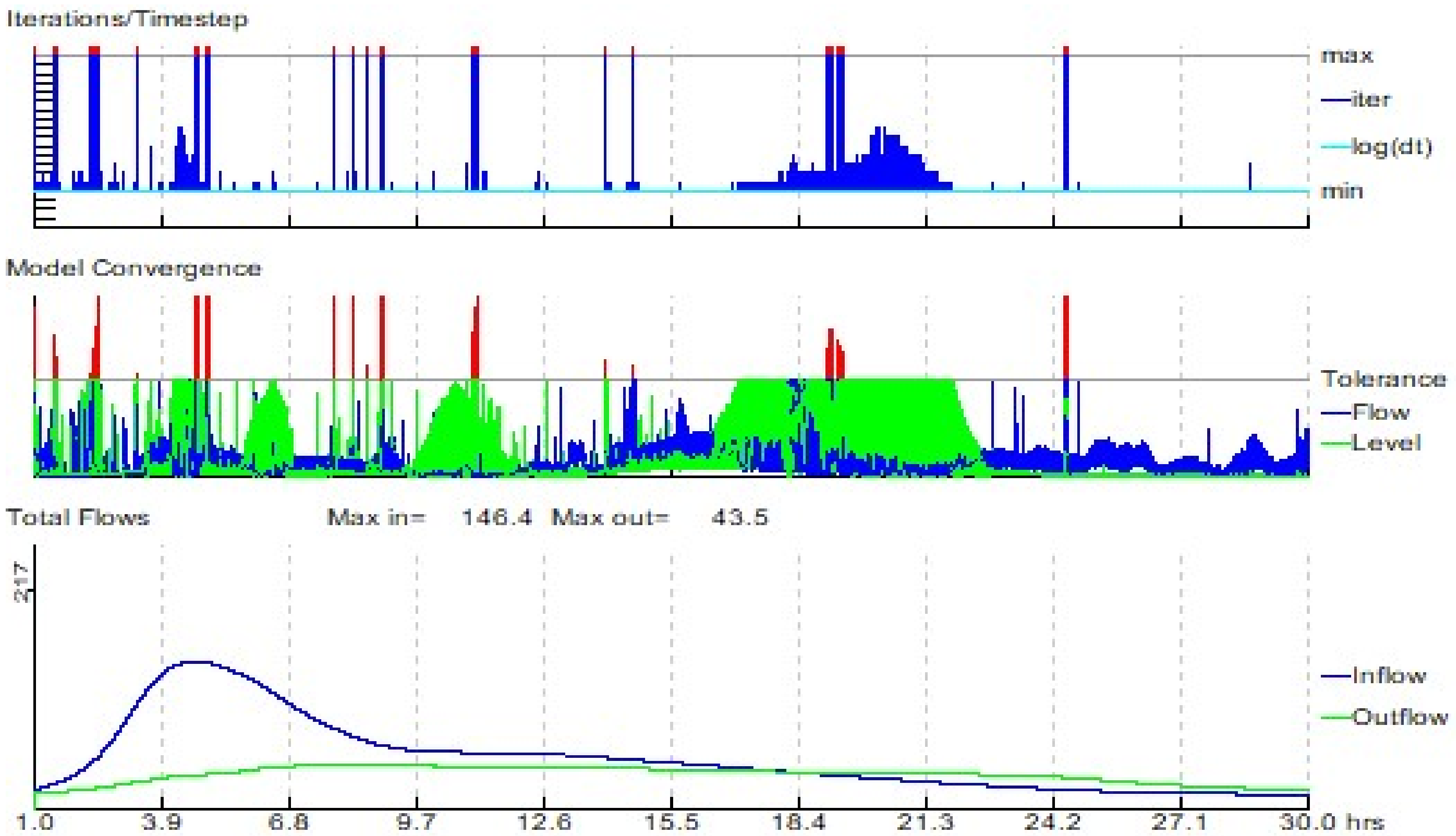
14.3 Flood Modeller Model Convergence plots



Datafile: ...\.._1D\UPPERMOLE_UMFAS_CULVERT_023.DAT
Results: ...\106C_GAL_GENESIS_100YRCC20PCT3HR.zzl
Ran at 13:47:25 on 27/04/2023
Ended at 11:33:18 on 28/04/2023
Start Time: 0.500 hrs
End Time: 30.000 hrs
Timestep: 1.0 secs

Current Model Time: 30.00 hrs
Percent Complete: 100 %

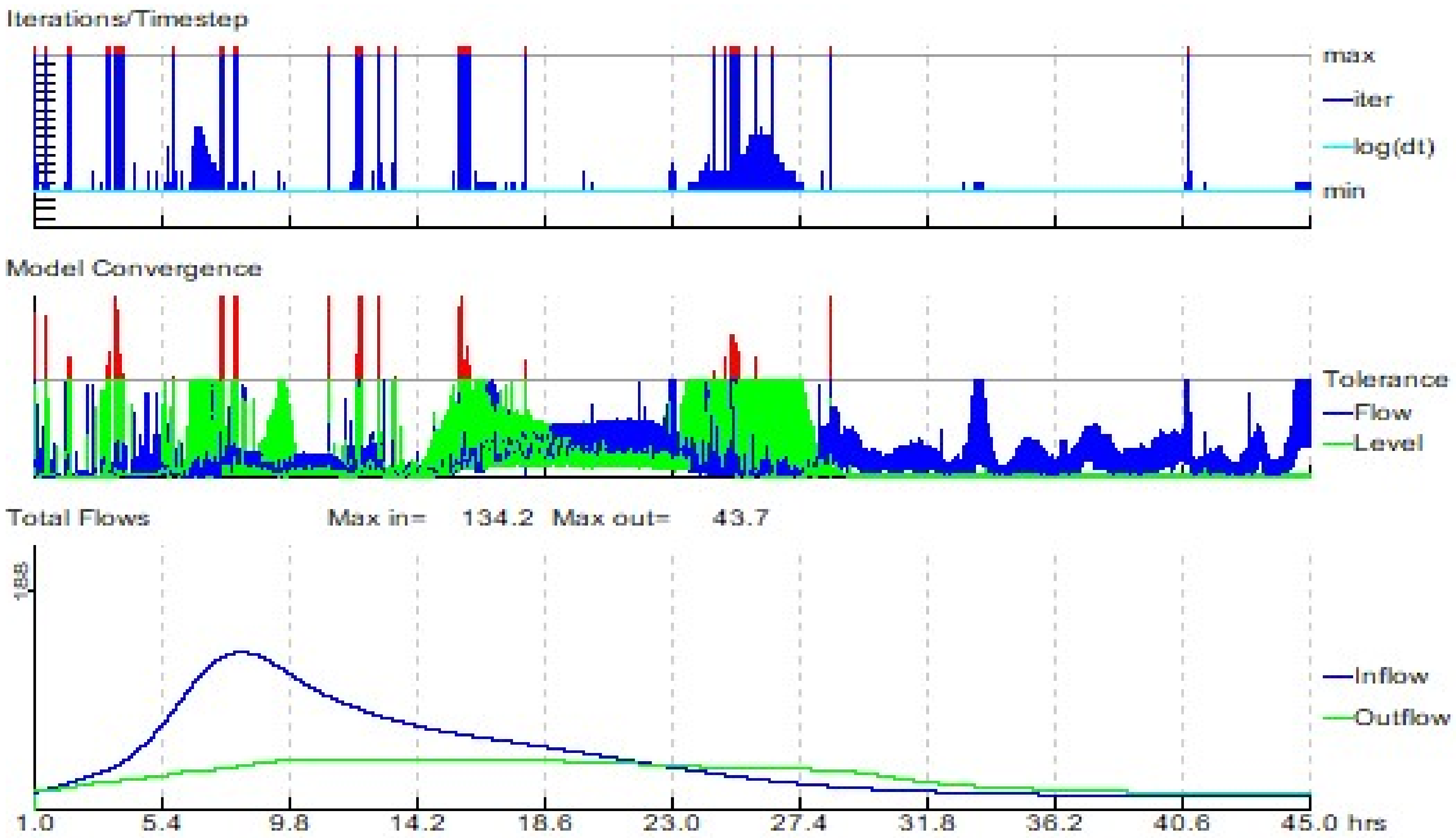
Figure 14-10: Flood Modeller Model Convergence plot – Baseline 1% AEP +20% CC, 3 hours event.



Datafile: ...\.._1D\UPPERMOLE_UMFAS_CULVERT_023.DAT
Results: ...\106C_GAL_GENESIS_100YRCC20PCT6HR.zzl
Ran at 15:45:24 on 28/04/2023
Ended at 10:39:57 on 29/04/2023
Start Time: 1.000 hrs
End Time: 30.000 hrs
Timestep: 1.0 secs

Current Model Time: 30.00 hrs
Percent Complete: 100 %

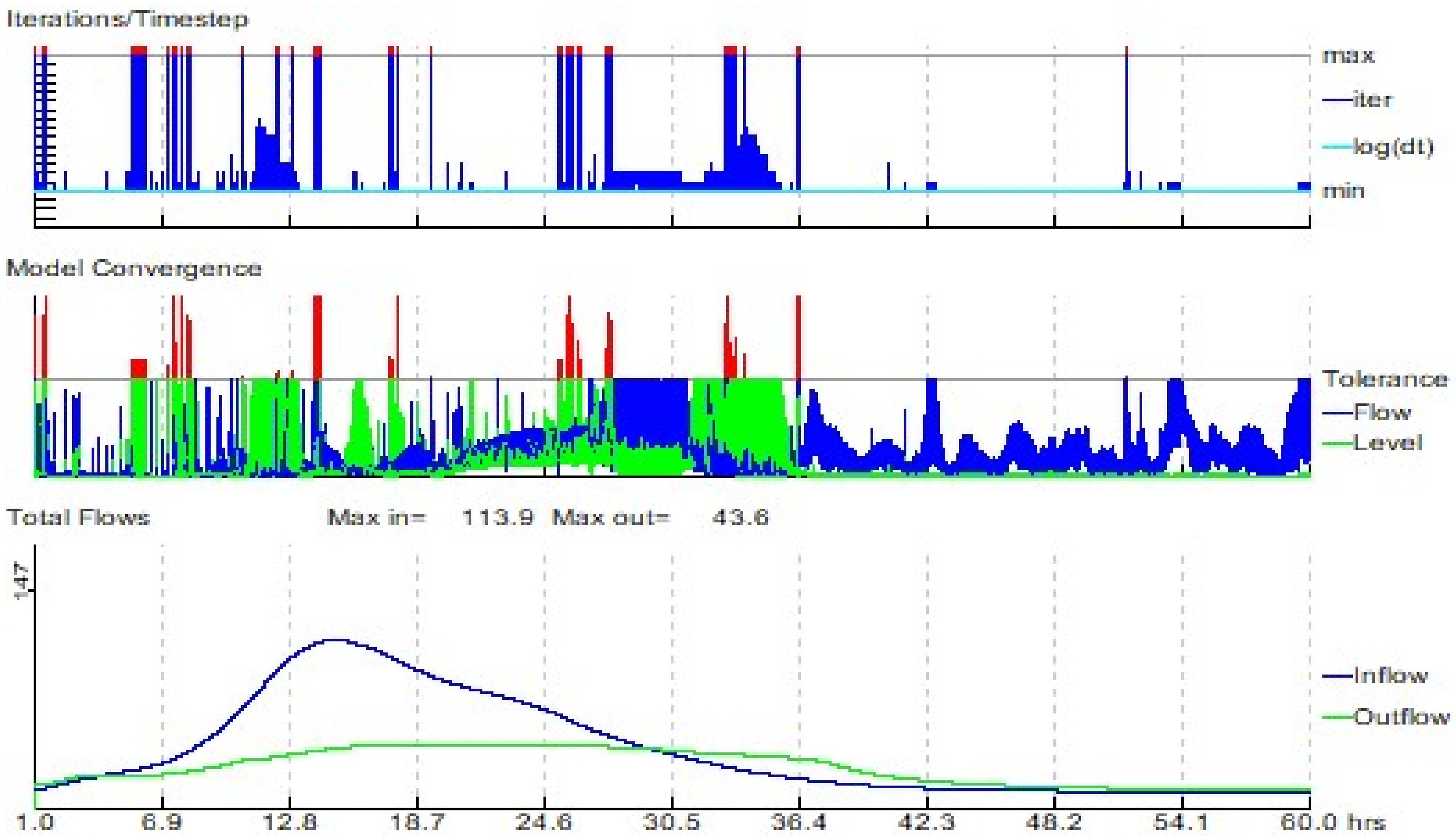
Figure 14-11: Flood Modeller Model Convergence plot – Baseline 1% AEP +20% CC, 6 hours event.



Datafile: ...\.._1D\UPPERMOLE_UMFAS_CULVERT_023.DAT
Results: ...\106C_GAL_GENESIS_100YRCC20PCT12HR.zzl
Ran at 15:45:42 on 28/04/2023
Ended at 03:18:26 on 30/04/2023
Start Time: 1.000 hrs
End Time: 45.000 hrs
Timestep: 1.0 secs

Current Model Time: 45.00 hrs
Percent Complete: 100 %

Figure 14-12: Flood Modeller Model Convergence plot – Baseline 1% AEP +20% CC, 12 hours event.



Datafile: ...\.._1D\UPPERMOLE_UMFAS_CULVERT_023.DAT
Results: ...\106C_GAL_GENESIS_100YRCC20PCT24HR.zzl
Ran at 15:45:39 on 28/04/2023
Ended at 20:01:35 on 30/04/2023
Start Time: 1.000 hrs
End Time: 60.000 hrs
Timestep: 1.0 secs

Current Model Time: 60.00 hrs
Percent Complete: 100 %

Figure 14-13: Flood Modeller Model Convergence plot – Baseline 1% AEP +20% CC, 24 hours event.

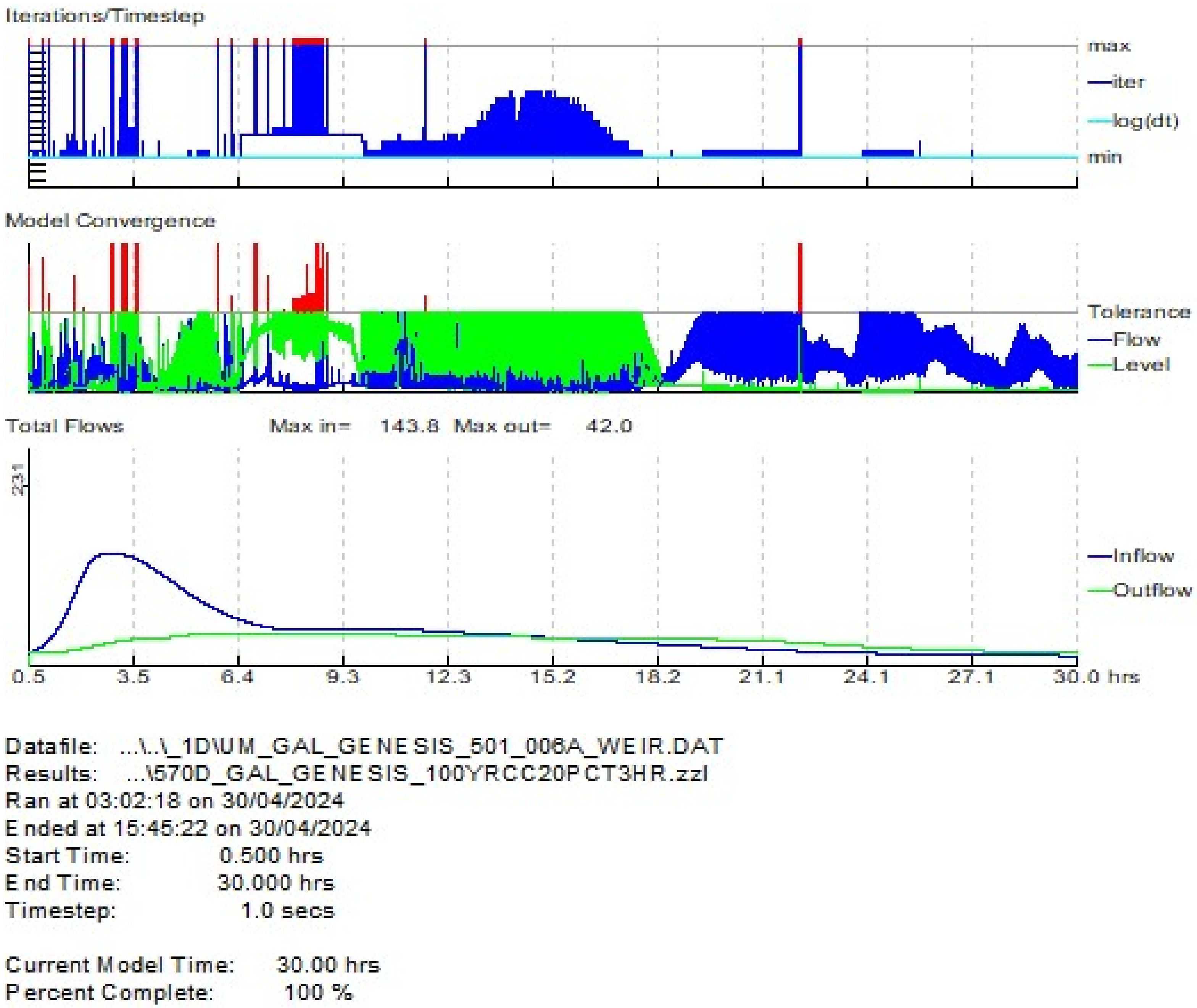


Figure 14-14: Flood Modeller Model Convergence plot – With-Project 1% AEP +20% CC, 3 hours event.

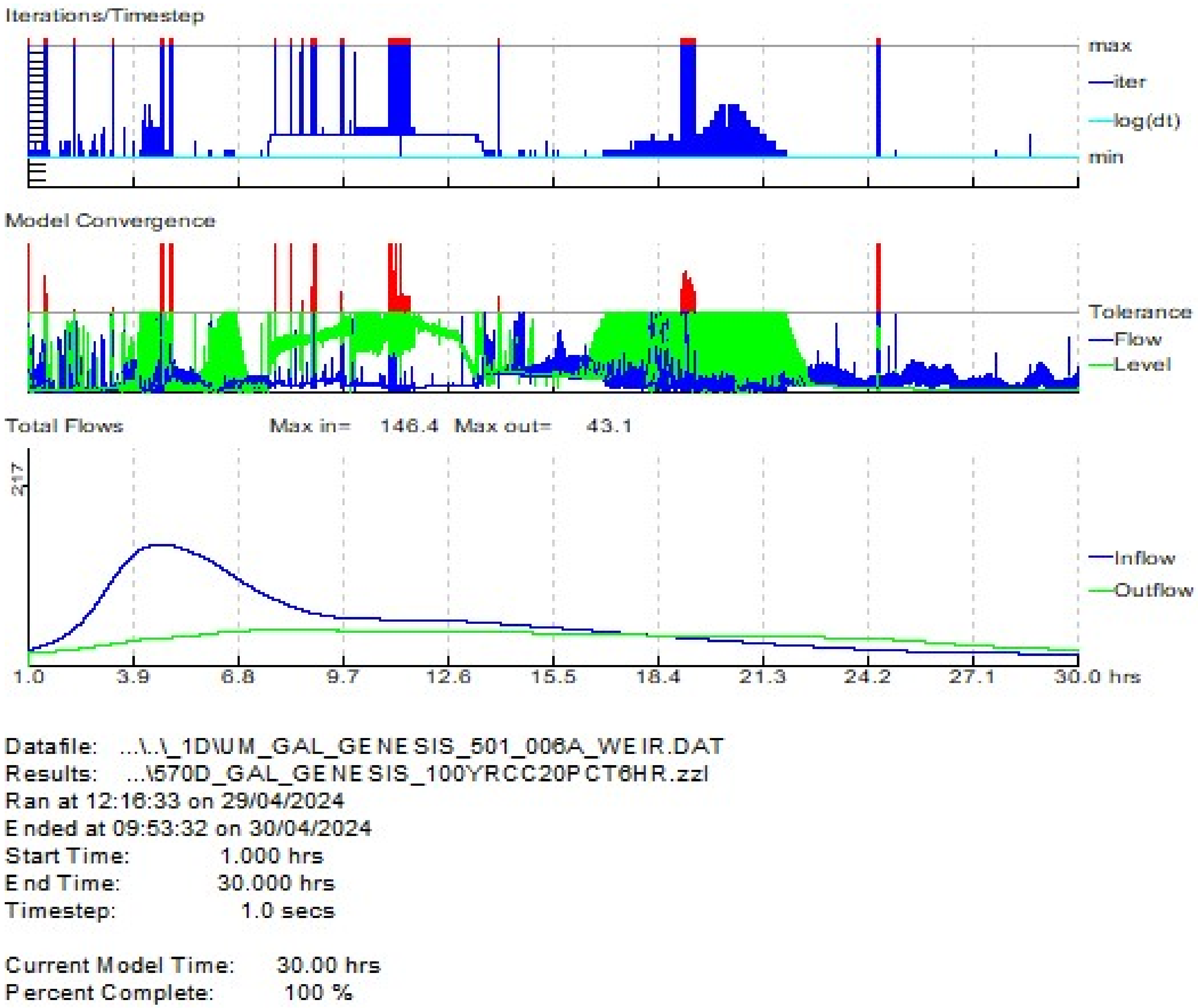
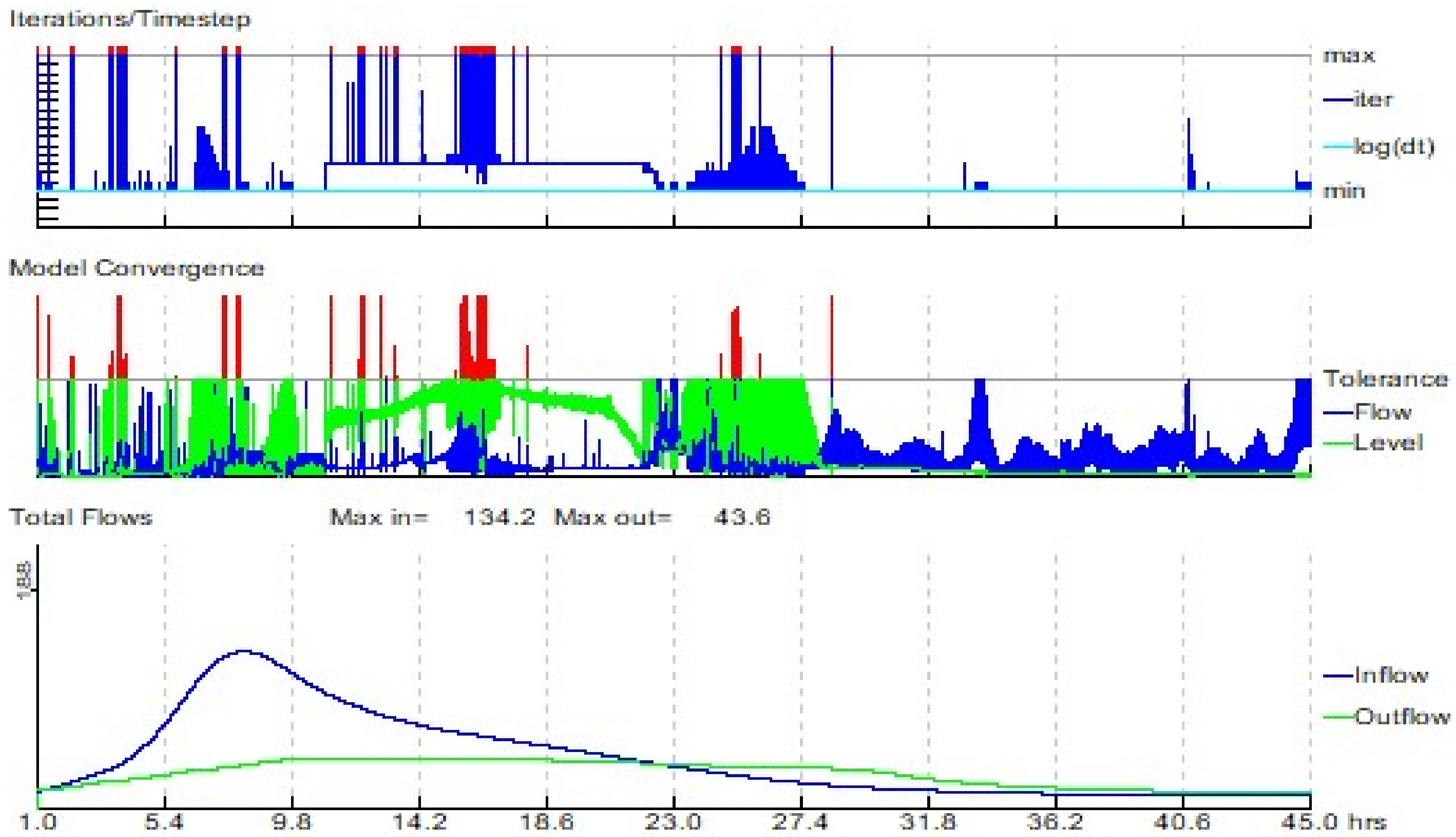


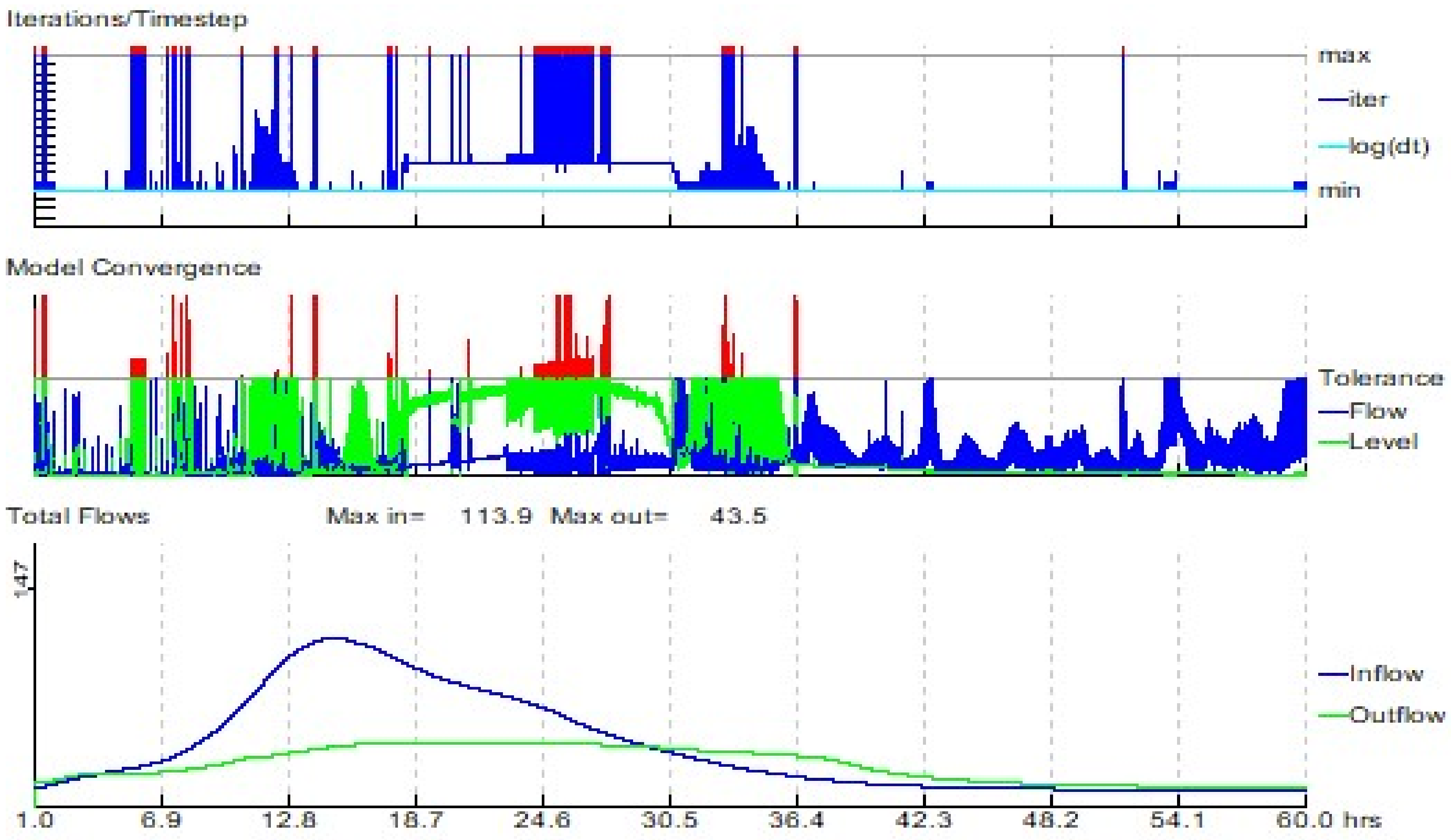
Figure 14-15: Flood Modeller Model Convergence plot – With-Project 1% AEP +20% CC, 6 hours event.



Datafile: ...\.._1D\UM_GAL_GENESIS_501_006A_WEIR.DAT
Results: ...\570D_GAL_GENESIS_100YRCC20PCT12HR.zzl
Ran at 13:56:09 on 30/04/2024
Ended at 20:15:12 on 01/05/2024
Start Time: 1.000 hrs
End Time: 45.000 hrs
Timestep: 1.0 secs

Current Model Time: 45.00 hrs
Percent Complete: 100 %

Figure 14-16: Flood Modeller Model Convergence plot – With-Project 1% AEP +20% CC, 12 hours event.



Datafile: ...\.._1D\UM_GAL_GENESIS_501_006A_WEIR.DAT
Results: ...\570D_GAL_GENESIS_100YRCC20PCT24HR.zzl
Ran at 18:59:26 on 27/04/2024
Ended at 22:37:04 on 29/04/2024
Start Time: 1.000 hrs
End Time: 60.000 hrs
Timestep: 1.0 secs

Current Model Time: 60.00 hrs
Percent Complete: 100 %

Figure 14-17: Flood Modeller Model Convergence plot – With-Project 1% AEP +20% CC, 24 hours event.

14.4 TUFLOW Cumulative Mass Error and dVol plots

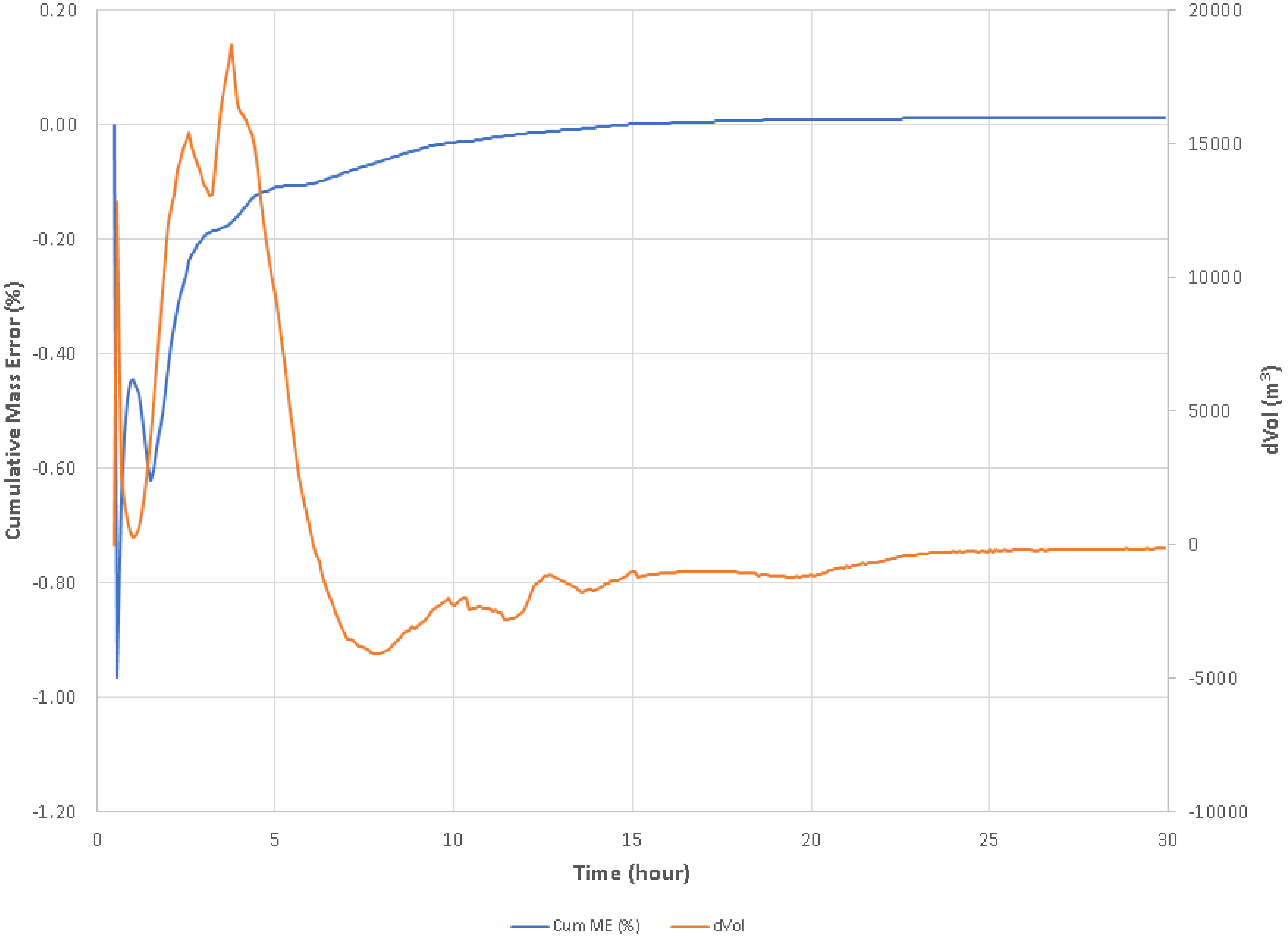


Figure 14-18: TUFLOW Cumulative Mass Error and dVol – Baseline 1% AEP +20% CC, 3 hours event.

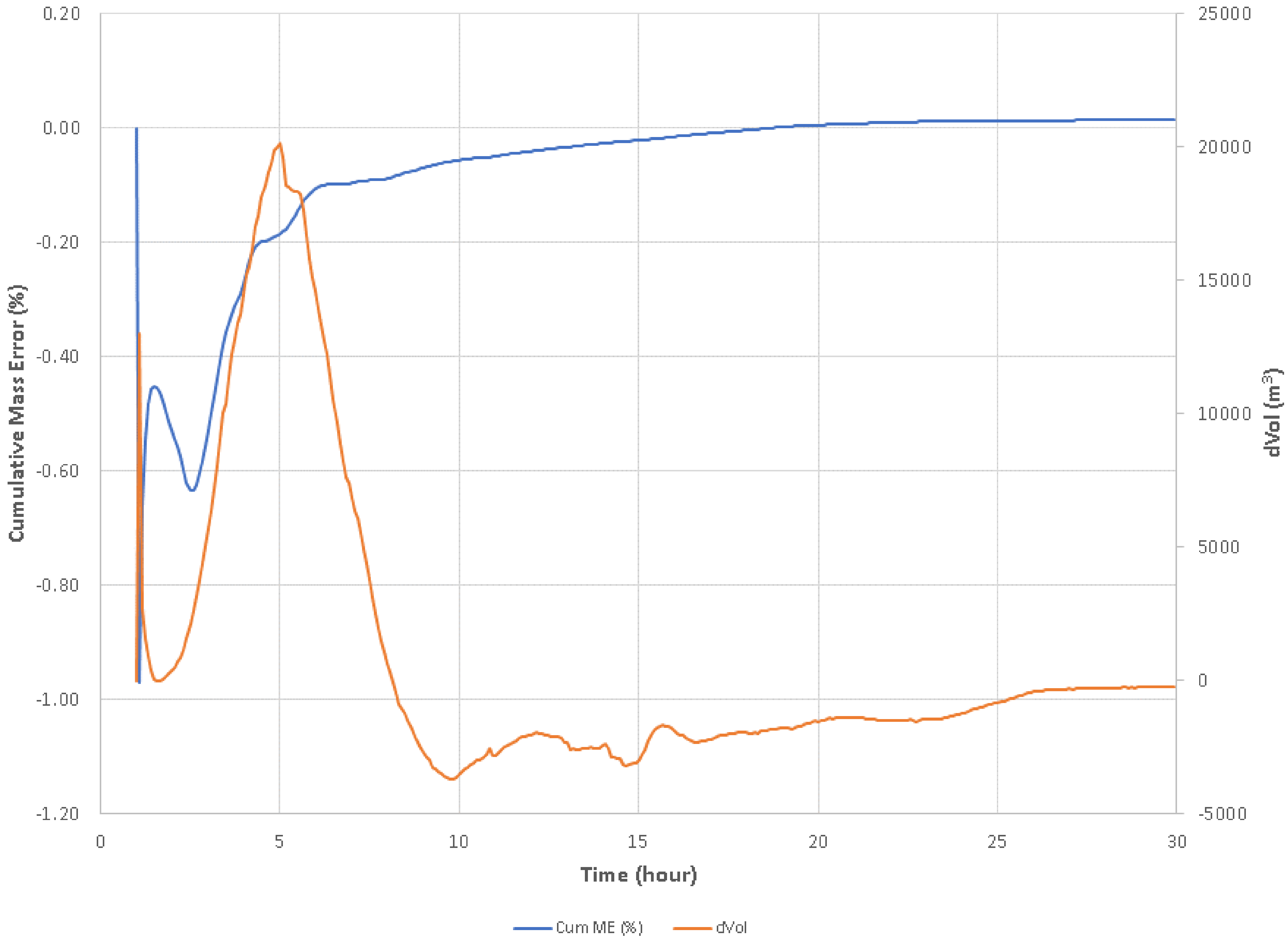


Figure 14-19: TUFLOW Cumulative Mass Error and dVol – Baseline 1% AEP +20% CC, 6 hours event.

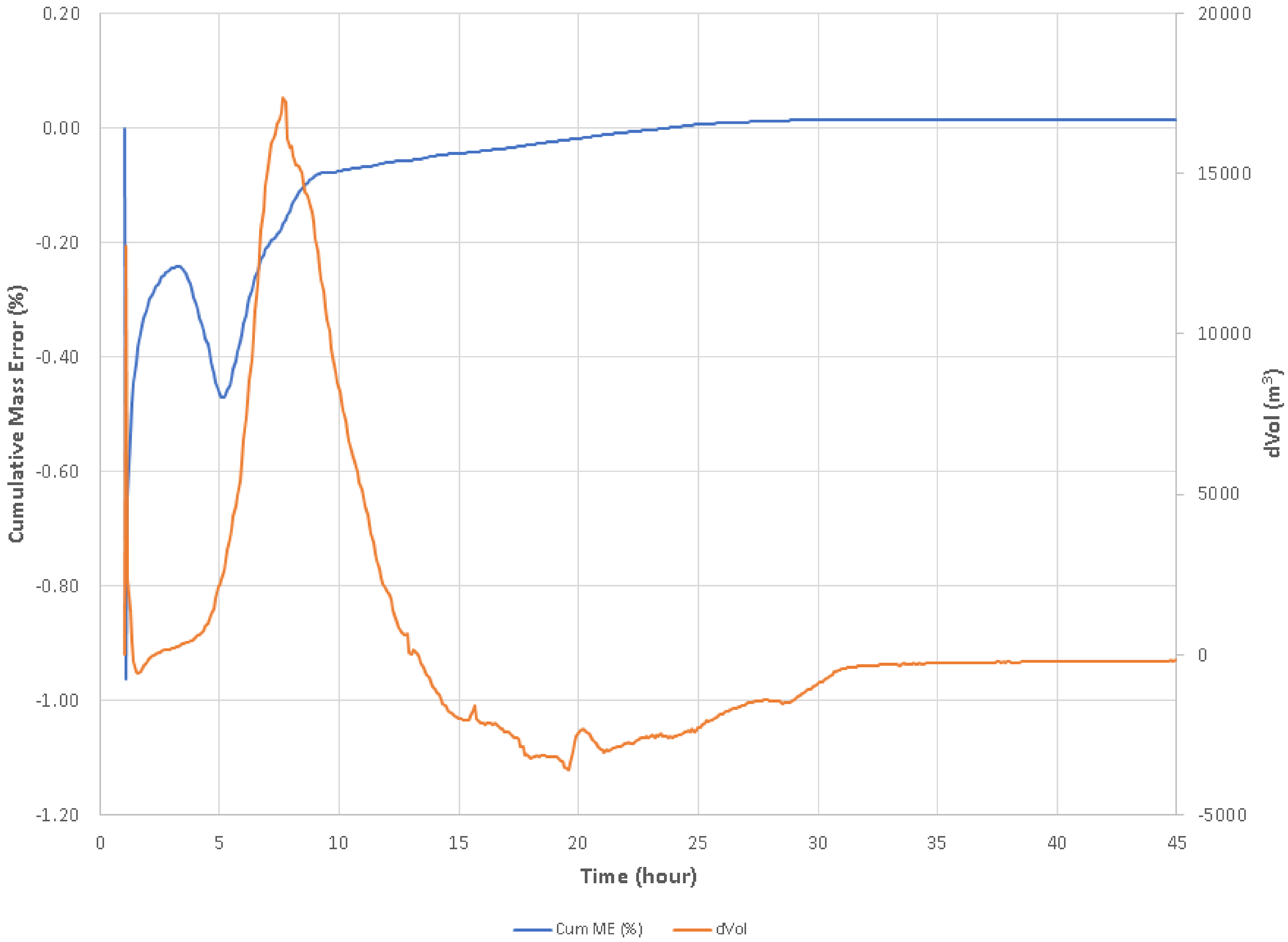


Figure 14-20: TUFLOW Cumulative Mass Error and dVol – Baseline 1% AEP +20% CC, 12 hours event.

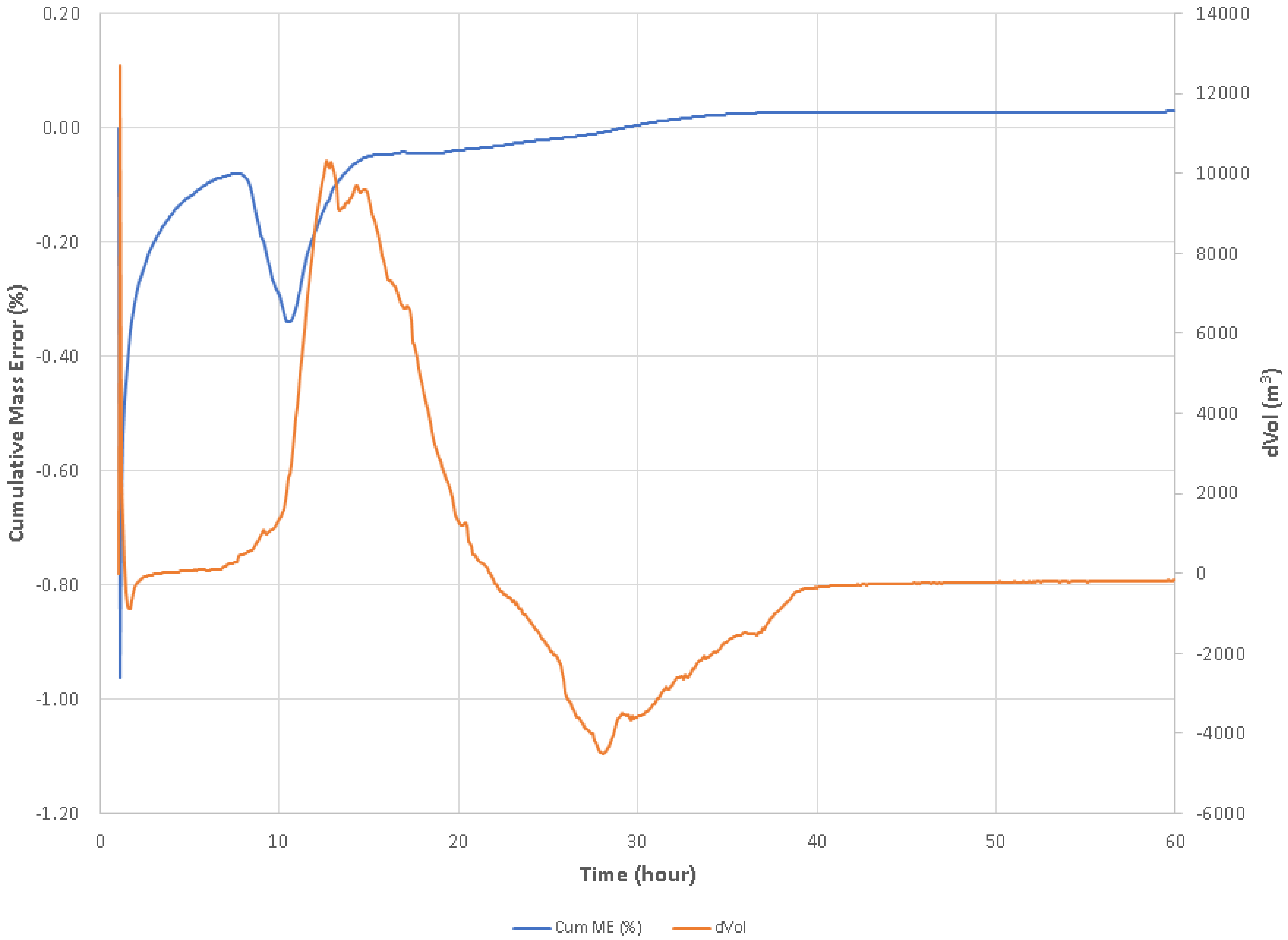
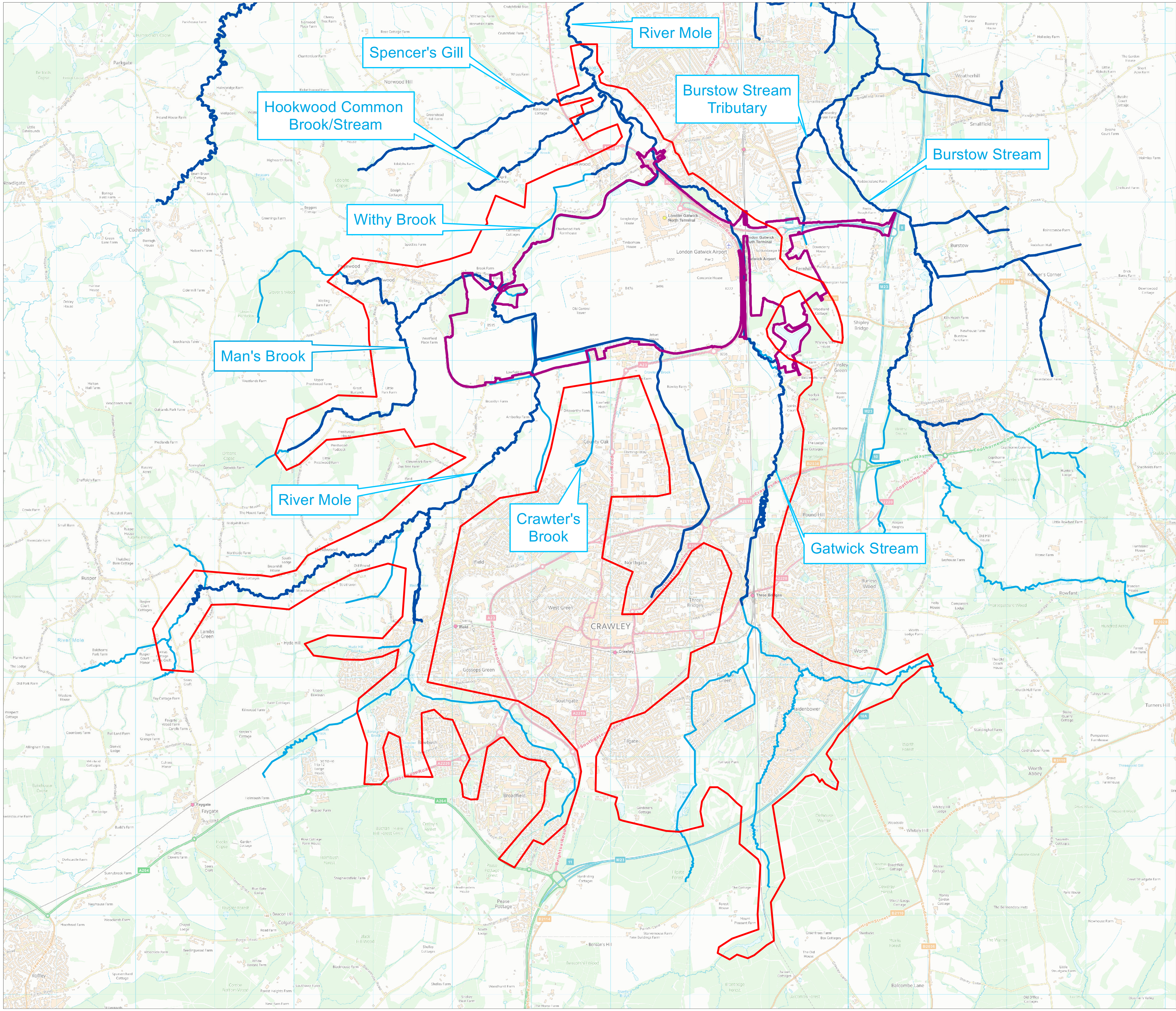


Figure 14-21: TUFLOW Cumulative Mass Error and dVol – Baseline 1% AEP +20% CC, 24 hours event.



LONDON GATWICK

KEY

- Project Boundary (DCO)
- Fluvial Model Study Area
- Main Rivers
- Ordinary Watercourses

DOCUMENT

Environmental Statement
Appendix 11.9.6 Annex 5

DRAWING TITLE

Fluvial Model Study Area

DATE

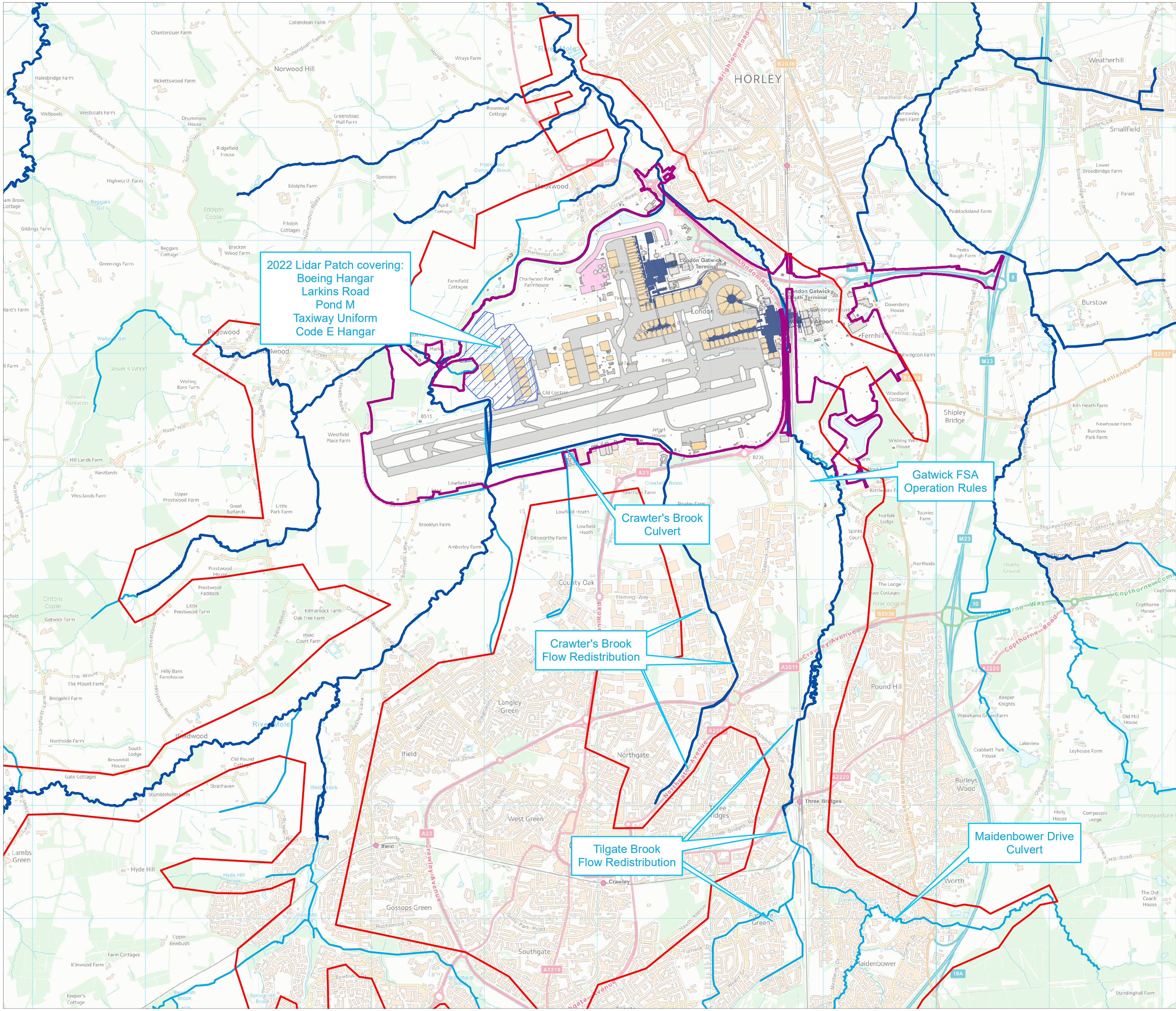
June 2023

ORIENTATION	DRAWING NO.	REVISION
N	FIGURE 1.3.1	For ES
	DRAWN BY	PM / CHECKED BY
	KE	MS

SCALE @ A3 1:45,849

0 295 590 1,180 1,770 2,360 m

\\Uk-lon-fas02\projects\SSBU\GADD001A-Gatwick-EMR\@Projects\GALCTC25-Northern-Runway-Water\500 GIS\Figures\MXDs\ES\FRA\Annex5\Annex5_Figure 1.3.1.mxd



LONDON GATWICK

KEY

- Project Boundary (DCO)
- Fluvial Model Study
- Main River
- Ordinary Watercourses
- 2022 2m LiDAR patch

Existing Elements

- Terminal
- Runway/Taxiway
- Hangar
- Stands
- Environmental Mitigation
- Other existing airport infrastructure

DOCUMENT

Environmental Statement
Appendix 11.9.6 Annex 5

DRAWING TITLE

Baseline Model Modifications
Locations

DATE

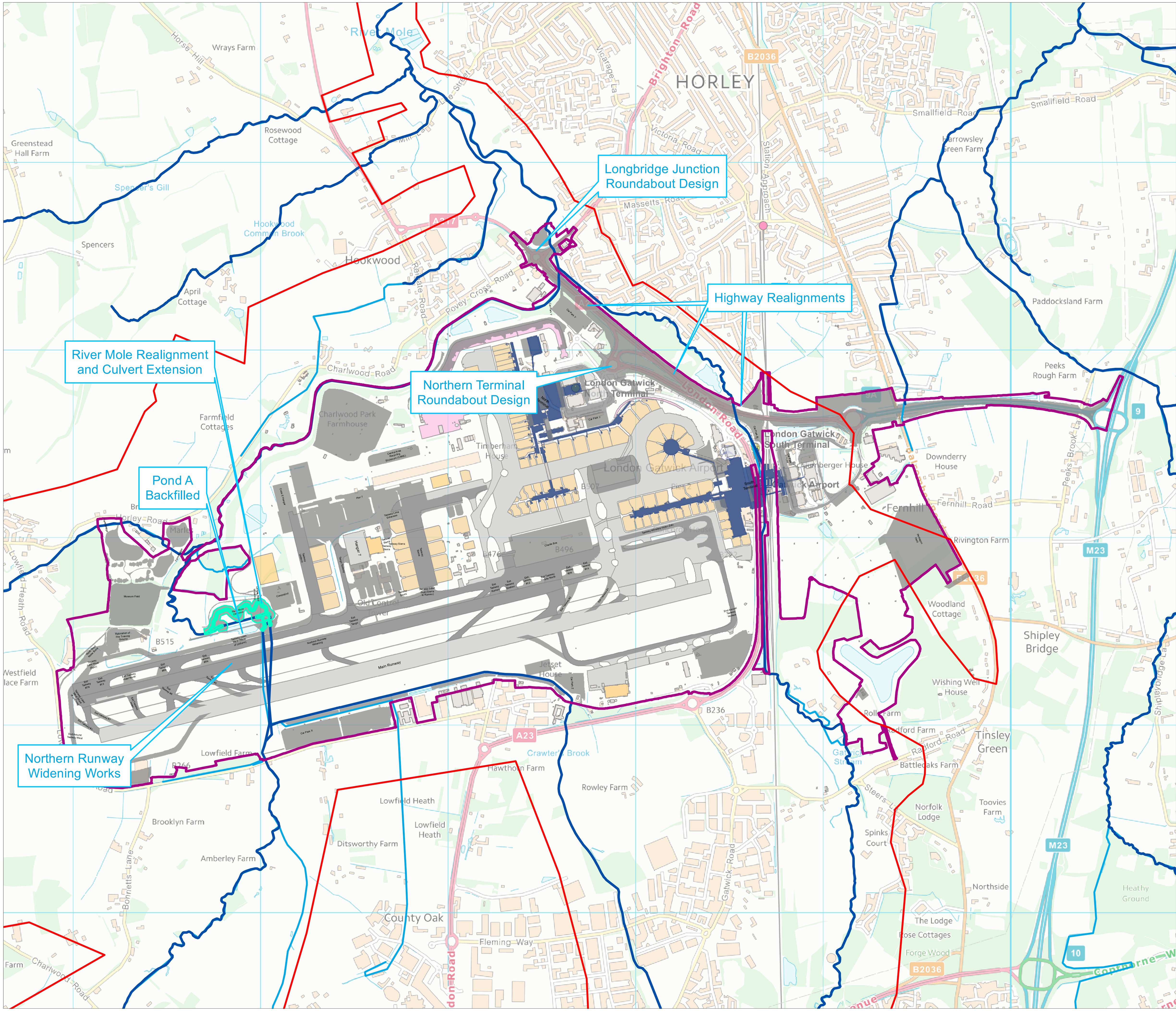
June 2023

ORIENTATION	DRAWING NO.	REVISION
N	FIGURE 4.1.1	For ES
	DRAWN BY	PM / CHECKED BY
	KE	MS

SCALE @ A3 1:32,143

0 205 410 820 1,230 1,640 m

\\Uk-lon-fas02\projects\SSBU\GADD001A-Gatwick-EMR\@Projects\GALCTC25-Northern-Runway-Water\500 GIS\Figures\MXDs\ES\FRA\Annex5\Annex5_Figure 4.1.1.mxd



LONDON GATWICK

KEY

- Project Boundary (DCO)
- Fluvial Model Study Area
- Main River
- Ordinary Watercourses

Existing Elements

- Terminal
- Runway/Taxiway
- Hangar
- Stands
- Environmental Mitigation
- Other existing airport infrastructure

Proposed Project Elements

- Proposed Project Elements
- River Mole Extended Culvert and Realignment

DOCUMENT: Environmental Statement Appendix 11.9.6 Annex 5

DRAWING TITLE: With-Scheme No-Mitgation Model Modifications Locations

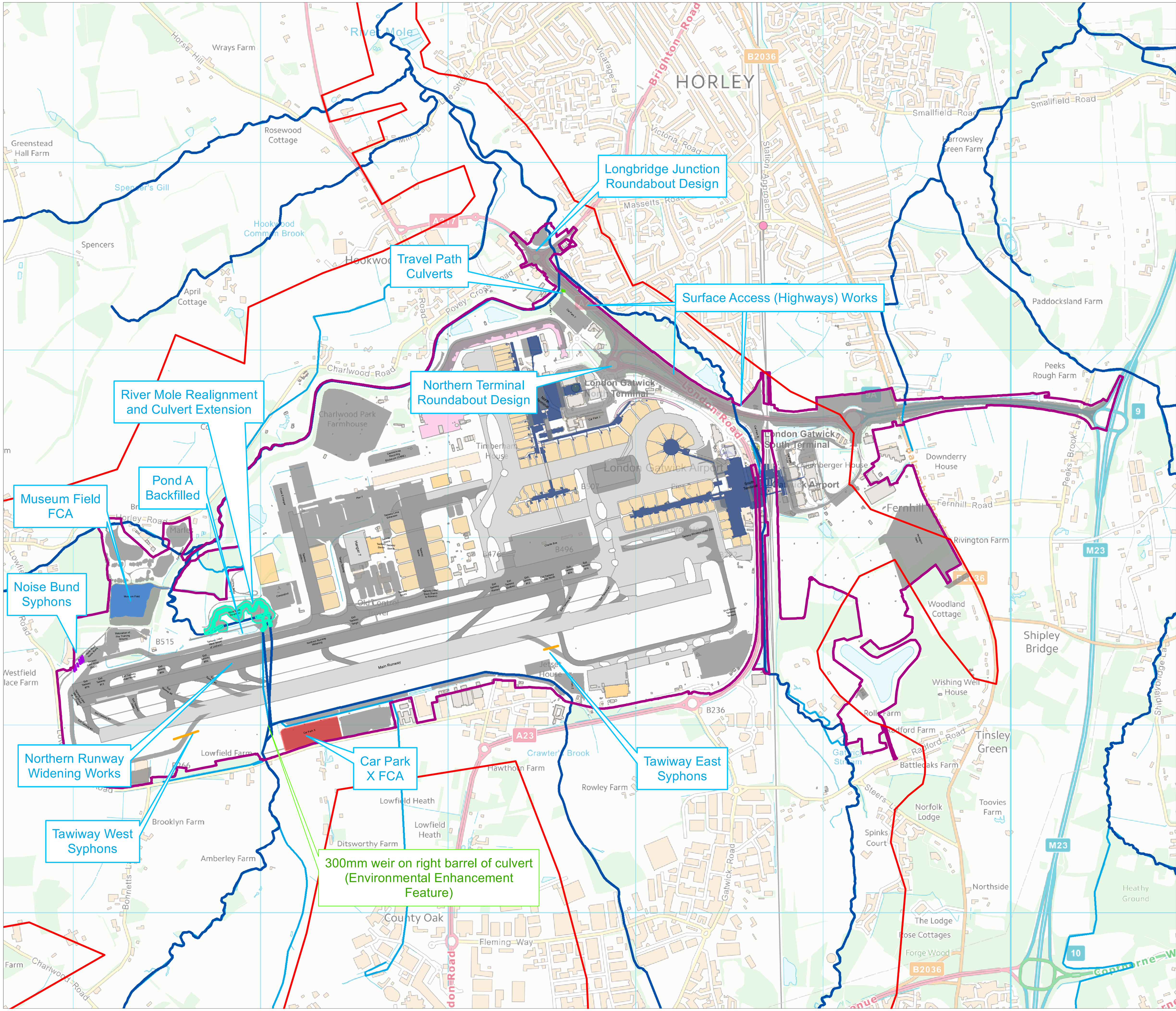
DATE: June 2023

ORIENTATION	DRAWING NO.	REVISION
N	FIGURE 5.1.1	For ES
	DRAWN BY: KE	PM / CHECKED BY: MS

SCALE @ A3 1:19,363

0 120 240 480 720 960 m

\\Uk-lon-fas02\projects\SSBU\GADD001A-Gatwick-EMR\@Projects\GALCTC25-Northern-Runway-Water\500 GIS\Figures\MXDs\ES\FRA\Annex5\Annex5_Figure 5.1.1.mxd



LONDON GATWICK

KEY

- Project Boundary (DCO)
- Fluvial Model Study Area
- Main River
- Ordinary Watercourses

Existing Elements

- Terminal
- Runway/Taxiway
- Hangar
- Stands
- Environmental Mitigation
- Other existing airport infrastructure

Proposed Project Elements

- Proposed Project Elements
- River Mole Extended Culvert and Realignment

Mitigation Measures

- Museum Field FCA
- Car Park X FCA
- Airfield Syphons
- Noise Bund Syphons
- Travel Path Embankment Culverts

DOCUMENT
Environmental Statement
Appendix 11.9.6 Annex 5

DRAWING TITLE
With-Scheme Mitgation Model Modifications Locations

DATE
June 2023

ORIENTATION	DRAWING NO.	REVISION
N	FIGURE 5.2.1	For ES
	DRAWN BY	PM / CHECKED BY
	KE	MS

SCALE @ A3 1:19,363

0 120 240 480 720 960 m

\\Uk-lon-fas02\projects\SSBU\GADD001A-Gatwick-EMR\@Projects\GALCTC25-Northern-Runway-Water\500 GIS\Figures\MXDs\ES\FRA\Annex5\Annex5_Figure 6.1.1.mxd

Annex 6

Flood Resilience Statement

Table of Contents

1 Introduction

1.1 Introduction

1.1.1 The Northern Runway Project (the "Project") is a proposal to make best use of Gatwick Airport's ("Gatwick") existing runways and infrastructure. The Project proposes alterations to the existing northern runway which, together with the lifting of the current restrictions on its use, would enable dual runway operations. The Project includes the development of a range of infrastructure and facilities which, with the alterations to the northern runway, would enable the airport passenger and aircraft operations to increase. Further details regarding the components of the Project can be found in **ES Chapter 5: Project Description** (Doc Ref. 5.1).

1.1.2 The airport lies in the upper catchment of the River Mole, and three main rivers run through and around the site (the River Mole, Gatwick Stream and Crawter's Brook). The airport is at existing risk of flooding from these watercourses and the Project would have the effect of reducing fluvial flood risk overall.

1.1.3 This Statement sets out how Gatwick Airport Limited ("GAL") will manage flood events including warning systems and well-defined management and evacuation procedures for the lifetime of the Project. It also describes how GAL works with other emergency responders and how it will continue to do so.

1.2 National Planning Policy Requirements

1.2.1 This Statement has been prepared in accordance with the relevant policy requirements.

Airports National Policy Statement

1.2.2 The Airports National Policy Statement ("ANPS") (Department for Transport, 2018a), although primarily provided in relation to a new runway at Heathrow Airport, remains a relevant consideration for other applications for airport infrastructure in London and the south east of England.

1.2.3 The ANPS requires an applicant to *'Consider if there is a need to remain operational during a worst case flood event over the preferred scheme's lifetime'* (paragraph 5.154 of the ANPS).

National Policy Statement for National Networks

1.2.4 The NPS for National Networks ("NNNPS") (Department for Transport, 2014)[1] sets out the need for development of road, rail and strategic rail freight interchange projects on the national networks and the policy against which decisions on major road and rail projects will be made. This has been taken into account in relation to the highway improvements proposed as part of the Project.

1.2.5 The NNPS requires that *'…any project that is classified as 'essential infrastructure' and proposed to be located in Flood Zone 3a or b should be designed and constructed to remain operational and safe for users in times of flood…'* (Paragraph 5.109 of the NNNPS).

National Planning Policy Framework

1.2.6 The National Planning Policy Framework ("NPPF") sets out the need to apply a sequential (risk based) approach to the location of development to place it areas of the lowest risk of flooding, through application of the sequential test. If this is not achievable once wider sustainability development objectives are taken into account the Exception test may have to be applied. As stated in paragraph 164 b) of the NPPF, to pass the second part of the Exception test it should be demonstrated that: '*the development will be safe for its lifetime taking account of the vulnerability of its users'*.

1.2.7 Paragraph 167 of the NPPF requires the applicant should demonstrate that:

'b) the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;

c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;

d) any residual risk can be safely managed; and

e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.'

1.1.1 This Statement has been prepared to demonstrate how GAL will ensure that the development will remain safe for the lifetime of the Project.

1.3 Government Guidance

1.3.1 The "Guidance on Flood Risk and Coastal Change" was published by the Department for Levelling Up, Housing and Communities and the Ministry of Housing, Communities and Local Government and last updated 25 August 2022 (the "Guidance"). This Guidance, among other things, sets out what is expected to be included in emergency plans related to flooding for proposed developments to in order to demonstrate that the development will be safe.

1.3.2 The Guidance sets out particular considerations that should be included in a flood emergency plan:

- The type of flood risk present;
- The extent to which advance adequate flood warnings can be given in a flood event;
- The number of people that would require evacuation from the area potentially at risk;
- Adequate evacuation routes and identified places for evacuated people to be (taking into account the length of time any evacuation may last);
- Account should be given to the likely impacts of climate change e.g. increased water depths and the impact on escape routes;
- Safe access and escape should be maintained for the lifetime of the development; and
- Developers should seek to minimise reliance on emergency services to make development safe.

[1] The Department for Transport ("DfT") published a revised draft National Policy Statement for National Networks ("NPSNN") for consultation on 14 March 2023. The consultation closed on 6 June 2023 and the DfT is currently analysing responses. The draft NPSNN confirms in paragraph 1.16 that the existing NPSNN remains the relevant government policy and has full force and effect in relation to any applicable applications for development consent accepted for examination before designation of the updated NPSNN. The draft NPSNN further notes in paragraph 1.17 that the emerging draft NPSNN is capable of being an important and relevant consideration in the Secretary of State's decision making process. As such, the Applicant will continue to monitor the progress of the NPSNN review process and incorporate any updates to the Project's application documentation where considered appropriate in due course.

1.3.3 This Statement demonstrates how GAL's emergency plans will be suitable for the proposed development and maintained throughout the operation of the Project.

1.4 Flood Resilience Statement Objectives

1.4.1 The objectives of this Statement are to demonstrate the Project's compliance with the national planning policy requirements and Government Guidance as set out in Section 1.2 and are as follows:

- Provide the Project context and summarise the sources of flood risk to the Project;
- Set GAL's management of flooding within the context of its existing incident and crisis management protocols;
- Summarise how the airport is alerted to heightened flood risk through advance warnings and its actions to prepare for and manage flood events including the alerting of other parties; and
- Describe the measures adopted to ensure user safety through evacuation routes and planned procedures and demonstrate the airport's operational resilience during an extreme flood event.

2 Gatwick's existing emergency flood plans

2.1.1 By its very nature as a major transport interchange and an operational airport, GAL already has well developed emergency planning procedures in place to protect the safety of the public and staff in the event of a major incident, including flooding events.

2.1.2 In relation to flood events, the existing procedures:

- provide for the alerting of staff and passengers and coordination of multi-agency action in an emergency with the aim of safeguarding life and property;
- define the areas of responsibility for those participating in specific plans;
- ensure the airport remains informed of potential flood risk via its own monitoring activity and alerting from the Environment Agency and other parties;
- ensure the safety and welfare of passengers and staff in a flood event;
- establish dry rendezvous points and routes to them; and
- set security procedures during a flood event.

2.1.3 The Resilience Planning Group (RPG) is a multi-agency sub-committee of the Sussex Resilience Forum (SRF) which is chaired jointly by GAL and Sussex Police and meets quarterly. The RPG work together to ensure that GAL, as a category 2 responder under the Civil Contingencies Act 2004, is aligned and embedded within the local and national response plans.

2.1.4 GAL is also represented at other relevant SRF committees ensuring that area, countywide and local plans and responses are aligned to ensuring an optimum response in the case of an incident.

2.1.5 In a major incident the agreed protocols dictate that the Police will assume control and coordinate the actions of the other responding organisations and parties and GAL will comply with the requirements of the Police in such situation.

2.1.6 Airport emergency plans and procedures will be reviewed at least annually, and as and when necessary, for example:

- to assimilate learning points to a major flooding incident;
- to take into account amended Government guidance; and
- to take into account any changes in configurations or assumptions.

2.1.7 GAL will continue to attend the SRF, co-chair the RPG and coordinate other Emergency Planning meetings with the first responders. These include:

- Police
- Crawley Borough Council (LLFA and Contingency Planning);
- Reigate and Banstead Borough Council (LLFA and Contingency Planning);
- Environment Agency (Thames Region);
- Fire and Rescue Service; and
- Local Ambulance Service.

3 Sources of Flood Risk

3.1 Baseline Flood Risk

3.1.1 This section summarises the baseline situation at the Project site, full details are included in the **ES Appendix 11.9.6: Flood Risk Assessment** (FRA) (Doc Ref. 5.3). The principal sources of flood risk are considered to be fluvial (rivers), surface water and reservoir failure. Groundwater flood risk is not considered to be a significant risk due to the predominantly clay geology at the airport. The Project contains mitigation measures for its own impact that will also reduce baseline flood risk.

3.1.2 **Fluvial:** The primary flood mechanism at Gatwick is fluvial (rivers) associated with the River Mole and its tributaries (primarily the Gatwick Stream and Crawter's Brook). Fluvial flooding at Gatwick tends to occur after periods of prolonged and heavy rainfall. The existing site includes areas in Flood Zones 2 and 3 as can be seen from the Environment Agency published flood zone mapping (see **ES Appendix 11.9.6 Figure 5.2.2** (Doc Ref. 5.3)). Internal passenger areas of the South and North Terminals remain dry during these events, however, terminal basements and access roads could be flooded in an extreme event (as occurred in December 2013).

3.1.3 **Surface water:** See **ES Appendix 11.9.6 Figure 5.3.3** and **5.3.4** (Doc Ref. 5.3). Surface water flooding may occur to North Terminal basements under particular circumstances when existing attenuation and treatment ponds are at capacity, although in such extreme circumstances emergency discharges can be made from Pond D to the River Mole to prevent flooding. Localised surface water flooding can also occur after an intense summer thunderstorm.

3.1.4 **Reservoir Flooding:** See **ES Appendix 11.9.6 Figure 5.5.1** (Doc Ref. 5.3). Gatwick operates four raised reservoirs each with the potential to store significant volumes of water. These reservoirs are contained within long earthfill embankments. Should one of these embankments fail (breach) the sudden release of stored water could result in severe flooding, with potentially widespread impacts on airport infrastructure, off-site commercial and residential properties, and with a risk to life.

3.1.5 The airport is not within an "Area Benefitting from Flood Defences" (Environment Agency, 2023) as published by the Environment Agency. However, GAL does own and operate the Gatwick Stream Flood Storage Area (FSA) approximately 1.3km upstream (south) of the South Terminal. The FSA does include raised banks to store floodwater that in an extreme event could fail. The Environment Agency's "Risk of Flooding from Reservoir Failure" mapping does take the consequence of that into account, albeit amalgamated with other reservoirs. However, inspection and maintenance requirements of the Reservoirs Act 1975 ensure the risk of failure is considered to be very low.

3.1.6 Additionally, there are other raised reservoirs upstream (to the south) of the airport, operated by third parties, which also pose a threat to the airport in the event that the dams associated with these reservoirs were to fail. However, the inspection and maintenance requirements of the Reservoirs Act 1975 would also apply to these reservoirs.

3.2 The Project's interaction with flood risk

3.2.1 The Project will not increase flood risk to other parties through the provision of embedded mitigation measures including:

- Floodplain compensation areas at Museum Field and Car Park X;
- Syphons to maintain floodplain connectivity beneath the north-west noise bund and wall and beneath two taxiways;
- Attenuation storage within the airfield surface water drainage network; and
- Attenuation storage for the additional runoff from the highways improvement works.

3.2.2 The Project would reduce flood risk and peak water levels over an extensive area but only by a few millimetres compared to the baseline as a result of these mitigation measures on the Gatwick Stream in Riverside Garden Park and on the River Mole downstream of Longbridge roundabout (see **ES Appendix 11.9.6 Figure 7.2.6** (Doc Ref. 5.3)).

3.2.3 The Project would not increase flood risk to other parties but would increase flood risk within the airfield to the north-west of the northern runway, although not within an operational area that would affect passengers. This would extend to south of the main runway and to the south of South Terminal in an extreme 1 per cent (1 in 100) AEP +40 per cent climate change event (see **ES Appendix 11.9.6 Figure 7.2.6** (Doc Ref. 5.3)).

3.2.4 Figures that demonstrate the interaction of the Project with fluvial and surface water flood risk are included in the **ES Appendix 11.9.6: Flood Risk Assessment** (Doc Ref. 5.3), see:

- **ES Appendix 11.9.6 Figure 5.2.2** (Doc Ref. 5.3) for the published fluvial flood zones;
- **ES Appendix 11.9.6 Figure 5.3.2** (Doc Ref. 5.3) for fluvial flood risk; and
- **ES Appendix 11.9.6 Figures 5.3.3** and **5.3.4** (Doc Ref. 5.3) for short and long duration surface water storms respectively.

3.3 Flood risk to users of the Project

3.3.1 This section focuses on the effects to users in different parts of the Project and how they may be affected by a flood event during construction and operation.

Construction

3.3.2 During the initial construction period (around 2024-29) the construction sequence is to build the flood mitigations for the Project ahead of the infrastructure which impacts the floodplain which ensures no increase in flood risk.

3.3.3 In this period there is only one active Construction Compound that could be affected by flooding. The access road to the Car Park Z Staging and Laydown compound, located to the south east, could be inundated up to 160mm in the 1 per cent (1 in 100) AEP fluvial event plus 16 per cent. The majority of the compound area would not be flooded. If this occurred, the compound could be withdrawn from service during the event and alternative compounds relied upon.

3.3.4 During the later construction of the surface access works (expected around 2029 to 2032) the construction compounds at Longbridge Roundabout and Car Park B could also be affected to different degrees in flood events.

3.3.5 By implementing mitigation measures, including situating any welfare facilities outside flood extents within the compound, elevating cabins on steel legs above peak water levels and ensuring the Contractors sign up for notification of flood warnings, the compounds would remain safe for their temporary lifetime without increasing flood risk elsewhere.

3.3.6 A Water Management Plan (WMP) has been prepared as **Annex 1** to the **ES Appendix 5.3.2: Code of Construction Practice** (CoCP) (Doc Ref. 5.3), including an appropriate drainage strategy to ensure all flood risks related to construction activities would be mitigated or safely managed within the Project boundary. This will ensure that people and infrastructure remain protected from identified flood risks.

3.3.7 By the end of the initial construction period (circa 2029) all of the flood compensation areas and other necessary water-related mitigation works and all airfield and access improvement works will have been completed.

Operation

3.3.8 Effects to staff and passengers during operation of the Project are summarised below.

3.3.9 **Airfield:** in fluvial flood events there would be widespread betterment (see **ES Appendix 11.9.6 Figure 7.2.4** (Doc Ref. 5.3)) in most areas of the airfield. There would, however, be increased flood depths directly south of the relocated fire training ground and a small grassed area to the south of the main runway.

3.3.10 **ES Appendix 11.9.6 Figure 7.2.2** (Doc Ref. 5.3) shows that for the 1 per cent (1 in 100) AEP fluvial event plus 12 per cent climate change allowance the runways and taxiway system remain above the fluvial flood extents although there will be flooding of grassed areas. At larger events: 1 per cent (1 in 100) AEP plus 20 per cent and plus 40 per cent, apron areas around the South Terminal and some stands on the North Terminal remain prone to shallow flooding. This situation would be managed by staged closure and withdrawal from service of facilities (see below).

3.3.11 Surface water flood extents vary with the modelled scenarios (30 minute and 1440 minute duration storms, plus allowances for climate change). Overall surface water flow paths would not significantly change or be interrupted by the Project and the level of risk would remain similar to existing. Flood depths vary locally and mainly within the range of 10 to 50mm increase or decrease. At all locations, depth of flooding on airfield operational areas is less than 400mm and not a threat to life. Gatwick would manage the safe closure of the areas until they could be returned to service and the airport is expected to remain operational.

3.3.12 **Terminal and passenger amenities**: **ES Appendix 11.9.6 Figure 7.2.4** (Doc Ref. 5.3) shows that flood depths from fluvial flooding are expected to decrease marginally around the Terminal areas. The impact of the proposed Car Park Y surface water storage tank is expected to decrease the threshold of surface water flooding in North Terminal basements to between the 2 percent (1 in 50) and 1.33 per cent (1 in 75) AEP events.

3.3.13 **Road infrastructure:** the Project design avoids any increase in surface water flooding on the roads. Reductions in fluvial flooding in the areas surrounding the Longbridge roundabout, Riverside Garden Park and downstream of Brighton Road bridge crossing.

4 Flood Alerting Systems

4.1.1 The Project has been assessed to be at risk from flooding and is covered by the Environment Agency's online flood warning system.2

4.1.2 As the operator of an operational airport and in the context of historical flood risk, GAL has sophisticated monitoring systems and works closely with the Environment Agency to monitor flood risk and implement flood alerting systems.

4.2 Gatwick Airport Limited's Responsibilities

4.2.1 GAL would carry out the following roles as the developer and operator of the Project:

- monitoring the flood risk and ensuring contingency plans and evacuation plans remain up to date and are activated when appropriate;
- taking all practicable measures to ensure its critical infrastructure remains operational in a flood event;
- taking reasonable measures to notify staff, passengers and third party organisations on the airport regarding the flood risk following notification of an impending event;
- taking a coordinating role to ensure safety to life and limb and evacuating persons from areas where flooding is expected to occur; and
- liaising with the Police and other emergency responders as appropriate, until such time that the Police or other Agency assumes command authority.

4.2.2 Where a development has been adopted by a public authority, that authority will assume responsibility for ensuring adequate flood procedures are in place upon adoption of the development. This will be the case in relation to the surface access highway works.

4.2.3 During the construction period for the Project, GAL will ensure that arrangements are in place for the Principal Contractor(s) to receive appropriate alerts. Further information on the safe working practices, site evacuation and flood alerting systems during the construction period is in the **ES Appendix 5.3.2: CoCP Annex 1 – Water Management Plan** (Doc Ref. 5.3) which is appended to **ES Appendix 5.3.2: Code of Construction Practice** (Doc Ref. 5.3).

4.3 Fluvial Alerting Methods

4.3.1 The airport is in receipt of weather alerts as part of its day-to-day operations which will continue throughout the life of the Project. Additionally, remote sensing equipment linked to building management systems will continue to allow GAL to monitor continuously the levels on the River Mole, Crawter's Brook and Gatwick Stream.

4.3.2 GAL will continue to liaise with the Environment Agency to define a "Flood State" based on the flood risk. The various Flood States and the respective actions to be taken are shown in Table 4.3.1. The Environment Agency is responsible for notifying the Gatwick Engineering Operations Manager in the event that fluvial flooding is likely.

Table 4.3.1 Gatwick Flood States

Flood state	Flood risk	Actions
Clear	No current flood risk	Green for next five days. Be aware and keep eye on the weather situation.
1	Med/high risk OR significant/severe impact predicted	Be prepared for flooding and start activation of adverse weather protocols.
2	EA may issue Flood ALERT	Respond: implement mitigation measures
3	Flooding in progress. EA may issue Flood WARNING directly to GAL.	Respond: implement crisis management protocols, flood mitigation measures and preparations for evacuation.

4.4 Ongoing monitoring

4.4.1 GAL places a high priority on ensuring that its monitoring and warning systems are accurate and well reliable. Working practices are reviewed on a regular basis and both internally and in discussion with the Environment Agency to ensure that the most appropriate systems are in place.

5 Incident Response

5.1.1 GAL has invested heavily in flood mitigation across the airport and it will continue to be a priority throughout the lifetime of the Project.

5.2 Flood Mechanisms

5.2.1 The key fluvial flood mechanisms at the airport will be:

- Flooding of the area to the northwest of the northern runway via an overland flow path southwards from the Man's Brook;
- Flooding from the River Mole between the A23 and Car Park Y, upstream (south) of the A23 crossing of the watercourse;
- Exceedance of the capacity of the River Mole runway culvert that results in flooding upstream (south) of the runway;
- Exceedance of the capacity of the Gatwick Stream culvert beneath South Terminal; and
- Exceedance of the capacity of Crawter's Brook to the south of the runway.

5.2.2 The locations most likely to flood (in order of descending frequency) up to a 1 in 100 (1%) Annual Exceedance Probability event are:

- The area between the Fire Training Ground and the River Mole;
- The River Mole floodplain at Longbridge roundabout;
- The River Mole to the south of the runway culvert;
- The area of land between Car Park Y and the A23;
- The area between the Crawter's Brook and the main runway; and
- The South Terminal.

5.2.3 Given the relatively flat topography flood water would be expected to rise gradually and would not give rise to significant velocities. The incident will be managed by the Airport Operational Teams as appropriate in accordance with crisis management protocols and there is little to no risk of fatality as a result of fluvial flooding at the airport.

[2] See Environmental Agency webpage: https://check-for-flooding.service.gov.uk/

5.2.4 Surface water flooding would either be the result of exceedance of the capacity of the airfield drainage network leading to localised, short-term ponding or flooding in the approaches to North Terminal as a result of exceedance of the capacity of the surface water drainage network in that area.

5.3 Safe Access and Egress During a Flood Event

5.3.1 Hydraulic modelling shows that there will be safe routes of exit from the Passenger Terminals onto the A23 and M23 in all conceivable flood scenarios. **ES Appendix 11.9.6: Annex 6 Figure 5.3.1** (Doc Ref. 5.3) indicates safe routes of access and egress from both airport terminals during an extreme flood event – referred to by the Environment Agency in their flood risk and climate change guidance[3] as 'Credible Maximum Scenario', which at Gatwick this is the 1 per cent (1 in 100) AEP plus 40 per cent event. Further information on this event and assessment is included in the **ES Appendix 11.9.6: Flood Risk Assessment** (Doc Ref. 5.3).

5.3.2 The railway line is also expected to be available, but experience has shown that it may be susceptible to flooding and be withdrawn from service. The runway surfaces will remain above fluvial flood levels.

5.4 Activation of Contingency Plans

5.4.1 Depending on the Flood State that has been declared by GAL, the initial response will be in accordance with the protocols in relation to managing adverse weather events and flood threat. These will provide for an escalating response, starting with raising awareness and promulgation of information, then practical management action by GAL teams and business partners, and the corresponding alerting of emergency responders. In all cases, operational actions taken depend on the actual situation at hand to manage safety.

5.4.2 For flooding in the up to 1 per cent (1 in 100) AEP event, the airport expects to remain open and to manage the situation at hand, if necessary by evacuating persons to safe and dry areas. Progressive withdrawal of facilities from service will occur, and evacuation of areas likely to be affected by flooding.

5.4.3 The potential effects of wider disruption will, however, also be factored into any decision to affect a reduction in flight movements, or in-extremis, a managed closure of the airport for safety reasons.

5.4.4 GAL will liaise with the Police and Airlines, Local Resilience Forum members, ATC, NATS, UKAIS, Media organisations, National Highways, Coach Operators, Network Rail and the train operating companies and any other organisations as necessary. The response action required, particularly in extreme flooding event, will be specific to the situation happening.

5.4.5 In an extreme flooding event, the situation would be unlikely to be confined to Gatwick and indeed could affect a large area of the South East of England. It is likely that forewarning would have been given from the Government, Met Office and the Environment Agency (GAL receives a bespoke flood warning from the latter in any case).

5.4.6 In such an event, and in close liaison with Government and the Police, Gatwick could promulgate the reduction of services or managed closure of the airport ahead of the predicted incident. Initially, measures would be implemented to advise people not to travel and then further actions to prevent additional people accessing the airport. For example, the road entrances to the airport at the M23 Spur, North and South Terminal Roundabouts could be closed to prevent people coming to the airport, and train passengers instructed not to disembark. All non-operational and non-essential staff could be instructed to leave, or to remain at home pending further instruction.

5.4.7 The airport will attempt to depart as many passengers as possible on those flights still operating. Passengers arriving on flights to Gatwick will leave normally, if prevailing conditions are safe to do so, and road connections and public transport links remain operable. Passengers unable to board flights, and members of the public remaining within the Terminals will be encouraged to leave via their own vehicles if still safe to do so, or on public transport while it remains available. It is anticipated that not all may be willing or capable of doing so. Passenger and staff welfare in such circumstances is covered within existing protocols.

5.4.8 In the event that evacuation was required and ground level terminal forecourts are flooded to prevent a safe route, then bus and coach services will be directed to provide dedicated evacuation services using the dry access routes. The railway line will remain in use unless services are suspended by Network Rail.

5.5 Evacuation Plan for Terminal Areas

5.5.1 Terminal areas susceptible to flooding will be closed and remaining persons evacuated to higher levels within the buildings. Terminal Operations and Security Staff will direct passengers to the safe areas with particular consideration for vulnerable users.

5.5.2 Evacuation will take place as follows:

- South Terminal – safe areas include the main concourse level, mezzanine level and departure lounges. The safe exit route from the airport above flooding is from concourse level across railway to Hilton Hotel and thereafter dry (as in "above fluvial flooding") road exit to A23/M23.
- North Terminal – safe areas include mezzanine and departure lounges. The safe exit route above flooding is to the upper ramp level and thereafter dry road exit to A23/M23.
- Hotel accommodation at North and South Terminals is elevated, accessed by link bridges and would provide emergency accommodation if necessary.
- Catering outlets and other retail in the Terminals will provide welfare meals as necessary.

5.5.3 Full evacuation outside of Terminals is not expected unless required for other safety reasons. If necessary, flood barriers will be activated and Security Staff posted to direct passengers to safe locations. Aviation security will not be compromised in the course of facilitating the above. All passengers will be subject to departure screening as is usual, and unscreened passengers will not be allowed to mix with those having gone through security. In the event this did occur, then all passengers would have to be re-screened in accordance with Department for Transport protocols.

[3] See Environment Agency webpage: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

5.6 Response to Other Sources of Flooding Incident

Surface water flood risk

5.6.1 Surface water flooding from a summer storm (typically of high intensity and low volume) may also result in disruption to airport operations and limited closure of facilities. There may be localised ponding of rainfall but this would be expected to drain via the drainage network with only temporary disruption.

5.6.2 A winter storm (typically low intensity but high volume) has the potential to overwhelm the capacity of the drainage network and place the ground level of North Terminal at risk of flooding. However, such an event would take some time to occur and through a combination of weather forecasting and monitoring of water levels in the drainage network Gatwick would have time to prepare for any disruption through the procedures described in this Statement. Staff may have to evacuate from basement areas. Provision of mitigation for the Project reduces the risk of surface water flooding to between the 2 per cent (1 in 50) AEP to 1.33 per cent (1 in 75) AEP event.

Reservoir failure flood risk

5.6.3 GAL owns and maintains onsite statutory reservoirs that store de-icer contaminated runoff prior to treatment and manages flood risk in the event of an incident and will continue to do so through the lifetime of the Project. The Project itself has no effect on the operation or maintenance of Gatwick's reservoirs and does not alter reservoir flood risk.

5.6.4 In the event of failure of an upstream reservoir Gatwick would be contacted by the Emergency Services or crisis management team dealing with the incident.

5.6.5 Flood extents are expected to be similar to fluvial (river) flooding events where these occur in the areas local to the reservoirs. If sufficient time is available then key priority evacuation areas, where depth and speed of flow in an uncontrolled breach could put lives at risk, will be evacuated first. Thereafter, the incident will be managed through crisis management protocols.

5.7 Managed return to service post incident

5.7.1 In an extreme fluvial flood event it could take flood waters over 24 hours to recede sufficiently to allow direct access to Terminal forecourts at ground level. The managed return to service will be coordinated with the Police and other relevant authorities and parties.

5.7.2 The airport will seek to restore operations as soon as safe to do so working in coordination with the relevant authorities, however, this will be in the context of the prevailing situation following the flood event.

5.7.3 Following an extreme flood event post incident reviews and learning point identification exercises will be undertaken with relevant parties as appropriate.

6 Impact of Climate Change on flood emergency plans

6.1.1 There is a need to consider any flood management measures in the context of the future flood risk that would occur due to the predicted impacts of climate change over the lifetime of the Project. The detailed consideration of the predicted impact of climate change on flood risk is described in the **ES Appendix 11.9.6: Flood Risk Assessment** (Doc Ref. 5.3).

6.1.2 The UK Climate Projections 2018 (UKCP18), (Met Office et. al., 2018) include the government's current assessment of the likely changes to precipitation across the UK due to future climate change. These projections have informed the current Environment Agency guidance on how this should be considered by FRAs for development applications, as set out in: "Flood Risk Assessments: Climate Change Allowances Guidance" published in February 2016, last updated in May 2022 (Environment Agency, 2022). The allowances are applied to fluvial and surface water flood risk respectively via:

- Peak River Flow Climate Change Allowances by Management Catchment published in July 2021 and updated in February 2022 (Environment Agency, 2022b).
- Peak Rainfall Intensity Climate Change Allowances by Management Catchment published in May 2022 (Environment Agency, 2022c).

6.1.3 For this Project the design life and therefore the allowance for climate change varies. For the airfield and associated works, the adopted lifetime for the Project is 40 years and for the surface access works, the adopted lifetime for the Project is 100 years. It is considered that a longer design life for the airfield works would not be realistic given it is likely there will be further significant changes to the airport and its operations in that timescale. The aviation industry has changed considerably during the past 40 years and Gatwick has developed to meet these changes. This characteristic of change is anticipated to continue to some degree. Assessment of climate change allowances over a longer design life for the airfield is therefore considered disproportionate.

6.1.4 The Higher Central allowance has been adopted as the Project has been classified as "Essential [transport] Infrastructure" based on NPPF Annex 3 (Department for Levelling Up, Housing and Communities, 2012) in Flood Zone 2 and 3. The subsequent allowances that have been adopted by the Project are set out in Table 5.7.1 for fluvial (rivers) and rainfall intensity (for surface water drainage design).

Table 5.7.1 Adopted Climate Change Allowances

Project Element	Fluvial Uplift	Rainfall Intensity Uplift
Airfield	+12 per cent	+25 per cent
Highways Improvements	+20 per cent	+40 per cent

6.1.5 Climate change is likely to change the frequency of severe events but will not affect escape or evacuation routes at Gatwick as these are already optimised to avoid flooded areas and consider the predicted impacts of climate change. The **ES Appendix 11.9.6: Flood Risk Assessment** (Doc Ref. 5.3) provides information on the flood extents for different storm events. While the Project would increase flood risk compared to existing in certain locations on the airport, outside the airport boundary it would be reduced.

7 Figures

7.1.1 The following figures are included to support this Statement:

- **ES Appendix 11.9.6: Annex 6 Figure 5.3.1** (Doc Ref. 5.3)
- **ES Appendix 11.9.6 Figure 5.2.2** (Doc Ref. 5.3)
- **ES Appendix 11.9.6 Figure 5.3.2** (Doc Ref. 5.3)
- **ES Appendix 11.9.6 Figure 5.3.3** (Doc Ref. 5.3)
- **ES Appendix 11.9.6 Figure 5.3.4** (Doc Ref. 5.3)
- **ES Appendix 11.9.6 Figure 5.5.1** (Doc Ref. 5.3)
- **ES Appendix 11.9.6 Figure 7.2.2** (Doc Ref. 5.3)
- **ES Appendix 11.9.6 Figure 7.2.4** (Doc Ref. 5.3)
- **ES Appendix 11.9.6 Figure 7.2.6** (Doc Ref. 5.3)

8 References

Published Documents

Defra/EA (2005) Flood Risk Assessment Guidance for New Development. Available at: http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=FJPProjectView&Location=None&ProjectID=12015

Department for Levelling Up, Housing and Communities (2021) National Planning Policy Framework (NPPF), HMSO. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework–2

Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities and Local Government (2021) National Planning Practice Guidance (NPPG). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf

Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities and Local Government (2019a) Climate change guidance. Available at: https://www.gov.uk/guidance/climate-change

Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities and Local Government (2022) Flood risk and coastal change guidance. Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change

Department for Transport (2018) Airports National Policy Statement: new runway capacity and infrastructure at airports in the south-east of England. Available at: https://www.gov.uk/government/publications/airports-national-policy-statement

Design Manual for Roads and Bridges (DMRB) (2022) CG 501 - Design of highway drainage systems. Available at: https://www.standardsforhighways.co.uk/search/6355ee38-413a-4a11-989b-0f33af89c4ed

Environment Agency (2022a) Flood risk assessments: climate change allowances. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Environment Agency (2022b) Peak river flow climate change allowances by management catchment. Available at: https://www.gov.uk/government/publications/peak-river-flow-climate-change-allowances-by-management-catchment

Environment Agency (2022c) Peak rainfall climate change allowances by management catchment. Available at: https://www.gov.uk/government/publications/peak-rainfall-climate-change-allowances-by-management-catchment

Environment Agency (n.d.) Flood map for planning. [Online] Available at: https://flood-map-for-planning.service.gov.uk/

Environment Agency (n.d.) Long term flood risk map. [Online] Available at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

Met Office Hadley Centre (2018): UKCP18 Global Projections by Administrative Regions over the UK for 1900-2100. Available at: https://catalogue.ceda.ac.uk/uuid/7ebab0df1a794d1fae245256af7de633

Met Office, Department for Environment, Food and Rural Affairs (Defra), Department for Business, Energy and Industrial Strategy (BEIS) and Environment Agency (2009) UK Climate Projections 2009/ Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/ukcp09-users

9 Glossary

9.1 Glossary of terms

Table 9.1.1 Glossary of terms

Term	Description
AEP	Annual Exceedance Probability, eg 1 per cent AEP is equivalent to 1 in 100 probability of flooding occurring in any one year (or, on average, once in every 100 years).
CoCP	Code of Construction Practice
Defra	Department for Environment, Food and Rural Affairs. The government department responsible for environmental protection, food production and standards, agriculture, fisheries and rural communities in the UK. Among its responsibilities, Defra publishes guidance on, for example, flood modelling approaches and approaches to accounting for climate change in flood studies.
Development	The carrying out of building, engineering, mining or other operations, in, on, over or under land, or the making of any material change in the use of a building or other land.
Environment Agency (EA)	The Environment Agency is a non-departmental public body, established in 1995 and sponsored by Defra. Its responsibilities relate to the protection and enhancement of the environment in England. Environment Agency
ES	Environmental Statement
Exception Test	The Exception Test should be applied if, following application of the Sequential Test, it is not possible for the development to be located in Flood Zones with a lower probability of flooding. For the Exception Test to be passed it must be demonstrated that: ▪ The development provides wider sustainability benefits to the community that outweigh flood risk; and ▪ That the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible will reduce flood risk overall.
Flood Zone 1 Low Probability (FZ1)	NPPG Flood Zone, defined as areas outside Zone 2 Medium Probability. This zone comprises land assessed as having a less than 1 in 1,000 annual exceedance probability of river or sea flooding (less than 0.1 per cent) in any year.
Flood Zone 2 Medium Probability (FZ2)	NPPG Flood Zone which comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual exceedance probability of river flooding (1 per cent – 0.1 per cent) or between a 1 in 200 and 1 in 1,000 annual exceedance probability of sea flooding (0.5 per cent – 0.1 per cent) in any year.
Flood Zone 3a High Probability (FZ3a)	NPPG Flood Zone which comprises land assessed as having a 1 in 100 or greater annual exceedance probability of river flooding (greater than 1 per cent) or a 1 in 200 or greater annual exceedance probability of sea flooding (greater than 0.5 per cent) in any year.
FRA	Flood Risk Assessment.

	A site-specific assessment of flood risk. This is a statutory report for submission with planning applications in England.
FSA	Flood Storage Area. An area designed to deliberately fill with floodwater and retain it until river levels have reduced with the aim of reducing peak water levels and consequently flood risk downstream.
Functional Floodplain (Flood Zone 3b) (FZ3b)	NPPG Flood Zone, defined as areas in which water from rivers or the sea has to flow or be stored in times of flood. Functional floodplain will normally comprise of land having a 3.3 per cent (1 in 30) or greater AEP or land that is designed to flood, even if it would only flood in more extreme events (such as and 0.1 per cent (1 in 1,000) AEP).
GAL	Gatwick Airport Limited
Gatwick	London Gatwick Airport
Groundwater Flooding	Emergence of groundwater at the ground surface or the rising of groundwater into underground infrastructure (such as basements) under conditions where the normal range of groundwater level and flows is exceeded.
LLFA	Lead Local Flood Authority. Unitary Authorities or County Councils responsible for developing, maintaining and applying a strategy for local flood risk management in their areas and for maintaining a register of flood risk assets. Also, responsible for managing local flood risk (flooding from surface water, groundwater and ordinary watercourses).
NPPF	National Planning Policy Framework. National planning policy published by the Government, most recently in July 2021. It replaces most of the previous Planning Policy Statements, including that regarding flood risk (PPS25).
NPPG	National Planning Practice Guidance. Supporting guidance to the NPPF, published by the Government in March 2014 and updated since as an online resource, available at: (http://planningguidance.planningportal.gov.uk/). It replaces previously published Government guidance, including that regarding flood risk.
NPS	National Policy Statement
Residual Risk	A measure of the outstanding flood risks and uncertainties that have not been explicitly quantified and/or accounted for as part of the design process.
RoFSW	Risk of Flooding from Surface Water
Sequential Test	A national planning policy requirement that seeks to steer new development to areas with the lowest probability of flooding. In demonstrating that the requirements of the sequential test have been met, proposals should refer to the NPPF and Planning Practice Guidance, and the Environment Agency Flood Zones.
WMP	Water Management Plan