

Cambridge Rowing Trust
Murdoch House
Second Floor
Station Road
Cambridge
CB1 2RS

Cambridge Sport Lakes

Stage I Flood Risk

Assessment

July 2005

Mott MacDonald
Demeter House
Station Road
Cambridge CB1 2RS
UK
Tel : 44 (0)1223 463500
Fax : 44 (0)1223 461007

Cambridge Sport Lakes

Stage I Flood Risk Assessment

Report Nr 022941/07

Issue and Revision Record

Rev	Date	Originator	Checker	Approver	Description
A	July 2005	I Rockliffe / A Smith	T Spencer	D Hutchinson	First Issue for Submission to Environment Agency

This document has been prepared for the titled project or named part thereof and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of Mott MacDonald being obtained. Mott MacDonald accepts no responsibility or liability for the consequence of this document being used for a purpose other than the purposes for which it was commissioned. Any person using or relying on the document for such other purpose agrees, and will by such use or reliance be taken to confirm his agreement to indemnify Mott MacDonald for all loss or damage resulting therefrom. Mott MacDonald accepts no responsibility or liability for this document to any party other than the person by whom it was commissioned.

To the extent that this report is based on information supplied by other parties, Mott MacDonald accepts no liability for any loss or damage suffered by the client, whether contractual or tortious, stemming from any conclusions based on data supplied by parties other than Mott MacDonald and used by Mott MacDonald in preparing this report.

List of Contents		Page
Chapters and Appendices		
	Summary	1
1	Introduction	2
2	Site Information	2
	2.1 Location	2
	2.2 The Site	4
	2.3 Survey Information and Proposed Ground Levels	6
3	Flood Risk	8
	3.1 Potential Sources of Flooding	8
	3.1.1 River Cam Flooding	8
	3.1.2 Storm water Runoff	11
	3.2 Likely Impact of Flooding	14
4	Drainage	14
	4.1 Existing Drainage	14
	4.2 Proposed Drainage System	14
	4.2.1 Proposed Changes to Existing Surface Water Drainage	14
	4.2.2 Award Drain Aqueduct	15
5	Mitigation of Third Party Impacts	16
	5.1.1 Comparison of Floodplain Storage Volumes	16
	5.1.2 Surface Run-off	17
	5.1.3 Riparian Rights Downstream	17
6	Residual Risk	17
7	Conclusions	17
8	Additional Aspects to be included in a Stage II FRA	18
	Appendix A Plan of Proposed Sport Lakes	A-1

List of Figures:

Figure 1: Location Plan	3
Figure 2: Typical Section through Proposed Competition Lake and Embankment	4
Figure 3: Extent of 1 in 100 year return period Flood Event	5
Figure 4: Existing Ground Levels	7
Figure 5: October 2001 Flood Event – Aerial Photo 192	9
Figure 6: October 2001 Flood Event – Aerial Photo 276	10
Figure 7: Existing Drainage System	12
Figure 8: Proposed Drainage System	13

Summary

This flood risk assessment has been prepared by Mott MacDonald on behalf of the Cambridge Rowing Trust for the proposed development of the Cambridge Sports Lakes.

The Stage I assessment has been undertaken in accordance with Planning Policy Guidance Note 25 (PPG25), and is based on earlier submissions and comments received from the Anglian Region of the Environment Agency.

The site for the proposed development is currently unprotected against flooding from the River Cam. A small part (25%) of the site lies within the Flood Zone 3 category as described in Table 1 of PPG25, with an annual probability of fluvial flooding of greater than 1%.

After development, the majority of the site (ie excluding the lakes) will be more than 2 m higher than the predicted 1% annual probability river flood level of 4.96 m AOD, allowing for the impact of climate change. Based on the PPG25 sequential test for flood risk, the land based facilities therefore fall within Flood Zone 1 (less than 0.1% annual probability of fluvial flooding) with little or no risk of flooding. Camping will be restricted to the higher parts of the site with minimum elevation 7.0 m AOD. Access and egress routes will be provided at similar elevations which are well above maximum predicted flood level. No rowing would be allowed on the lakes in times of flood.

There is strong anecdotal evidence that there is no history of flooding in the drains upstream of the development. The site is well drained, and does not suffer stormwater runoff flooding problems. As part of the development, it is proposed to divert several of the local watercourses and drains into a new perimeter drain, which will be used with a settling basin and pumping station to attenuate storm drainage flows before discharge into the River Cam. An existing award drain (Award No 291) will cross the proposed canal which connects the River Cam to the Sport Lakes, passing through a new aqueduct.

The mitigation of potential third party impacts has been considered and the following points are made:

- The current amount of compensatory flood storage for the Cam downstream of Baits Bite Lock will be replaced by a much greater storage capacity in the Cam upstream of the lock.
- The proposed Cambridge Sport Lakes development will provide 34% additional flood compensatory storage to the River Cam compared to the current floodplain storage.

This, combined with fast access to this storage, will have a beneficial effect on the overall hydraulics of that section of the Cam basin, and will have a positive impact in reducing flood risk downstream. Stormwater runoff will be attenuated on site. Riparian rights downstream of the site will be not be adversely affected by the drainage diversions.

Given the minimal anticipated impact of flooding the site is considered suitable for the proposed development. Further security against flooding can be accommodated in the additional storage capacity of the lakes above the normal water level of the River Cam.

It is proposed to undertake a more detailed Stage II FRA for approval by the Environment Agency prior to construction. This will include the results of hydraulic modelling, a detailed drainage strategy, further details of the hydraulic structures proposed, and the proposed long term arrangements for operation, maintenance and management of the Sport Lakes.

1 Introduction

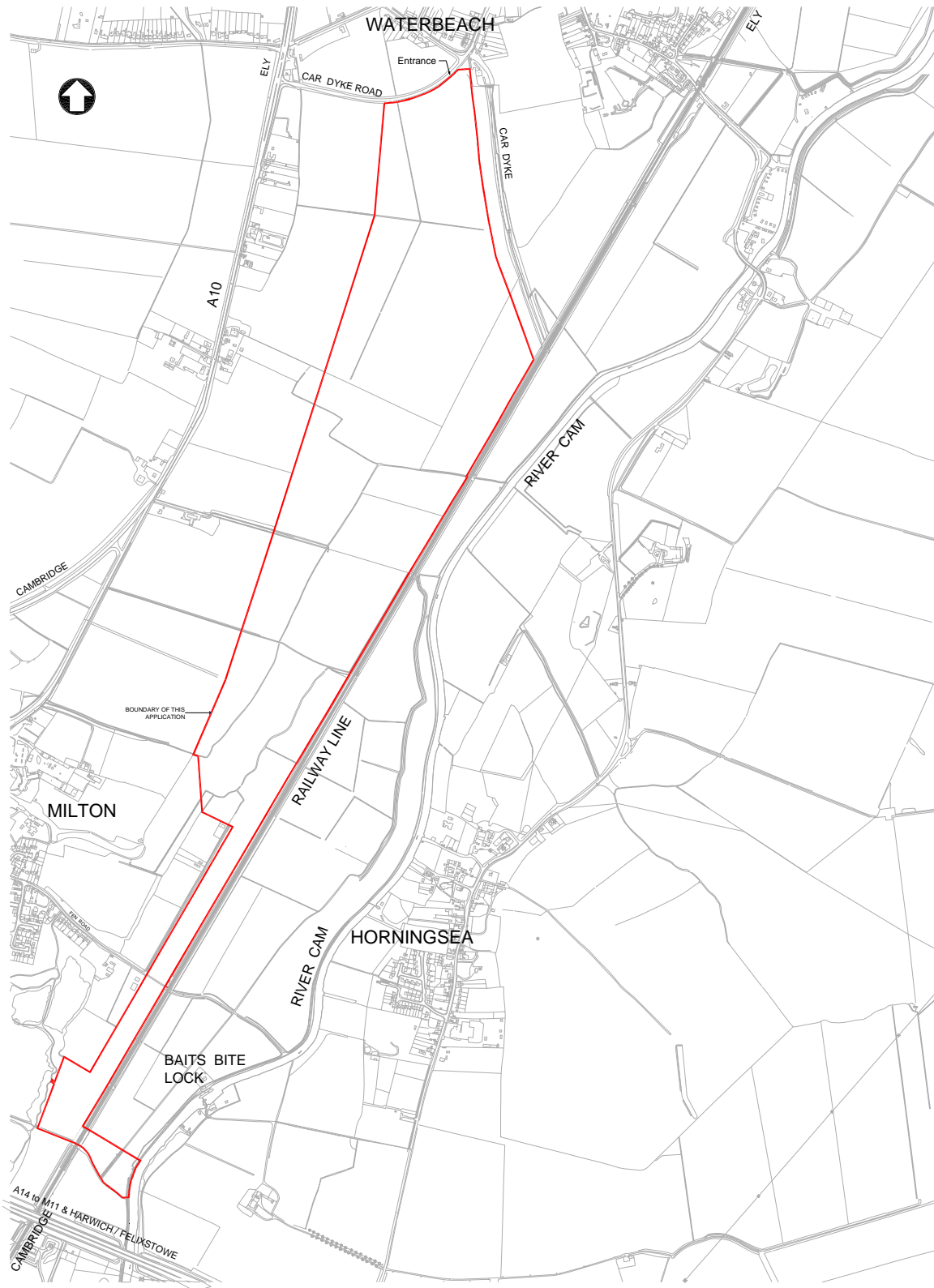
This Stage I Flood Risk Assessment (FRA) has been prepared by Mott MacDonald in support of a refresher planning application by Cambridge Rowing Trust (CRT) to create the Cambridge Sport Lakes - a regional centre for the teaching and practice of multi-sports, leisure and recreational activities. The centre will consist of two connected lakes for rowing and associated sports, a storage lake for water quality and angling, BMX, BSX and Triathlon tracks, a boathouse complex and a country park.

The FRA has been prepared in line with Appendix F to the Planning Policy Guidance Note 25: Development and Flood Risk (ODPM, 2001). Specific consideration in the assessment has been given to a number of points raised by the Environment Agency in written comments to Cambridge Rowing trust, and during a meeting on 01/06/05. In particular, it was agreed that for the purposes of the planning application a Stage I FRA would be sufficient, on condition that a more detailed analysis and details would be included in a Stage II FRA for the proposed development before the start of construction.

2 Site Information

2.1 Location

The site is located between Milton Country Park to the south and the village of Waterbeach to the north, approximately 3 miles north of Cambridge. Figure 1 shows the general location of the site and its relationship to the River Cam.



Ordnance Survey digital mapping
© Crown copyright. All rights reserved license no. 1000 20449

Figure 1: Location Plan

2.2 The Site

The site is currently used as farmland and its characteristics are typical of the fen land to the north east of Cambridge. It is low-lying, flat and open, dissected by man-made drainage channels with a few hedgerows and prominent tree belts.

The Cambridge Rowing Trust is planning to develop the site, as shown in Appendix A. The proposed development comprises the construction of a canal connecting the River Cam via a railway underpass to new training and competition lakes with associated sports facilities, plus a storage lake and country park. A typical section across the proposed development is shown in Figure 2.

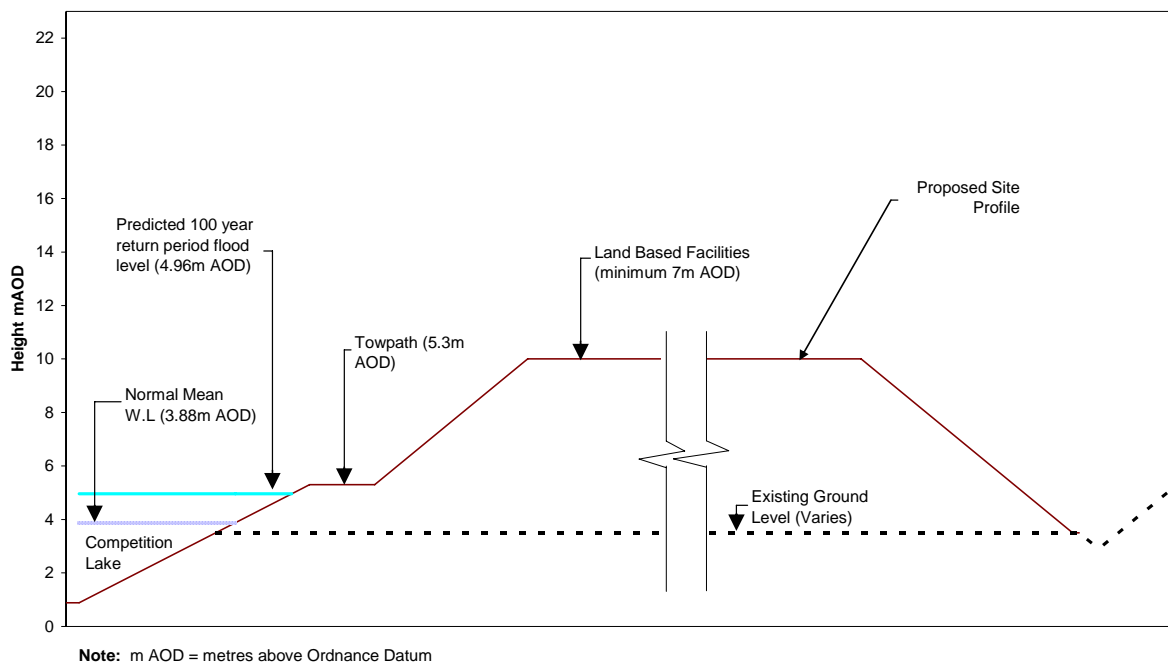


Figure 2: Typical Section through Proposed Competition Lake and Embankment

(not to scale)

Flooding of the River Cam has been assessed by Mott MacDonald in 2005 as part of the Strategic Flood Risk Assessment (SFRA) for South Cambridgeshire District Council. Figure 3 depicts the extent of a 1 in 100 return period flood event (ie 1% annual probability) with the boundary of the proposed development shown in red.

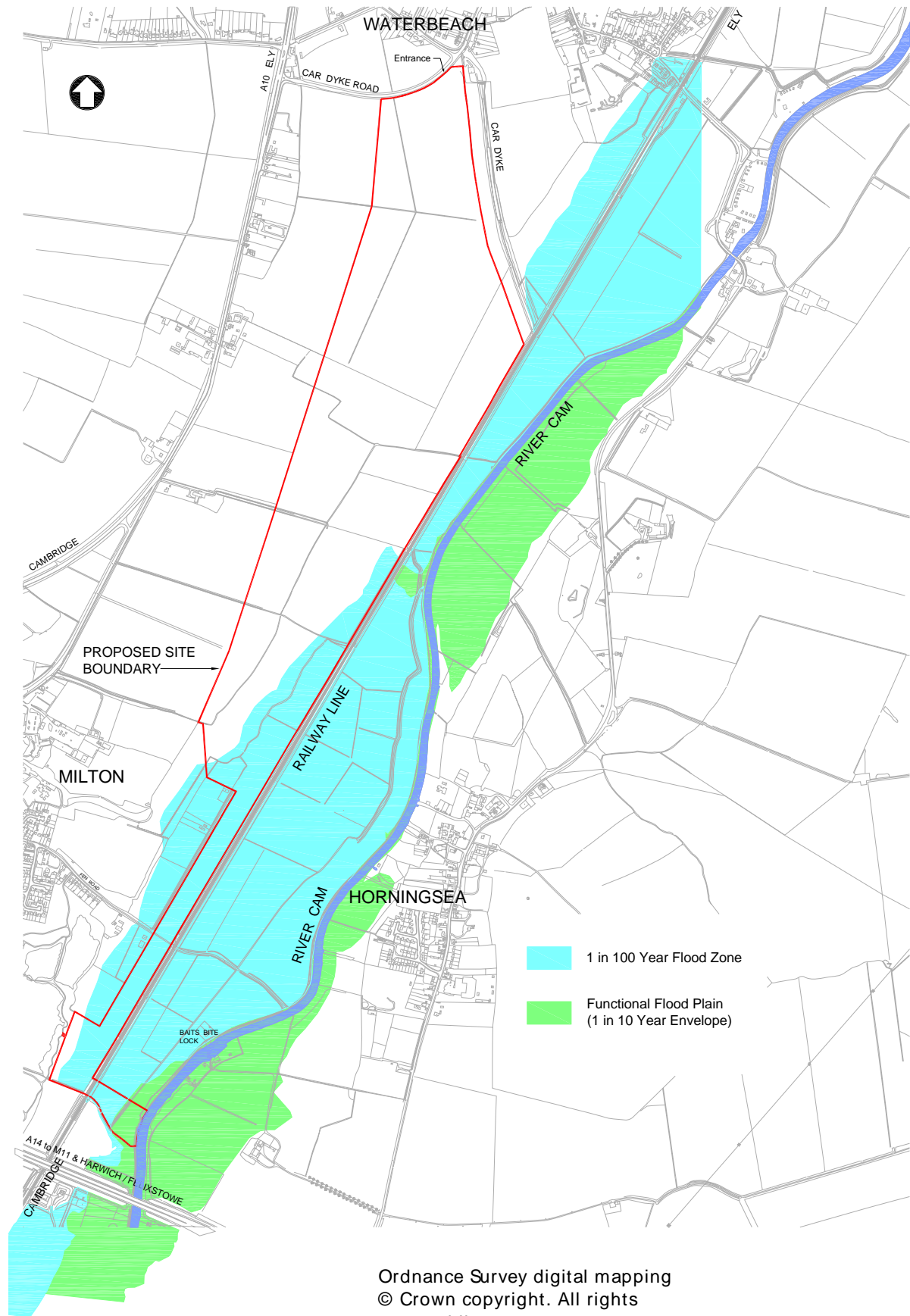


Figure 3: Extent of 1 in 100 year return period flood event

2.3 Survey Information and Proposed Ground Levels

Figure 4 shows the existing ground levels across the site based on a reconnaissance topographic survey commissioned by CRT in 1992. The typical cross section in Figure 2 shows the proposed development in relation to the existing ground levels. The lakes on site would have embankments with a minimum bank top level of 7 m AOD. The area to the side of these banks would be a landscaped plateau at a similar elevation, in places with an access road, elsewhere with a towpath alongside the Canal, and an area for camping with BMX and BSX tracks.

For the purpose of this assessment, the mean water level of the lakes is assumed to be 3.88 m AOD, based on the normal water level in the River Cam upstream of Baits Bite Lock.

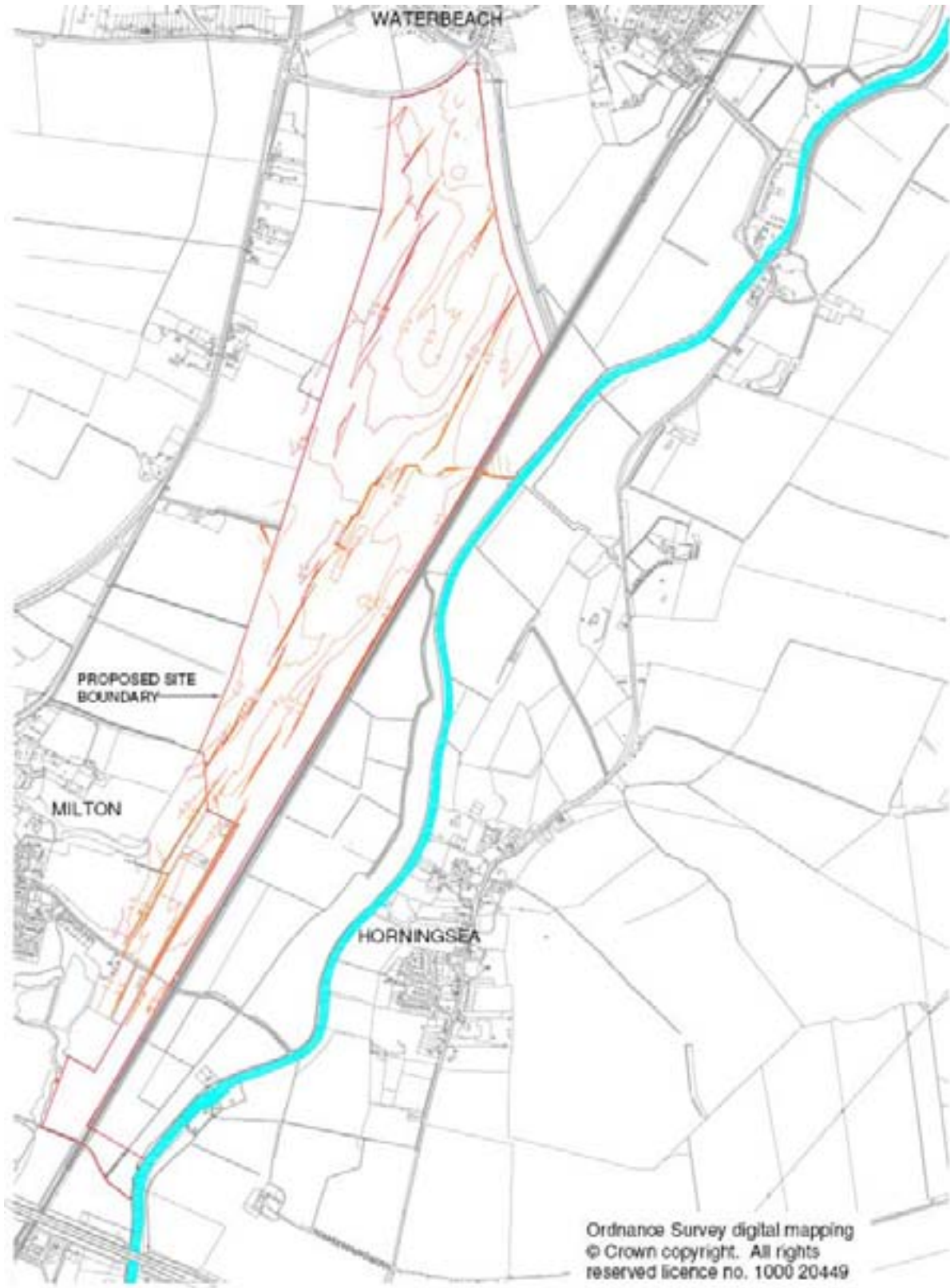


Figure 4: Existing Ground Levels

Note: Contour levels shown in mAOD

Figure 4: Existing Ground Levels

Note: Contour levels shown in m AOD

3 Flood Risk

3.1 Potential Sources of Flooding

3.1.1 River Cam Flooding

Current Situation

The River Cam presents a flood risk during periods of sustained rainfall. The last major flood event in 2001 led to extensive damage to properties in Cambridge and flooding of undefended land downstream of the site. Figures 5 and 6 depict this flooding from aerial views, clearly indicating that the area west of the railway acts as passive floodplain storage with no floodplain flow parallel to the river in that area. Therefore the development will not interrupt active flows across the floodplain.

Access for floodwater to the passive floodplain storage area west of the railway is currently from the River Cam downstream of Baits Bite Lock via three small brick Award Drain culverts under the railway embankment. The choke effect of these culverts is high, and thus any attenuation provided by this storage is likely to have negligible effect on the peak of the Cam hydrograph downstream of Baits Bite Lock.

The site is currently undefended against flooding from the River Cam. As discussed above, flooding of the River Cam has been modelled by Mott MacDonald previously as part of the South Cambridgeshire SFRA.

The majority of the 95 ha site lies in Flood Zones 1 and 2 as defined in Table 1 of Planning Policy Guidance Note 25, with less than 1% annual probability of fluvial flooding. A small part of the site (23.5 ha or 25%) falls within the Zone 3 category for fluvial flooding, with annual probability of flooding of 1% or greater, as shown in Figure 3.

Future Risks

The creation of a canal to connect the new development with the River Cam will allow flood water from the River Cam upstream of Baits Bite Lock to be accommodated within the lake network. This canal will be equivalent in cross sectional area to the River Cam, and therefore flow to and from the Lakes will be relatively unobstructed. From the South Cambridgeshire SFRA, the predicted water level for a 1 in 100 year return period event at the entrance to the Canal is 4.96m AOD. This includes an allowance for climate change. As the site will be bunded on all sides, the connection to the River Cam will be the only route for flood water to access the development. The land based facilities within the development will all be elevated at a minimum level of 7 m AOD. In line with the sequential test for flood risk in PPG25, it is clear that the land based facilities therefore fall within Flood Zone 1 (less than 0.1% annual probability of flooding) with little or no risk from flooding.

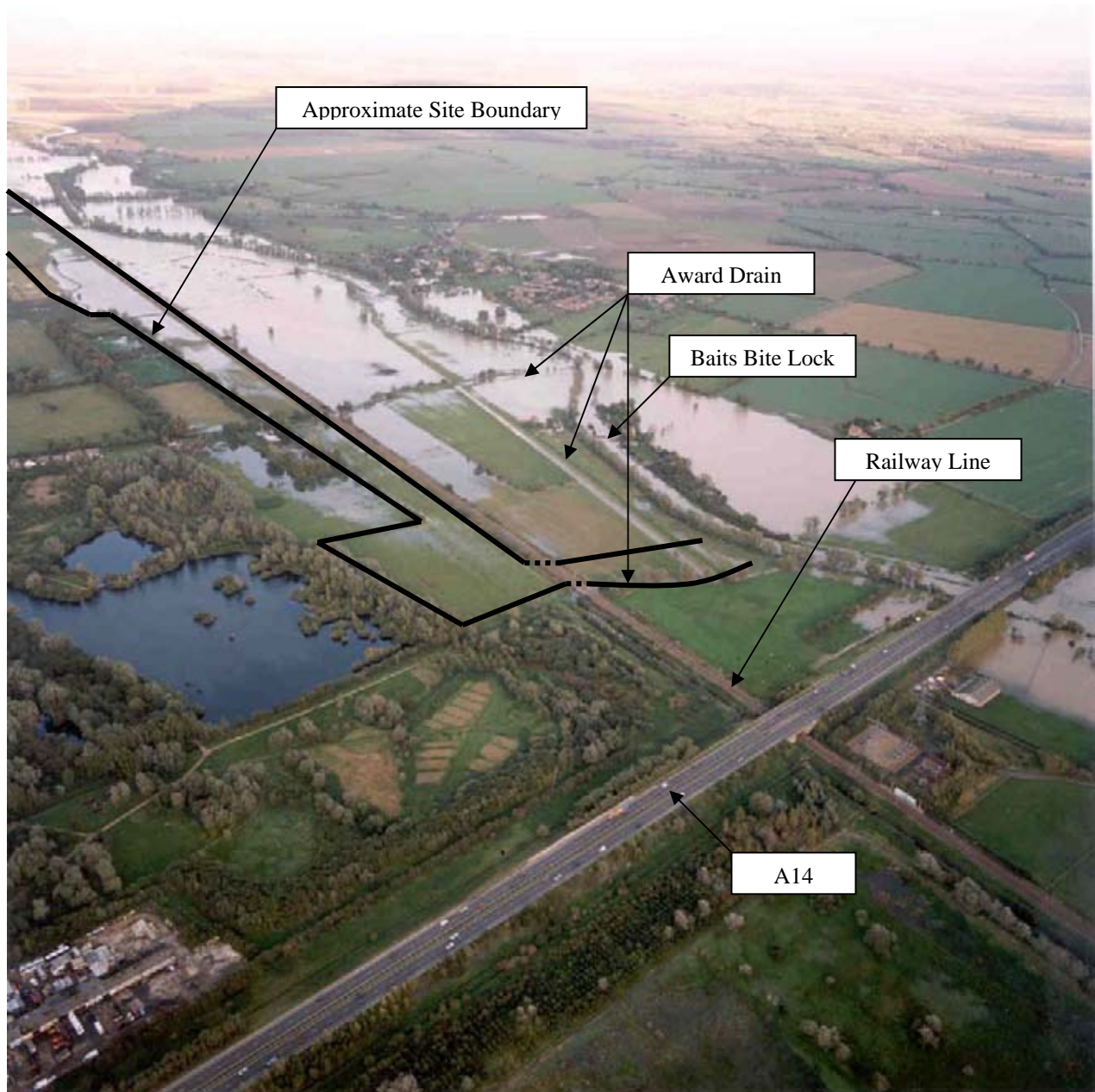


Figure 5: October 2001 Flood Event - Aerial Photo 192
(View from A14 towards Baits Bite Lock)

This photo depicts the Award drains close to Baits Bite lock and shows the area where the Canal will connect into the River Cam. The majority of the flooding is confined to the Cam side of the railway line, consistent with the results of the SFRA flood model.

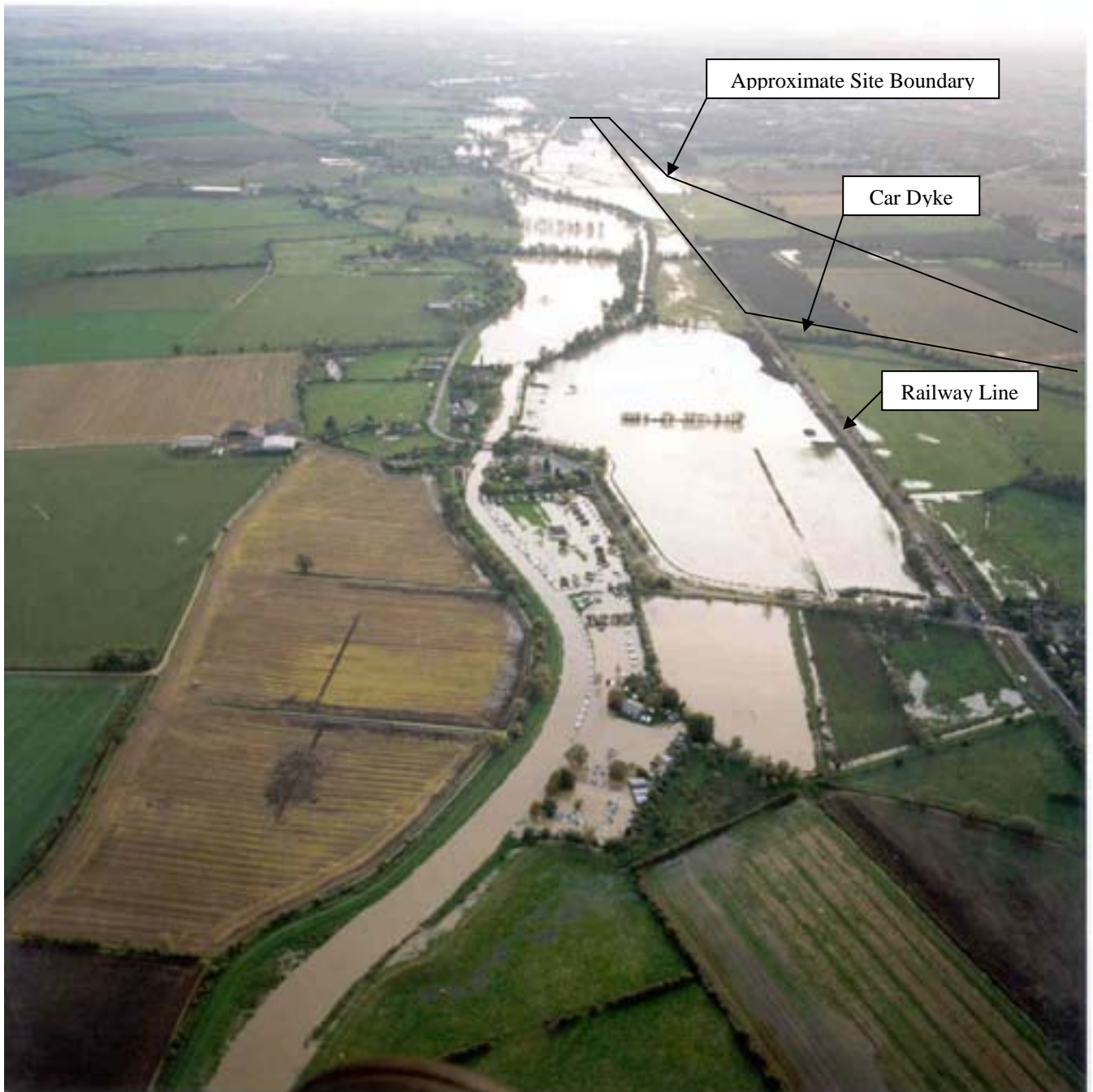


Figure 6: October 2001 Flood Event - Aerial Photo 276
(Looking upriver from Clayhithe)

As with the previous photo, this photo shows that the majority of the flooding was confined to the area between the railway line and the River Cam.

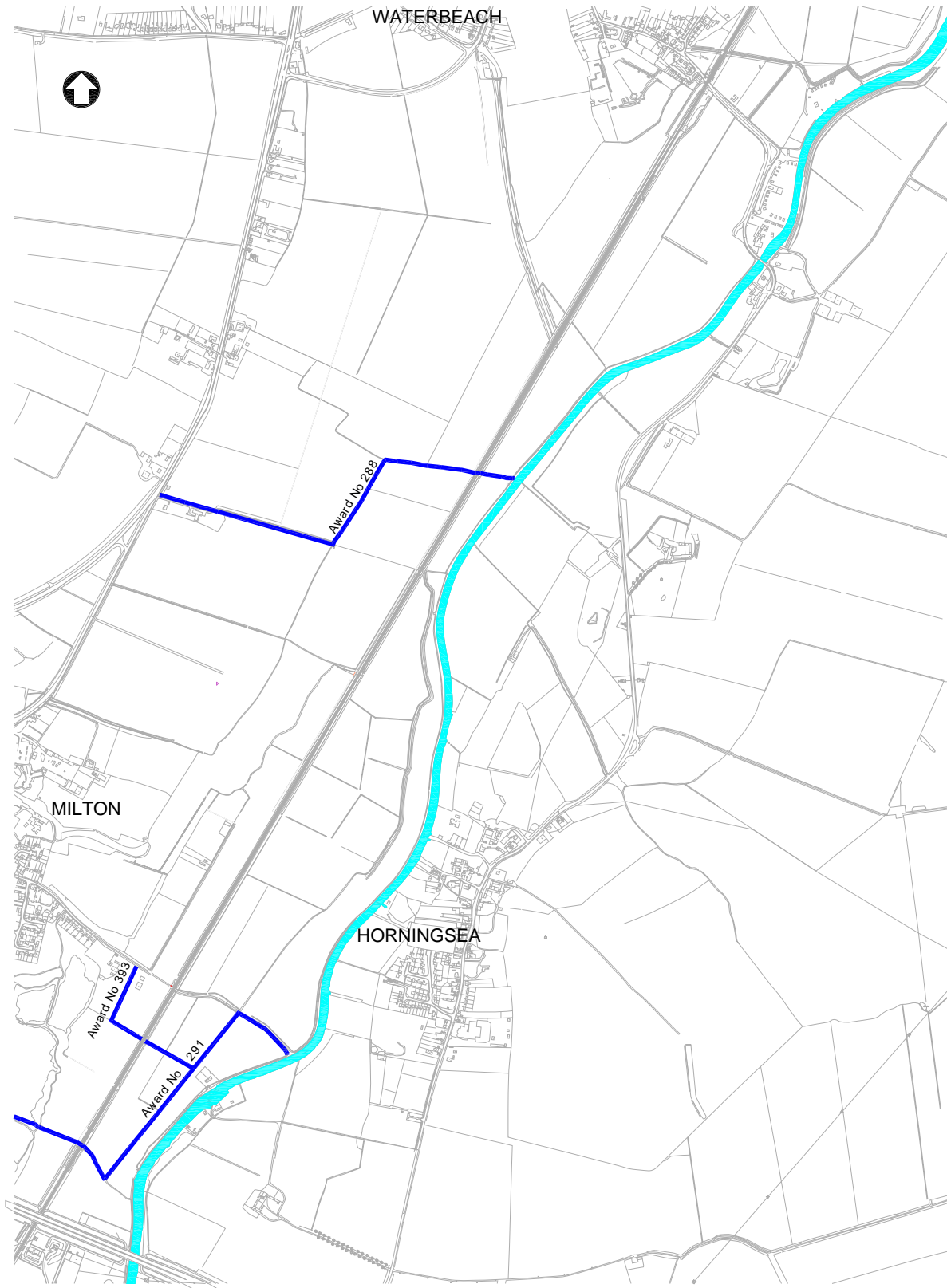
3.1.2 Storm water Runoff

Current

The risk of flooding from surface flow is very small in this area. The site is primarily free draining. There is a network of field drains across the area, but many of these are dry for most of the year, and some have silted up. Surface flow from adjacent residential areas is routed across the site via Award Drains which discharge into the Cam as illustrated in Figure 7. Anecdotal evidence indicates that there has never been a problem with flooding from surface run-off in this area.

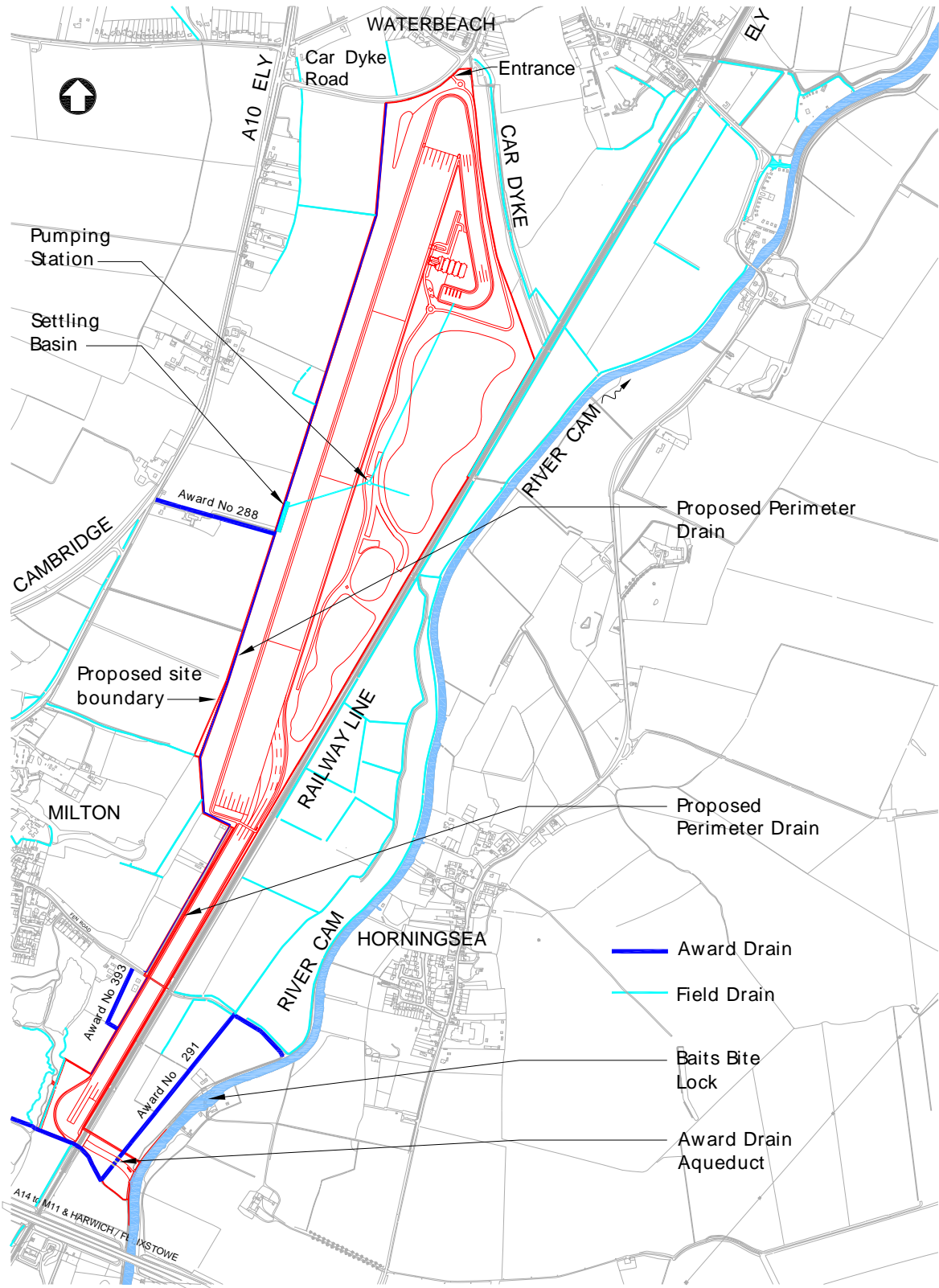
Future

The proposed development is designed so that surface runoff will drain directly to the rowing and storage lakes, and into the River Cam via a perimeter drain and pumping station. Figure 8 shows the proposed system. The perimeter drain will effectively replace the current railway drain which runs along the length of the railway line and picks up flow in the field drains to the west.



Ordnance Survey digital mapping
© Crown copyright. All rights reserved license no. 1000 20449

Figure 7: Existing Drainage System



Ordnance Survey digital mapping
 © Crown copyright. All rights reserved
 license no. 1000 20449

Figure 8: Proposed Drainage System

3.2 Likely Impact of Flooding

The proposed profile of the development is such that flood water can be accommodated and stored in the sport lakes without impact of the land based facilities. Access for flood water to the new lakes will be from the River Cam via the Canal, which is equivalent in cross-sectional area to the River Cam upstream of Baits Bite Lock. Flow to and from the Lakes should be relatively unobstructed, with the cross sectional area of the proposed culverts under the railway totalling approximately 30m².

Flooding on the site is expected to have a very small effect on the facility as a whole. The South Cambridgeshire SFRA carried out by Mott MacDonald shows a predicted flood level of 4.96m AOD at the proposed location of the Canal for a 1% annual probability flood event, including the predicted effect of climate change. The proposed bank top level alongside the sport lakes is a minimum of 7 m AOD, and therefore will not overtop. Assuming a mean water level of the lake of 3.88 m AOD, a rise of 1.42m could be accommodated before flood water reaches the towpath level of 5.3 m AOD around the competition lake. No camping would be permitted on the site at towpath level, and this would be restricted to the higher parts of the site with minimum elevation 7.0 m AOD. Access and egress routes would also be provided at similar elevations well above maximum predicted flood level at high level. No rowing would be allowed on the lake in times of flood.

Careful consideration has been given to surface flow, and a drainage strategy has been developed to ensure that the impacts from surface flow are minimised both on site and further downstream.

4 Drainage

4.1 Existing Drainage

Figure 7 shows the current drainage system in place across the site. The system comprises a network of field drains and three Award Drains which carry run-off from the residential areas of North Cambridge and Milton. A site survey carried out by Mott MacDonald on 02/06/05 and discussions with local farmers has revealed that most of the field drains are currently dry or silted up, and are not used by the farmers for irrigation purposes. The land itself is known to have good drainage properties, and as a result can be considered as free draining.

4.2 Proposed Drainage System

Preliminary proposals have been developed for the site to ensure that the existing drainage network will not be adversely affected, and that drainage problems are not exacerbated downstream.

As the site cuts through a number of Award and field drain routes, diversions will be required as demonstrated in Figure 8 and detailed below:

4.2.1 Proposed Changes to Existing Surface Water Drainage

Award Drain no. 288 - The project requires this drain to be diverted into the Lake by pumping through a permanent pumping station. A detailed design will be subject to a Condition and produced for approval by the relevant statutory bodies. Diversion of this drain would be completed and in operation before major excavation of the lakes.

Award Drain no. 291 - No diversion of this drain, which carries flows from North Cambridge, is required apart from carrying it under the Canal at the Award Drain Aqueduct.

Award Drain no. 393 - This drain will be diverted south west alongside the Training Lake to connect with Award Drain 291 west of the railway.

The Perimeter Drain will be built on the site boundary where there is not already an existing drain or the diverted Award Drain. The existing network of field drains outside the site boundary will all drain into this new drain, thus preserving the drainage and groundwater regime of the ground outside the perimeter.

A settling basin will be constructed on the perimeter drain, which will function as both a balancing pond to attenuate runoff from the drains upstream of the perimeter drain, and as a sump for the pump station. Water would be pumped either into the Competition Lake for discharge into the River Cam, or into the Storage Lake for lake flushing purposes.

4.2.2 Award Drain Aqueduct

The aqueduct carries the Canal over Award Drain no 291. It will be designed as multi-barrel, successive barrels being brought into action at higher water levels by an initiation weir. Design water velocities are at a level to optimise self-cleansing, and debris grilles will be fitted to Authority requirements to minimise cleaning and maintenance. Precautions will be taken against bank erosion and scour of the floor of the canal by the flume effect of the shallow water above the Aqueduct.

The design flow capacity of the Aqueduct will be greater than the maximum flow capacity of the culvert carrying the Award Drain under the railway immediately upstream. This will ensure that the maximum capacity of the Award Drain is retained, and thus will not affect any potential flood situation further upstream. As with all the hydraulic structures, approval by the Environment Agency for the final configuration of the Aqueduct will be obtained prior to construction.

5 Mitigation of Third Party Impacts

5.1.1 Comparison of Floodplain Storage Volumes

The footprint of the proposed development will occupy about 23.5 ha of the existing floodplain to the west of the railway line, with a current flood storage volume of approximately 205,000 m³, based on modelled water levels downstream of Baits Bite Lock. This assumes that during a flood water levels increase due to flow from the river through the three existing railway drain culverts.

However, by providing the Canal connecting and the new lakes to the Cam, a large volume of compensatory storage would become accessible to the River Cam system upstream of Baits Bite Lock.

Modelling undertaken by Mott MacDonald shows that the river level at the position of the proposed Canal is predicted at 4.8m AOD during a 1 in 100 year return period event (without climate change). The normal lake level will be 3.88m AOD and the surface area of the lake will be approximately 29.5 ha. The volume of available flood storage above 3.88m AOD for the full development is calculated to be approximately 275,000 m³, which is 34% greater than the current estimated floodplain volume of 205,000 m³. Setting aside the 1 in 100 year return period event, the maximum water level that can be accommodated by the lakes will be 5.3m. This equates to a total volume of flood storage of approximately 420,000 m³.

In summary:

Comparison of compensatory flood storage for 1 in 100 year return period event

	<i>Existing Flood Storage</i>	<i>Future Flood Storage</i>	<i>Increase</i>
<i>Area</i>	23.5 ha	29.5 ha	25%
<i>Volume</i>	205,000 m ³	275,000 m ³	34%

Total flood storage available within lakes

Normal Water Level	3.88 m AOD
Towpath Level	5.3 m AOD
Depth of flood that can be accommodated above normal water level without overtopping towpath	1.42 m
Surface area of Lakes	29.5 ha
Volume	420,000 m ³

Creation of this compensatory flood storage in the Upper Cam will be beneficial in reducing the flood risk to the River Cam system downstream of Jesus Green Lock, and the Ely Ouse system downstream of the confluence with the Cam. It will also have a beneficial effect on attenuating the peak of the Cam hydrograph.

5.1.2 Surface Run-off

Surface run-off from the development will be managed and attenuated on site. Surface run-off from the area west of the site draining through the existing network of drains will continue to flow into the River Cam as discussed above. The overall effect on the dynamics of the system would be neutral.

5.1.3 Riparian Rights Downstream

As discussed above, many of the field drains downstream of the development are currently dry and are not used for irrigation purposes. The farmers in the immediate area do not have abstraction licences, and therefore will not be adversely affected by any of the proposed drainage diversions.

6 Residual Risk

As described above, the site can accommodate a large volume of flood water above normal water level within the training and competition lakes. The risk to human life is therefore very small and well mitigated. Residual risks relate to the incidence of an extreme flood event with water levels in excess of 4.8m AOD. This is considered to be highly unlikely. There would be minimal impact on safety, as there would be sufficient time for people to evacuate the site prior to flood water reaching this level.

7 Conclusions

This Stage I Flood Risk Assessment has been undertaken in accordance with PPG25, and is based on earlier submissions and comments received from the Anglian Region of the Environment Agency.

The assessment shows that a small part (25%) of the site currently has an annual probability of fluvial flooding of greater than 1%.

The land based parts of the proposed development will be more than 2 m higher than the predicted 1% annual probability river flood level of 4.96 m AOD, allowing for the impact of climate change. Based on the PPG25 sequential test for flood risk, the land based facilities therefore fall within Flood Zone 1 (less than 0.1% annual probability of flooding) with little or not be at risk from fluvial flooding. Camping will be restricted to the higher parts of the site with minimum elevation 7.0 m AOD. Access and egress routes would also be provided at similar elevations well above maximum predicted flood level at high level. No rowing would be allowed on the lake in times of flood.

There is strong anecdotal evidence to suggest that there is no history of flooding in the drainage channels upstream of the development. The site is well drained, and does not suffer stormwater runoff flooding problems. As the development will intercept several of the local watercourses and drains, it is proposed to divert flows into a new perimeter drain, which will be used with a settling basin and pumping station to attenuate storm drainage flows before discharge into the River Cam. An existing award drain (Award No 291) will cross the proposed canal which connects the River Cam to the Sport Lakes, passing through a new aqueduct.

The mitigation of potential third party impacts has been considered and the following points are made:

- The current amount of compensatory flood storage for the Cam downstream of Baits Bite Lock will be replaced by a much greater storage capacity in the Cam upstream of the lock.
- The proposed Cambridge Sport Lakes development will provide 34% additional flood compensatory storage to the River Cam compared to the current floodplain storage.

This, combined with fast access to this storage, will have a beneficial effect on the overall hydraulics of that section of the Cam basin, and will have a positive impact in reducing flood risk downstream. Stormwater runoff will be attenuated on site. Riparian rights downstream of the site will be not be adversely affected by the drainage diversions.

8 Additional Aspects to be included in a Stage II FRA

We propose that the following tasks be incorporated as planning conditions to be discharged as part of a more detailed Stage II FRA prior to construction:

- (a) Flow modelling to demonstrate that the proposed lake levels are realistic and that the lakes can be effectively flushed through on an annual basis.
- (b) Detailed drainage network design to demonstrate that existing surface flows can be effectively attenuated including operation modelling of the pump system.
- (c) Detailed design of hydraulic structures such as the proposed Award Drain 'aqueduct'.
- (d) Development of options for the operation, maintenance and management of the Sport Lakes outlining responsibilities.

Appendix A Plan of Proposed Sport Lakes