Flood Risk & Drainage Assessment
George Best Belfast City Airport

Client:
George Best Belfast City Airport

Prepared by:
McCloy Consulting Ltd

December 2013
REVISION HISTORY

<table>
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<tr>
<th>Document Reference:</th>
<th>MCL298-03 DG01</th>
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<tr>
<td>Revision Reference</td>
<td>Revision Status</td>
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<td>DRAFT</td>
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CONTRACT

This report describes work commissioned by George Best Belfast City Airport following written instruction by their representative dated 29/10/2013.

Prepared by: ____________________________  Anthony McCloy
Chartered Engineer

Reviewed by: ____________________________  Kyle Somerville
Chartered Engineer

Approved by: ____________________________  Anthony McCloy
Managing Director

Date: 05 December 2013

DISCLAIMER

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It should be noted that this report has been prepared in accordance with Rivers Agency and Planning Service guidance and requirements current at the time of issue. McCloy Consulting Ltd. accepts no responsibility or liability arising out of changes in requirements in the period intervening final issue of the document and submission by the Client.
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EXECUTIVE SUMMARY

This Flood Risk Assessment report was commissioned by George Best Belfast City Airport (GB BCA) to support the proposals for amendment of the Article 40 agreement in place at GB BCA.

The principal effects of the modification would be to allow GB BCA to remove the constraint of the seats for sale limit (SFS) which is currently in place, introduce a noise contour control cap and other noise control measures. To support the potential change in airport operations physical changes may be necessary within the confines of the GB BCA boundary as described in Chapter 4 of the environmental statement.

In line with potential physical changes it is anticipated that there will be an increased usage of the site by staff and passengers. Full description of the ‘project’ is provided in Chapter 4 of the environmental statement.

This FRA primarily considers potential flooding of the GB BCA site from coastal flooding from Belfast Lough which is in close proximity to the site. There is no historic evidence of flooding at the GB BCA site; however the Strategic Flood Map (NI) Rivers and Sea indicates that the site is encroached by the coastal floodplain of Belfast Lough. There is no indication of fluvial flooding of the site by the Strategic Flood Map (NI) Rivers and Sea.

An analysis of all potential flooding mechanisms affecting the site has been undertaken as part of this assessment.

The Rivers Agency Q200 coastal flood level for Belfast Lough at the location of the site is 3.17m AOD. This assessment estimates the Q200 + Climate Change coastal flood level to be 3.28m AOD.

An assessment of levels between the Tidal Lagan / Belfast Lough and the site confirms that no direct surface pathway for floodwater to inundate the site from that source exists.

Ground levels below 3.17m AOD have the potential to flood and are shown as such on the associated floodplain maps. However, there is no surface connection between the coastal floodplain and the low lying areas of the site. The only means of connectivity exists through the existing drainage infrastructure.

The magnitude of all other mechanisms of flooding at the site is dictated by the coastal flood level.

As the site is affected by the Q200 coastal flood extent in the event that physical changes are delivered, a number of recommendations are made for that eventuality, including:

- Access & Egress – emergency evacuation / rescue plan for the areas of potential change should be incorporated into the development Health & Safety file and building management policy;
- Flood resilient construction measures would be incorporated to parts of the site where flooding is anticipated; and
- Surface water drainage design would be as per the requirements of “Sewers for Adoption Northern Ireland – 1st Edition” (WRc, 2009).

On this basis and following incorporation of the requirements stated in this report, it is considered that the ‘project’ will comply with the principles stated in PPS15 Planning and Flood Risk.
INTRODUCTION

1.1 Terms of Reference

This Flood Risk & Drainage Assessment report was commissioned by GB BCA to support the hydrology assessment which forms part of the environmental statement.

This assessment will determine potential sources of flooding at the site and their associated risk to life and property. The assessment will determine the suitability of the site for the ‘project’ in relation to flood risk, and propose appropriate design and mitigation measures where appropriate.

1.2 Statement of Authority

This report and assessment has been prepared and reviewed by qualified professional civil engineers with extensive experience in the water industry as required by Rivers Agency. McCloy Consulting Ltd. staff possess in excess of 25 years combined experience in the fields of flood risk, drainage, wastewater, and hydraulic modelling studies. The key staff member involved in this project is as follows:

- **Anthony McCloy BEng CEng MIEI** is a Charted Civil Engineer and Director of McCloy Consulting with in excess of 13 years specialising in the water industry, with particular expertise in hydraulic modelling, flood risk assessment and sustainable drainage design. Anthony is responsible for preparation of the report and management of the project.

1.3 Approach to the Assessment

Consideration has been given to the sources and extent of fluvial and coastal flooding at the site, as well as flooding to the site from pluvial sources, infrastructure failure, overland flow and ponding of localised rainfall within the site.

All stakeholders who hold data relating to flooding events in the area were contacted, and information gathered from responses received is incorporated in the following assessment. For the purposes of this site the primary stakeholders are:

- **DARD Rivers Agency**

A walk over survey of the site was conducted by John Carr of McCloy Consulting Ltd on the 25th July 2013; and by Anthony McCloy of McCloy Consulting on the 18th November 2013. The requirements for flood risk assessments are generally as set out in PPS15. Although the potential physical aspects of the ‘project’ are permitted development Planning Policy Statement 15: Flood Risk (June 2006) provides the context for the undertaking of this assessment and therefore is relevant. The detail and complexity of the study required should be appropriate to the scale and potential impact of the development. For the purposes of this study, the following have been considered:-

- Available information on historical flooding in the area;
- All available site level information;
- Estimates of design levels, equivalent to a 200-year (coastal) return period flood event; and a 100-year (fluvial) return period flood event;
- Allowances for increased flows resulting from the effects of climate change, or additional allowances for freeboard; and
- Assessment of the existing runoff characteristics and the potential impact the proposed development will have on the runoff.

Further guidance is also provided in the CIRIA Research Project 624 “Development and Flood Risk: Guidance for the Construction Industry” and PPS 15 – Planning and Flood Risk, and Revised Draft PPS 15 – Planning and Flood Risk (issued October 2013) provided by DoE Planning.
2 DETAILS OF THE SITE

2.1 Site Details

Table 2.1 Development Location

<table>
<thead>
<tr>
<th>Site Name</th>
<th>George Best Belfast City Airport</th>
</tr>
</thead>
<tbody>
<tr>
<td>County</td>
<td>Down</td>
</tr>
</tbody>
</table>

Location Plan:

- Potential Reconfigured aircraft parking areas
- Potential Reconfigured short stay car park and drop off / pick up area
- Potential additional long stay car parking area
- Musgrave Channel
- Main Terminal Building
- A2 Sydenham By-Pass
- Potential reconfigured overflow car park and taxi waiting area
Table 2.2 Summary of Potential Land Use Change / Site Properties

<table>
<thead>
<tr>
<th>Current Site Development</th>
<th>Proposed Site Development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land Use:</strong></td>
<td><strong>Land Use:</strong></td>
</tr>
<tr>
<td>Brownfield site - Mixed use, buildings, green</td>
<td>Car Parking</td>
</tr>
<tr>
<td>space, disused parking</td>
<td></td>
</tr>
<tr>
<td><strong>Permeable Area m²:</strong> 5250m² (within redline</td>
<td><strong>Permeable Area m²:</strong> 0m²</td>
</tr>
<tr>
<td>boundaries)</td>
<td></td>
</tr>
<tr>
<td><strong>Access Via:</strong></td>
<td><strong>Access Via:</strong></td>
</tr>
<tr>
<td>A2 Sydenham By-Pass</td>
<td>A2 Sydenham By-Pass</td>
</tr>
</tbody>
</table>

**Site Layout**

- Potential additional long stay car parking areas
- Potential Reconfigured Short Stay car par and Drop off / Pick up area
- Potential Reconfigured aircraft parking
- Potential Reconfigured overflow car park and taxi waiting area
- Potential Reconfigured Short Stay car par and Drop off / Pick up area
- Potential Reconfigured aircraft parking
- Potential Reconfigured overflow car park and taxi waiting area
2.2 Existing Site Description

There are three zones which are located within the GB BCA boundary which are indicated as having potential for development in the parameters plan (see Figure 4.1 of the environmental statement). The areas proposed for development have the potential to be affected by the following:

- The Connswater joins the Musgrave Channel adjacent to the proposed staff car park. The Musgrave Channel forms part of Inner Belfast Lough which is tidally influenced.
- The Sydenham Stream flows approximately 350m south east of the existing overflow car park/new staff car park. This follows the southern site boundary before connecting with an undesignated water course which discharges into the Musgrave Chanel of Belfast Lough and is therefore considered in conjunction with Conns Water.
- Tillysburn Stream flows into an undesignated watercourse known as the Kinnegar Water approximately 110m east of the long stay car park which flows north and discharges into Belfast Lough.

A drawing showing existing site levels has been provided by GB BCA and is provided in Appendix A of this report. Photographs of the existing site and its surroundings taken during the walkover survey are included in Appendix B.

2.3 The ‘Project’

The following sections describe the physical changes which may be required to support the change in airport operations described in Part 1 of Chapter 4 of the environmental statement which could occur if the Article 40 is modified in the way proposed.

Potential physical changes have been grouped into three zones as follows;

**Zone 1 - Staff Parking, Taxi Parking and Reconfiguration & Extension of Aircraft Parking**

Potential works within Zone 1 include staff car parking, taxi waiting area and reconfiguration and extension of aircraft parking.

*Staff car parking*

The staff car park could be located on land which is currently overflow surface parking.

*Taxi waiting area*

The existing taxi waiting area, adjacent to the existing overflow car park, could be reconfigured increasing its capacity. To reconfigure the existing taxi waiting area to create the required taxi waiting area would require the provision of new white lining.

*Aircraft Parking*

This would require the part removal of an existing building, which is currently adjacent to the Cargo building.

**Zone 2 - Short Stay Car Park and Pick-up and Drop-Off Reconfiguration**

Potential works within Zone 2 including the re-configuration of the short stay car park and relocation of the pick-up / drop-off area.

*Short stay car park*

The internal layout of the existing short stay car park could be reconfigured providing the additional spaces required.

*Pick-up / drop off area*

The existing pick-up / drop off area could be relocated from inside the existing short stay car park to outside the car park area. Four pick-up / drop off lanes could be provided increasing the capacity of the pick-up / drop off area from 20 to 41.

**Zone 3 - Car Hire parking/ Drop off and Long Stay Car Park**

Potential works within Zone 3 include the reconfiguration and upgrade of the car hire parking / drop off area and works associated with the long stay car park.

*Car Hire parking/drop off*

Both the existing car hire drop off and parking areas are located to the north of the main terminal building. The car hire drop off area would remain in the same location as the existing drop off area which is adjacent to the executive car park. The existing layout could be reconfigured to accommodate an additional 21 spaces.

The car hire parking area could also occupy a similar area as per the existing arrangement however internal reconfiguration would be required to facilitate an additional two spaces.

*Long stay car park*
To facilitate any additional long stay car parking spaces the existing internal layout could be reconfigured together with the resurfacing of existing overflow car parking area, hardstand areas and small areas of grassland. A small pre-fabricated building would also be demolished to facilitate any additional long stay car park spaces.

Facilitating the provision of the additional parking spaces would require the re-development of existing brownfield and greenfield areas – refer to Figures 4.1 – 4.4 included in Chapter 4 of the environmental statement and Appendix A of this report.

Each of these changes is permitted development for planning purposes.
3 BACKGROUND INFORMATION REVIEW

As part of the study data collection phase, a number of available sources of information were investigated in order to build an understanding of the potential risk of flooding to the site.

The following review highlights the key findings of the anecdotal evidence collection exercise.

3.1 Internet / Media / Background Search

A brief media search found no evidence of flooding at the site.

3.2 Northern Ireland Water

Northern Ireland Water Infrastructure Management / Developer Services were contacted directly in relation to out of sewer flooding records. NI Water has indicated verbally that it is unable to provide an indication of a history of flooding in the vicinity of the site.

A review of NI Water asset information indicates that a storm culvert (ø1050mm) runs is conveyed under the proposed extended taxi waiting area prior to discharge to the Connswater / Mallusk Channel.

A combined sewer pumping main runs through the length of the GB BCA site, originating at Park Avenue pumping station. The size and status of the main is unknown.

No indication of sewer flooding was indicated from an internet search.

3.3 Site maintained sewerage system

The site is currently served by a conventional drainage system, with surface runoff collected in gullies and channels. Flow is conveyed in pipes to arrangements of sampling chambers and oil interceptors prior to being conveyed to the respective final points of discharge. There are six points of discharge from the site for surface runoff to the receiving watercourses.

Surface runoff flows are generally conveyed to either the Kinnegar Water or the Connswater channel. Where sampling indicates an exceedance in discharge consent (Water Order 1999), surface runoff flows are diverted to the foul system as discussed below.

**Apron and runway.** All surface runoff flows pass via an oil interceptor, to a chamber which contains automated sampling equipment. Where conductivity of flow exceeds threshold levels (indicating presence of pollutant or contamination within the flow), penstocks within the diversion chamber diverts all flow to a containment lagoon, which has a volume of approximately 1,250m³. Flows from the lagoon are pumped to a secondary diversion chamber (MH12), which allows for diversion of flow to either the NI Water foul sewer (which conveys flow to Kinnegar WWTW) or the local storm drain (via the oil interceptor located in the car park).

**Car park, terminal building roof area and access roads.** All surface runoff flows are collected in a separate storm systems and pass via oil interceptors to the respective point of outflow.

Foul flows generated by the site discharge to a NI Water combined trunk sewer via gravity.

3.4 DARD Rivers Agency

The Rivers Agency predicted flood level for Belfast Lough is 3.17 m AOD. This level does not include any allowance for wave action or climate change.

Rivers Agency holds no record of flooding affecting the site although the Strategic Flood Map (NI) Rivers and Sea indicates part of the site lies within the coastal floodplain of Belfast Lough.

Copies of relevant correspondence are included in Appendix C.

3.4.1 Strategic Flood Map (NI) Rivers and Sea

As part of the FRA procedure the location of the site was reviewed with reference to the Strategic Flood Map (NI) Rivers and Sea, developed by Rivers Agency in co-operation with the Department of the Environment and published November 2008.

Figure 3.3 indicates areas which have the potential to lie within the coastal flood plain of the tidal Belfast Lough and as such could be inundated from that source.

Figure 3.4 indicates areas which are potentially at risk of surface water flooding.
There is no indication by fluvial flooding of the site by the Strategic Flood Map (NI) Rivers and Sea.

It should be noted that due to the inherent uncertainties in the flood modelling techniques and data used to produce the map, it is not sufficiently accurate to determine the flood risk to individual properties or specific point locations, and so verification of the floodplains shown is required.

Extracts from the above referenced flood maps are shown in the following figures.

**Figure 3.1: Extract from Strategic Flood Map (NI) Rivers and Sea – Historic Flood Extents**

- Potential extension to long stay car park
- Potential Reconfigured short stay car park and Drop off / Pick up area
- Potential Reconfigured overflow car park and taxi waiting

**Figure 3.2: Extract from Strategic Flood Map (NI) Rivers and Sea - Predicted (2030) Fluvial Flood Extents**

- Potential extension to long stay car park
- Potential Reconfigured short stay car park and Drop off / Pick up area
- Potential Reconfigured overflow car park and taxi waiting area
Figure 3.3: Extract from Strategic Flood Map (NI) Rivers and Sea - Predicted (2030) Coastal Flood Extents

- Potential Reconfigured airport parking
- Potential extensions to long stay car
- Potential Reconfigured short stay car park and Taxi waiting area
- Potential Reconfigured overflow car park and Taxi waiting area

Figure 3.4: Extract from Strategic Flood Map (NI) Rivers and Sea - Predicted Surface Water Flood Extent

- Potential extensions to long stay car park
- Potential Reconfigured short stay car park and Drop off / Pick up area
- Potential Reconfigured overflow car park and Taxi waiting area
- Potential Reconfigured airport parking
4  INITIAL ASSESSMENT

This section of the report considers the potential development proposals in the context of Policies FL1-4 set out with PPS15 and assesses the possible mechanisms of flooding, which have been determined from the anecdotal evidence presented in the previous chapter.

4.1 Requirements under PPS15 – Planning and Flood Risk

Table 4.1 Concurrence with Planning Policies

<table>
<thead>
<tr>
<th>Planning Policy</th>
<th>Assess?</th>
<th>Comment/Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLD 1 - Development in Flood Plains</td>
<td>Yes</td>
<td>The Strategic Flood Map (NI) Rivers and Sea indicates that the potential areas for the reconfigured staff car park, the reconfigured and extended long stay car park and the reconfigured aircraft waiting areas have potential to be encroached by the coastal floodplain of Belfast Lough.</td>
</tr>
<tr>
<td>FLD 2 - Protection of Existing Flood Defences</td>
<td>No</td>
<td>There are no Rivers Agency flood defences within or adjacent to the GB BCA site boundary.</td>
</tr>
<tr>
<td>FLD 3 - Development beyond Flood Plains</td>
<td>No</td>
<td>A review of aerial photography indicates that areas proposed for long stay car park extension are grassed and therefore considered to be partially permeable (identified as being located within Areas A1 and A3 as presented on Figure 4.1, Appendix A). Aerial photography indicates that existing overflow car park and taxi waiting area is 100% impermeable, therefore there would be no increase in surface runoff from any development. The area of the potential aircraft parking is currently 100% impermeable; therefore there would be no increase in surface runoff from any development.</td>
</tr>
<tr>
<td>FLD 4 - Flooding and Land Drainage</td>
<td>No</td>
<td>There would be no new culverts or canalisation on an existing watercourse as part of the ‘project’.</td>
</tr>
</tbody>
</table>

4.2 Possible Flooding Mechanisms

Table 4.2 Possible Flooding Mechanisms

<table>
<thead>
<tr>
<th>Source/Pathway</th>
<th>Significant?</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluvial Flooding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floodplain</td>
<td>Possible</td>
<td>The Strategic Flood Map (NI) Rivers and Sea indicates that there is no fluvial flooding of the site by the Conns Water or the Tillysburn Stream (which flows into the Kinnegar Water).</td>
</tr>
<tr>
<td>Culvert Blockage</td>
<td>N/A</td>
<td>No culverts with potential to block affect the Kinnegar Water downstream of the site.</td>
</tr>
<tr>
<td>Flood Defence Failure</td>
<td>N/A</td>
<td>The car parks are not protected by a designated fluvial flood defence.</td>
</tr>
<tr>
<td>Coastal Flooding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tidal/Coastal</td>
<td>Yes</td>
<td>Rivers Agency has indicated that all three zones lay adjacent to the coastal floodplain of Belfast Lough.</td>
</tr>
</tbody>
</table>
Table 4.2 Possible Flooding Mechanisms

<table>
<thead>
<tr>
<th>Source/Pathway</th>
<th>Significant?</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood Defence Failure</td>
<td>N/A</td>
<td>There are no formalised coastal flood defences in place.</td>
</tr>
<tr>
<td>Urban Drainage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewer Incapacity</td>
<td>No</td>
<td>No indication of urban drainage flooding / sewer incapacity in initial evidence search.</td>
</tr>
<tr>
<td>CSO Failure</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Pluvial Overland Flow</td>
<td>Possible</td>
<td>The Strategic Flood Map (NI) Rivers and Sea indicates that some small areas in the vicinity of the staff car park, the additional aircraft stands and the proposed extensions to the long stay car park may be susceptible to surface water flooding.</td>
</tr>
<tr>
<td>Groundwater</td>
<td>No</td>
<td>Groundwater flooding is typically not a consideration in Northern Ireland due to underlying geology and soil types prevalent in the region. Site does not lie in a localised basin in which elevated groundwater could gather.</td>
</tr>
<tr>
<td>Reservoirs / Canals /</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Artificial Sources</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.3 Summary of Initial Assessment

The primary potential source of flood risk to be considered is coastal flooding from the tidal Belfast Lough, as indicated by the Strategic Flood Map (NI) Rivers and Sea.

The possibility of flooding due to overland flow and pluvial flooding will also be considered.

Consideration of the impact of the development upon surface water runoff characteristics will be evaluated accordingly.
5 ASSESSMENT OF FLOOD MECHANISMS

5.1 Preamble

Rivers Agency, as part of its development control procedures, advises that development should be restricted to that part of the site lying outside of the 1-in-100 year (Q100) fluvial floodplain and the 1-in-200 (Q200) coastal floodplain.

The following assessment determines the worst case flood level at the site and any other hazards to life and property due to flooding.

Mitigation of flood risk is discussed in Section 6.

5.2 Tidal / Coastal Flooding

5.2.1 Belfast Lough

Flooding to low-lying land from the sea and tidal estuaries is caused by storm surges and high tides. It is noted that the site is not protected by formalised tidal defences.

Whilst it is noted that coastal / tidal flooding is more predictable due to its correlation with existing predicted tidal movements, the onset of flooding from the sea can be extremely rapid. Deep, fast-flowing water can create an extreme hazard. The severity of such flooding will depend on a number of factors, often in combination: the height of tides; weather systems; wind and wave conditions; topography; the effectiveness of drainage systems; and the condition of flood defences. The consequences and impacts of flooding from the sea and tidal waters are more severe than flooding from rivers.

Rivers Agency has provided a predicted Q200 coastal flood level for the site of 3.17mOD1.

An assessment of levels between the Tidal Lagan / Belfast Lough and the site confirms that no direct surface pathway for floodwater to inundate the site from that source exists.

Survey information has been provided by GB BCA, which indicates levels in the vicinity of the staff car park are generally at or above the coastal flood level of 3.17mAOD. The area of the aircraft parking is noted as being mostly below the Q200 flood level, however the area is disconnected from the coastal flood plain with no surface connection.

Similarly, analysis of LiDAR data indicates that there are low lying areas within the long stay car park (both existing and within the proposed extensions), with the area is disconnected from the coastal flood plain (i.e. no surface flow connection).

The only means of connectivity which exists is through the existing drainage infrastructure, which would be protected through the presence of non-return valves on the discharge outlets. In the unlikely event that coastal flooding of the site was to occur a maximum flood depth of 0.20m and 0.37m in the aircraft parking area and long stay car park would be anticipated respectively (on the basis of existing ground levels).

5.2.1.1 Effect of Climate Change

Predicted climate change data for sea level rise has been derived from UK Climate Change Projections (UKCP09). For purposes of the approximation it is assumed that:

- the design horizon for climate change estimations is 2030, common with the horizon for predictions utilised by Rivers Agency in the development of climate change effects shown on the Strategic Flood Map (NI) Rivers and Sea for inland waters, and that;
- predicted (modelled) Q200 data provided by Rivers Agency is current in 2013.

The published data indicates that for a “high” range estimate, sea levels are anticipated to increase in response to the effect of climate change by 111 mm (0.11m)2

The resultant Q200 + Climate Change level is 3.28 m AOD.

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1 Quoted flood level from previous GB BCA related correspondence DA2-08-7659
2 http://ukclimateprojections.defra.gov.uk/21729 last accessed 04/02/2013
5.2.1.2 Effect of Wave Action

The flood level provided by Rivers Agency includes the effect of storm surge; however Rivers Agency would generally recommend that the design level for proposed sites consider the effect of:

- Increased wave height due to increased storminess;
- Climate change.

The height, period and direction of the waves generated will depend on the wind speed and duration, direction and the fetch (the unobstructed distance of sea surface over which the wind has acted).

It is considered that the location of the ‘project’ is unlikely to be subject to large wave action, for the following reasons:

- The long stay car park site is sheltered by the outfall structure / access road crossing situated off Airport Road West and the situation of Heron Road Industrial Estate;
- The staff car park and additional aircraft parking are positioned off the Conns Water / Musgrave Channel, which would be well sheltered from the affects of wave action given its location in relation to Belfast Lough coastline.

It is therefore considered that the effect of wave action is likely to be low and can be adequately mitigated through application in design considerations for the project of a level of freeboard to structures and emergency access routes.

5.3 Pluvial Flooding (Drainage Assessment)

5.3.1 Pluvial runoff onto site

Heavily urbanised (impermeable) areas at a similar elevation are located adjacent to all areas of extended development. An existing convention drainage system drains the current site extents.

All areas proposed for development are relatively flat. There are no significant pockets where flows would tend to collect. There is therefore no significant risk identified of pluvial flooding at the site.

5.3.2 Pluvial runoff from site

The areas of the staff car park, the additional aircraft parking and the extended taxi waiting area are 100% impermeable, therefore any development results in no change in runoff characteristics compared to what is currently in place. The extended areas identified for the long stay car park, are at present partially permeable. These areas are identified as A1 and A3 on Figure 4.1 (Appendix A).

Table 5.1 provides an indication of the increase in runoff rates for the area of the site where there is a change in surface type (grassed areas changed to tarmac car parking). In total, the extent of grassed area identified as part of redevelopment proposals (based upon aerial photography) has been estimated as 0.52 hectares.

<table>
<thead>
<tr>
<th>Return Period</th>
<th>Runoff from areas identified as permeable (lps)</th>
<th>Runoff from redevelopment to impermeable (lps)</th>
<th>Increase in runoff (lps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in 2 year (1hr)</td>
<td>1.3</td>
<td>16.0</td>
<td>14.7</td>
</tr>
<tr>
<td>1 in 30 year (1hr)</td>
<td>2.3</td>
<td>34.7</td>
<td>32.4</td>
</tr>
<tr>
<td>1 in 100 year (1hr)</td>
<td>2.7</td>
<td>47.4</td>
<td>44.7</td>
</tr>
</tbody>
</table>

5.3.3 Effect of the ‘Project’ on any Existing Developments

The ‘project’ will not result in a significant increase in impermeable area, and hence it is likely that there will be minimal increase in runoff to local drainage systems, i.e. the ‘project’ will not cause any change to the receiving drainage system in terms of surface water runoff. Flows discharge either to the Kinnegar Water, or the Connswater channel, both of which discharge to Belfast Lough. Any discharge of additional runoff from the site would be subject to consent.
5.4 Summary

The current worst case flood level at the site is that of coastal flooding from Belfast Lough, with a $Q_{200}$ flood level at the site of 3.17mAOD.

The magnitude of all other mechanisms of flooding at the site is dictated by the coastal flood level. The effect of climate change on fluvial flooding has been considered, concluding that the $Q_{200}$ (Climate Change) flood level is 3.28mAOD.
6 SUMMARY OF FINDINGS AND RECOMMENDATIONS

6.1 Summary of Findings

There is no evidence of historic flooding occurring at the GB BCA site; however the Strategic Flood Map (NI) Rivers and Sea indicates that the site lies adjacent to the predicted fluvial flood plain of the Tillysburn Stream and may be encroached by the Belfast Lough coastal floodplain.

A detailed assessment of coastal, pluvial and fluvial flooding mechanisms affecting the site has indicated that the worst case flood level is that of coastal flooding, i.e. \( Q_{200} \) of 3.17mOD.

An assessment of climate change indicates a \( Q_{200} + \) Climate Change flood level at the site of 3.28mAOD. \( Q_{200} \) and \( Q_{200} + \) Climate Change floods cause the majority of the existing site to flood.

No other significant flood mechanism exists at the site.

6.2 Design Considerations

6.2.1 Land Use

This assessment demonstrates that the dominant flood mechanism affecting the site is that of coastal flooding, and that fluvial flooding up to \( Q_{100} \) magnitude without tidal influence will not cause flooding of the site.

Where fluvial flooding is no longer a consideration, it is considered permissible to raise ground levels within the site in order to achieve dry access and finished floor levels, without increasing flood risk elsewhere through displacement of flood volume or restricted conveyance. There are therefore no restrictions in terms of infilling of the site.

The development focuses on the re-use of existing hard surfaces; and hard surfacing of a small grassed area and therefore resilient to any potential flood inundation.

The type of development is therefore considered appropriate to the flood risk sources present.

6.2.2 Finished Road and Parking Levels

Rivers Agency generally recommends that finished road and parking levels within development sites adjacent to or in a floodplain should facilitate a freeboard of 600mm added to the design flood level\(^3\). This freeboard allows for the inherent difficulty in predicting hydrological flows, and ensures that levels are conservative when considering the increased risk and level of flooding due to climate change.

For the purposes of this study, any finished formation levels are recommended to be set at a minimum design level of 3.77 mAOD (3.17mAOD+0.6m freeboard). Any deviation from this requirement would be agreed with DARD Rivers Agency.

Residual risk is considered in Section 6.4.

6.2.3 Emergency Access & Egress

It is normally considered essential to provide dry access and egress during flooding events.

Site access and egress is via the A2 Sydenham By-Pass and onwards via Holywood Road.

A detailed evacuation management plan should be incorporated as part of the maintenance contract / health and safety file for any development taking place on the site.

6.2.4 Flood Proofing

The ‘project’ is not considered prone to flood damage. No further recommendations are made in relation to flood proofing.

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\(^3\) Correspondence DA2-13-20383 contained in Appendix C of this report
6.2.5 **Drainage Design**

Any surface water drainage design is to be as per the requirements of “Sewers for Adoption – Northern Ireland” (WRc, 2009).

It is assumed that drainage from the long stay car park will discharge ultimately to the Tillysburn Stream / Kinnegar Water via existing / upgraded sewerage infrastructure, subject to any consent required from the relevant authority.

Further it is assumed that drainage from the staff car park and aircraft parking will discharge ultimately to the Connswater / Musgrave Channel via existing / upgraded sewerage infrastructure, subject to consent from the relevant authority.

Drainage should be designed to have a free discharge at min. Q30 flood level, or where a risk of surcharge site drainage outfalls should be fitted with a non-return valve. Any discharge of additional runoff discharged from the site would be subject to consent.

Access for maintenance of drainage including discharge locations is to be detailed in as-built / health and safety information provided to the relevant adopting authority.

Where water is designed to pond or flow overland on the site it shall be in accordance with the guidance in CIRIA C635 – Designing for Exceedance, to ensure that surface ponding / flow does not cause risk to life or property, i.e. ponding is maintained at road kerb height (100mm) or lower, with low overland flow velocities.

6.3 **Summary of Flood Risk and Mitigation**

The following table summarises the mechanisms of flooding identified in the course of this study, their associated hazards, and proposed measures to mitigate the predicted risk.

<table>
<thead>
<tr>
<th>Identified Flood Mechanism</th>
<th>Hazard Rating</th>
<th>Likelihood</th>
<th>Risk</th>
<th>Mitigating Measure</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluvial Flooding</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>Site predicted to lie outside the Q$_{100}$ floodplain. No further mitigation required.</td>
<td>L</td>
</tr>
<tr>
<td>Coastal flooding</td>
<td></td>
<td></td>
<td></td>
<td>Car park areas finished formation levels to be set at a minimum of 3.77m AOD. Any deviation from this requirement would be agreed with Rivers Agency. Evacuation plan would be included and implemented as part of Health &amp; Safety file for any development.</td>
<td>L</td>
</tr>
<tr>
<td>Proposed staff car park areas (including Taxi waiting area)</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed long stay car park areas</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>Any car park areas finished formation levels would be set at a minimum of 3.77m AOD. Any deviation from this requirement would be agreed with Rivers Agency. Evacuation plan for extended areas would be incorporated as part of Health &amp; Safety file for any development.</td>
<td>L</td>
</tr>
</tbody>
</table>
## Table 6.1 Summary of Risks and Mitigation

<table>
<thead>
<tr>
<th>Identified Flood Mechanism</th>
<th>Hazard Rating</th>
<th>Likelihood</th>
<th>Risk</th>
<th>Mitigating Measure</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Flooding</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>Short stay car park is not shown to be inundated by coastal floodplain as indicated by the Strategic Flood Map (NI) Rivers and Sea. Evacuation plan for reconfigured short stay car park and pick up/drop off area to be incorporated as part of Health &amp; Safety file for any development.</td>
<td>L</td>
</tr>
<tr>
<td>Proposed reconfiguration of the short stay car park and pick up/drop off area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal flooding aircraft parking areas</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>Any aircraft parking areas finished formation levels would be set at a minimum of 3.77mAOD where practicable. Any deviation from this requirement would be agreed with Rivers Agency. Evacuation plan for extended areas would be incorporated as part of Health &amp; Safety file for any development. Parking would not be utilised in the event of inundation by floodwater.</td>
<td>L</td>
</tr>
<tr>
<td>Effect of climate change</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>Additional depth of flooding due to climate change does not cause a significant increased risk to areas of any development anticipated to flood.</td>
<td>L</td>
</tr>
<tr>
<td>Effect of development on other developments</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>Any development would be located outwith the fluvial floodplain. Any modified ground levels in the coastal floodplain would have no effect on coastal flood storage or conveyance – no further mitigation required.</td>
<td>L</td>
</tr>
<tr>
<td>Pluvial runoff &amp; Rainfall Ponding</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>Any site development would cause negligible change to surface water runoff characteristics. Drainage design to be as per the requirements of “Sewers for Adoption – Northern Ireland. Further mitigation in the form of attenuation to be provided at the discretion of Rivers Agency.</td>
<td>L</td>
</tr>
</tbody>
</table>

### 6.4 Residual Risk

Any development within or adjacent to a watercourse or floodplain would be subject to a residual risk, due to the occurrence of a flood event greater than that adopted as a design basis.
Table 6.2 Residual Impacts

<table>
<thead>
<tr>
<th>Description of Risk</th>
<th>Hazard</th>
<th>Residual Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underestimation of Q&lt;sub&gt;200&lt;/sub&gt; flood level</td>
<td>Inundation of the site for a Q&lt;sub&gt;200&lt;/sub&gt; event</td>
<td>Flood events in excess of the anticipated magnitude Q&lt;sub&gt;200&lt;/sub&gt; year event would cause flooding to the site (footpaths / parking levels), the extent of which would be dependent on the flood magnitude.</td>
</tr>
<tr>
<td>Freeboard may not comply with typical Rivers Agency requirement</td>
<td>Inundation of the site for a Q&lt;sub&gt;200&lt;/sub&gt; event</td>
<td>Car and aircraft parking areas / may be inundated by a Q&lt;sub&gt;200&lt;/sub&gt; event. Flood resilience measures would be implemented in areas not complying with minimum freeboard in order to mitigate residual risk.</td>
</tr>
<tr>
<td>Access and egress routes to and from the site flooded by Q&lt;sub&gt;200&lt;/sub&gt; flood event</td>
<td>Dry access/egress impossible during flood event</td>
<td>Dry access and egress from GB BCA is available via A2 Sydenham By-pass and onwards to Holywood Road.</td>
</tr>
<tr>
<td>Flooding from extreme coastal events (well in excess of Q&lt;sub&gt;200&lt;/sub&gt; event) inundating the proposed site</td>
<td>Inundation of the site.</td>
<td>Extreme flood events well in excess of a Q&lt;sub&gt;200&lt;/sub&gt; year event would cause flooding to the site, the extent of which would be dependent on the flood magnitude.</td>
</tr>
</tbody>
</table>

6.5 Consideration of Regulations

6.5.1 FLD1 – Development within the Floodplain

The ‘project’ is not affected by the Q<sub>100</sub> fluvial floodplain of the Tillysburn Stream or the Connswater.

The areas within the GB BCA site identified for potential development are not affected by the Q<sub>200</sub> coastal floodplain of Belfast Lough. It is noted that existing site levels within parts of the potential reconfiguration of the staff car park, the aircraft parking areas and the long stay car park are below the Q<sub>200</sub> coastal floodplain level; however these areas are isolated as they are not directly connected coastal via a surface flow route.

Recommendations have been made for ground raising to 3.77m AOD, and any reduction from this level would be in agreement with DARD Rivers Agency.

This assessment therefore considers the ‘project’ complies with PPS15 FLD1 even though there is no need to establish compliance.

6.5.2 FLD3 – Development beyond Floodplains

The ‘project’ has been demonstrated to cause negligible or beneficial change to surface water runoff characteristics and will not cause increased flood risk elsewhere.

This assessment therefore considers the ‘project’ complies with PPS15 FLD3 even though there is no need to establish compliance.

*It has not been considered necessary to further assess the development with reference to FLD 2 and 4, as detailed in Section 4.1.*
APPENDIX A

Existing & Proposed Layouts
APPENDIX B

Site Visit Photographs
Figure B1: Photographs of Existing Site

Photograph View 1 – Area proposed for extension to long stay car park

Photograph View 2 – Area proposed for extension to long stay car park
Photograph View 3 – Area proposed for Staff car park and taxi waiting area

Photograph View 4 - Area proposed for Staff car park (Aircraft stand area in background)
APPENDIX C

Rivers Agency Correspondence
APPENDIX D

Flood Extent Mapping
APPENDIX E

Drainage Calculations