Flood Risk Assessment

Proposed Redevelopment of Former Kingspan Works, Charlestown Road, Glossop.

Aitchison Raffety Property Consultants.

Ref 12732-5002-00

Met Consulting Engineers
Southgate House
Pontefract Road
Stourton
Leeds
LS10 1SW

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INTRODUCTION

1.1 BACKGROUND

1.2 Met Consulting Engineers Limited have been commissioned by Aitchison Raffety Property Consultants to carry out a Flood Risk Assessment (FRA) for the proposed redevelopment of the former Kingspan Works, Charlestown Road, Glossop, to provide a mixed use development.

1.3 The FRA will form part of the full planning application, as required by Planning Policy Statement 25: Development and Flood Risk (PPS25), published by the Office of the Deputy Prime Minister.

1.4 The site lies either side of the A624 Charlestown Road 1 Kilometre to the South of Glossop, The site totals an area of 4.62 Hectares and contains a variety of Industrial Buildings, many of which are now vacant and are no longer considered suitable for reuse.

1.5 A Development Plan has been prepared for the site and this has been used in the preparation of this assessment and is attached in Appendix B. The Development Plan zones areas of the site for Residential, Offices, Workshop and Live/ Work units, this also considers the wider context and identifies possible adjacent sites for redevelopment to provide a cohesive development plan for Charlestown. This report only considers the site under our control, but provides principals that may be adopted across the development plan area.

2.0. SCOPE OF WORK

2.1 The objective of a Flood Risk Assessment is to demonstrate that a proposed development is sustainable in flood risk terms. This means that the development should not itself be at a significant risk of flooding or result in an increased flood risk elsewhere. The guidance given in Planning Policy Statement 25: "*Development and Flood Risk" (PPS25)* has been followed in preparing this assessment.

2.2 This report is the result of a Flood Risk Assessment for the proposed development. The following tasks have been carried out as part of the assessment:

a) Review of available information

b) Identification and consideration of all the potential flood risks associated with the proposed development.

c) Confirmation of flood zone designation, design flood level and assessment of effects and required mitigation.

d) Preliminary assessment of the effect of the proposed development on Flood zones and flood flow paths.

e) Consideration of other flood risks and any required mitigation (overland flows, artificial drainage systems, infrastructure failure and groundwater flooding)

f) Identification and scoping of any further work required.

3. SITE DESCRIPTION

3.1 CATCHMENT DESCRIPTION

3.2 The proposed development is situated approximately 1 Kilometre to the south of Glossop Town Centre. The site is located immediately north of the junction between Bray Clough Brook and Long Clough Brook. Downstream of the junction the watercourse takes the name of Long Clough Brook, and this skirts the development site flowing to the North West along the fringe of Glossop before joining Glossop Brook to the West of Glossop. The site is shown to be affected by the indicative flood plain of the Long Clough Brook. (see Appendix C Fig 1)

3.3 The two watercourses in question, the Long Clough Brook and Bray Clough Brook can be classified as upland streams. They are both characterised by steep sided valley slopes and the source of both streams is relatively close in the highland areas to the south and south east of the site. The catchments of both brooks are fairly small in area but are formed by steep moorland slopes with little vegetation. These catchments respond rapidly to rainfall events with a short response time and a high peak flow. The channel bed through the site comprises of coarse gravel and cobbles, there are several culverts and bridges along its length and these are potential sources of blockages and place constraints on conveyance of flow through the site.

3.4 The Charlestown and Glossop area is known to have flooded in 1944. This event is thought to have been significantly greater in magnitude than a 1 in 100 year event. During the lifetime of the site, the buildings have not been known to suffer flooding from the Brook, however, there have been instances of overland flow ponding in the low point on Charlestown Road. The highway drains in this vicinity can quickly become silted and ineffective and this has led to floodwater entering the buildings to the west on it’s way back into the Brook.

4. EXISTING SITE DESCRIPTION

4.1 The site is located to the East and West of Charlestown Road, South of Glossop Town Centre and lies within the valley formed by Long Clough Brook. The site is currently occupied by a varied range of industrial buildings that have been left vacant for some time. To the West lies a scrap yard and Transport Depot accessed via a private Road immediately adjacent to Long Clough Brook. To the South East lies mainly open arable fields, and to the North and North East are Residential properties and Glossop Fire Station.

4.2 The site is currently occupied by a range of buildings formerly occupied by Kingspan. The current buildings and hard standing areas on the site are outlined and highlighted on drawings 12732-5002-02 and 03 in Appendix F, Fig 1.
A considerable area of the site is covered by buildings and hard standings, all of which are positively drained. (see photographs in Appendix E) The plan area of the existing buildings and hard-standing Areas total 1.56ha and these are highlighted on the attached drawings.

4.3 United Utilities have drainage within the site and Charlestown Road and this has been overlaid onto the site survey (Appendix E fig 1 and 2) All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register. This includes flooding incidents from Foul, Combined, and Surface Water Sewers that are deemed public and maintained by the Water Company. Flooding from Highway Drains, Land Drains Rivers/ watercourses and private drains are not recorded on the register. This register leads to prioritising improvements intended to prevent reoccurrence, and has been used in formulating the Strategic Flood Risk Map showing flooding from all sources.

4.4 The land in question covers an area of approximately 4.6 Hectares and has a fall of approximately 11 metres from the south towards the north. Ground levels on the site range from approximately 174m to 163m AOD as shown on the topographic survey attached in Appendix D (Fig 1).

4.5 General Geology

From an examination of the published geological map of the area (Solid Geology Map, UK South Sheet) the solid geology is shown to be Namurian (Millstone Grit Series) from the Carboniferous Period. Drift deposits are expected to be minimal or non-existent.

BGS boreholes in the vicinity of the site show the strata to comprise various bands of Clay and Gravel to a depths of up to 17m (55 ft), overlying various bands of Shale, Gritty Shale and Gritstone.

4.6 Hydrogeology

The published Groundwater Vulnerability Map for the area indicates the site to be situated over a Minor Aquifer (Variably Permeable). These can be fractured or potentially fractured rocks which do not have a high primary permeability, or other formations of variable permeability including unconsolidated deposits. Although not producing large quantities of water for abstraction, they are important for local supplies and for supplying base flow to rivers.

The soils to the vast majority of the site are classified as having Low Leaching Potential. These are soils in which pollutants are unlikely to penetrate the soil layer because water movement is largely horizontal or they have a large ability to attenuate or diffuse pollutants.

5. PROPOSED DEVELOPMENT

5.1 A Draft Layout Plan has been prepared for the site and this has been used in the preparation of this assessment and is attached in Appendix B (Fig 2). The Development Plan zones areas of the site for Residential, Offices, Workshop and Live/ Work units, the Concept plan (Fig 1) considers the wider context and identifies possible adjacent sites for redevelopment to provide a cohesive development plan for Charlestown. This report only considers the site under our control, but provides principals that may be adopted across the development plan area.

6. ACCEPTABLE LEVELS OF FLOOD RISK

6.1 PLANNING REQUIREMENTS

6.2 Acceptable levels of flood risk for developments are defined in Planning Policy Statement 25: Development and Flood Risk (PPS25). Flood risk has traditionally been discussed in terms of a “return period”, e.g. a 1 in 100 year flood. This can be misleading as, in reality, a flood of a particular magnitude has the same chance of occurring in any given year regardless of when it last occurred. This terminology is therefore now replaced by expressions of annual probability or the chance of such an event occurring in any given year. A 1 in 100 year flood is now expressed as a 100 to 1 chance of being equalled or exceeded in any year (1% annual probability of flooding).

6.3 PPS25 applies a sequential and exception test to assign the level of flood risk depending upon the annual probability of flooding occurring.

Zone 1 – Low probability (<0.1% annual probability)

Zone 2 – Medium probability (1% - 0.1% annual probability)

Zone 3A High probability (>1%)

6.4 The detailed design of the scheme has had full regard to the criteria outlined above, and indeed detailed discussions have been undertaken with the Environment Agency.

6.5 A sequential approach has been taken to the forward planning of the site, with the approach within the Flood Risk Assessment greatly reducing the impact of flooding on the development area.

7. RISK BASED APPROACH. THE SEQUENTIAL AND EXCEPTION TEST.

7.1 Risk based approach.

7.2 Regional planning bodies and local planning authorities are required to prepare and implement Planning strategies that help to deliver sustainable development by appraising, managing and reducing flood risk. This requires authorities to prepare Regional Flood risk appraisals or Strategic Flood Risk Assessments. In carrying this out, Local planning authorities are expected to apply a risk based approach to the preparation of development plans and their decisions on development control through a sequential test.

7.3 This assessment of risk should apply the source- pathway- receptor model to planning for development in areas of flood risk and this requires:
A strategic approach which avoid adding to the causes or sources of flood risk, by such means as avoiding inappropriate development in flood risk areas and minimising run-off into the downstream catchment

7.4 Managing flood pathways to reduce the likelihood of flooding by ensuring maximisation of the use of SUDS, and take account of its susceptibility to flood, and of the likely routes and storage of floodwater, and its influence on flood risk downstream.

7.5 Reducing the consequences of flooding on the receptors, ie, people, property, infrastructure, by avoiding inappropriate development in areas at risk of flooding.

8. The Sequential Test.

8.1 The sequential test should be applied to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.

8.2 In areas at risk of river flooding, preference should be given to locating new development in Flood zone 1, however if there are no reasonably available sites in Flood Zone 1, the flood vulnerability of the proposed development can be taken into account in locating development in Flood Zone 2 and then Flood Zone 3.

8.3 Parts of the existing site are indicated to fall within Flood Zone 2 and 3 and these areas are limited to the locality of Long Clough Brook, drawings attached in Appendix G fig 1 indicate the extent of the 1000 year and 100 year climate Change flood level on the existing site, effectively anything beyond these zones is considered Zone 1.

8.3 Use of the Sequential Approach to development is used to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas.

9. The Exception Test.

9.1 If, following application of the sequential test it is not possible, consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied. The test provides a method of managing flood risk while still allowing necessary development to occur.

9.2 The Exception Test is only appropriate for use when there are large areas in Flood Zones 2 and 3, where the sequential test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons.

9.3 The Exception Test must demonstrate that the development provides wider sustainable benefits to the community that outweigh flood risk, it must be on previously developed land, and must demonstrate that the development will be safe without increasing flood risk elsewhere and if possible reduce flood risk.

10. FLOOD RISKS AND MITIGATION

10.1 This section describes the potential sources of flooding and their impact on the proposed development and where required, the proposed mitigation measures.

10.2 Potential sources of flooding are from fluvial river flooding, overland flows, groundwater, drainage systems and infrastructure failure. All these flood risks are described in the sections below.

11. OVERLAND FLOWS.

11.1 Risks

11.2 Flooding from overland flows is caused when the intensity of rainfall exceeds the infiltration capacity of the surface onto which it falls, or when, during prolonged periods of wet weather, the soil becomes so saturated that it cannot accept any more water. Developments that include significant impermeable surfaces, such as roads, car parks and roofs, may increase the occurrence of overland flow. Overland flow will tend to occur for a similar period of time as the rainfall event that causes it. However, the flood water may remain for some time after accumulating at the surface in low areas with no significant outlet.

11.3 Developments can enhance the risk of flooding from overland flows due to the increased volume of surface water run off. In the case of the Charlestown Road site, this already has substantial areas of hard paving totalling 1.86Ha.

11.4 Mitigation

11.5 The proposed layout and levels of the site are such that flood water will be directed away from the buildings and adjacent land, Current site levels are such that flood water is directed to the North and back into Long Clough Brook.

11.6 The development will not increase the volume of surface water run off as the existing hard paved areas on the site total 1.86Ha. These could reasonably contribute flows in the order of 216 Litres per second into the surrounding network based on a 50mm storm event. Care needs to be taken that the rate of surface water run off to Long Clough Brook is not increased by an improvement in the drainage system. This will be mitigated by restricting the outfall rate to that of the current site incorporating an element of storage within the drainage system.

11.7 The intention will be to drain surface water into Long Clough Brook at a restricted rate of discharge at two or three points downstream of the development it serves. It will be necessary to reduce the maximum discharge rate from the site by 30% therefore the maximum outfall rate for surface water should be restricted to 150 Litres per second from all outfalls.

12. GROUNDWATER FLOODING.

12.1 Risks.

12.2 Groundwater flooding is caused by water originating from beneath the ground surface from permeable strata through a natural process, usually after periods of higher than average rainfall.

12.3 From an examination of the published geological map of the area (Solid Geology Map, UK South Sheet) the solid geology is shown to be Namurian (Millstone Grit

Series) from the Carboniferous Period. Drift deposits are expected to be minimal or non-existent.

BGS boreholes in the vicinity of the site show the strata to comprise various bands of Clay and Gravel to a depths of up to 17m (55 ft), overlying various bands of Shale, Gritty Shale and Gritstone.

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12.4 The published groundwater vulnerability map for the area indicates the site to be situated over a minor aquifer of variable permeability. This is described as fractured or potentially fractured rocks which do not have a high permeability, or other formations of variable permeability including unconsolidated deposits. Although these do not produce large quantities of water for abstraction they are important in supplying base flow to Rivers.

12.5 A large above ground steel tank exists behind the main warehouse building and this is fed by pipe work from a groundwater source beyond the site boundary. This was obviously used in the dyeing and bleaching processes of the original buildings. This does not appear to be permanently active as water flowing through this system has only been witnessed since November 2010.

12.6 There is also groundwater flowing from various pipes and manholes dotted around the area of the tank highlighted in 12.5 above, some of these pipes appear from underneath buildings, and again, flow has only been witnessed in recent months

12.7 The Environment Agencies groundwater maps indicate that the site does not lie within any source protection zone.

12.8 Mitigation

12.9 It is clear from the above that the bands of sands and gravels below the site assist in conveying groundwater to Long Clough Brook however the silty clay layers above, prevent groundwater rising to the surface in extreme wet weather conditions.

12.10 Such bands obviously carry water from the Hillside and arable fields beyond the site boundary to the east, and it is likely that further sources will reveal themselves once re-construction activities commence. Accumulatively these sources could generate a serious flow of water that could potentially create a flood risk to property. Due to the continuing down throw of the natural contours from the east to the west and with Long Clough Brook skirting the lower western boundary, the likelihood of intercepting ground water flows across any part of the site is fairly high.

12.11 Any redevelopment proposal for the site will need to incorporate a robust land drainage network, particularly along the Eastern boundary. These routes and silt traps will need highlighting to adjacent landowners, preferably on title documents, as they will become riparian owners and responsible for the future maintenance of the sections within their boundary

13. ARTIFICIAL DRAINAGE SYSTEMS

13.1 Risk

13.2 Many constructed drainage systems such as pipes, sewers, land drains and drainage channels exist to manage run off from developments. During prolonged periods of heavy rainfall, flooding may occur if the rainfall event exceeds the capacity of the drainage system or if the system becomes blocked through lack of maintenance. Flooding will also occur if the system surcharges due to a high water level within the receiving watercourse.

13.3 The highway drainage system in Charlestown Road is known to surcharge during heavy rainfall and water ponds on the carriageway, this is mainly due to a lack of maintenance however the drainage network has not been designed to cater for the more extreme events. Surface water does not have to become very deep before it breaches the threshold of the doorways on the adjacent buildings to the west and surface water continues through the building finding its way back into the watercourse through doors on the rear elevation.

13.4 Mitigation

13.5 The drainage system will be designed to a recognised industry standard in a manner that will not increase contributing flows to the Long Clough Brook. PPS25 requires that surface water from a development site should, as far as practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

13.6 The design of the drainage system will need to cater for the 100 year storm event with an allowance for climate change, current data suggests this will provide a 30% increase in rainfall up to the year 2115.

13.7 A principal surface water drainage proposal is attached in Appendix F fig 3 with Simulation calculations for the 100year event with Climate change attached These calculations are based on a maximum discharge of 150Litres per second and indicate a storage volume of 155m^3 with no flooding.

13.8 Improvements to Charlestown Road through the site will also require improvements to the highway drainage system that will be designed to better cater for such events.

14. INFRASTRUCTURE FAILURE.

14.1 Risk.

14.2 Where infrastructure exists that retains, transmits, or controls the flow of water, flooding may result if there is a structural, hydraulic, geotechnical, mechanical or operational failure. Because of the nature of these structures, Dams, canals, defence breach, bridge/culvert blockage, sudden onset of flooding from these can be catastrophic.

14.3 Mitigation

14.4 There is no known flood risk to the site from failure of infrastructure. Long Clough Brook is Main River and is therefore maintained by the Environment Agency. Redevelopment of the site will demolish most of the buildings on the site, two of which straddle over Long Clough Brook. Removal of these buildings, and opening up of the culverted sections of the watercourse will dramatically reduce the risk of flooding and provide easier access for maintenance.

14.5 Further enhancement can be achieved by providing a raked screen to the remaining culvert inlet structure under Charlestown Road, this will dramatically reduce the risk of blockage from large trees washed downstream from the woodland upstream.

14.6 Redevelopment of the site will bring an effective woodland management scheme of the area around the existing Mill Pond and Brook to the south, this will reduce the risk of timber washing downstream to block culvert entrances.

15. FLUVIAL FLOODING

15.1 Risk.

15.2 Flooding from rivers and other natural watercourses is usually caused by prolonged and intense rainfall generating high rates of run off which overwhelm the capacity of the river to transmit the water downstream.

15,3 Long Clough Brook and Bray Clough Brook can be classified as upland streams. They are both typically characterised by steep sided valleys covered in thin moorland soils with poorly established vegetation. These catchments are likely to be highly responsive to rainfall events with a short response time and a high peak flow. The catchment to both streams is fairly small and the site is relatively close to their source which is the highland areas to the south and southeast of the site.

15.4 There is no historic evidence of flooding at the site but there is some anecdotal evidence of surface water issues on Charlestown Road.

15.5 The proposed development site is located within zones 2 and 3 of the flood plain to the Long Clough Brook and would be at risk of flooding if designed without due regard to flood risk management and sustainability.

15.6 An extract of the Environment Agencies flood Extents map in Appendix C fig 1 shows the extent of the flood plain for the 1 in 100 year and 1 in 1000 year annual exceedance probability. Both these events are shown to affect the site. The High Peak Borough Council Strategic Flood Map in Appendix C fig 2 is fairly similar, however this impacts less on the site.

15.7 The Environment Agency have modelled Long Clough Brook from its junction with Bray Clough Brook 2254m downstream to its outfall into Glossop Brook.

This ISIS model has been provided and taken as a basis to model the effects of removing the culverts under Buildings 1 and 2.

15.8 This model clearly indicates that the culvert under building 1 becomes overwhelmed on the 1000 year event as the flood level reaches 172.34m AOD, 2.2m above the 100 year climate change level. Under such conditions floodwater would breach both banks of the channel, but due to the existing structures, would predominantly flow through the site under consideration and to the North. Due to the existing topography, this would flow out onto Charlestown Road and head North to the low point, before heading west and back into the watercourse. The impact of the 1000 year and 100 year climate change event is represented on drawings 12732-5002-07, 08, 09, and 10

Upstream culvert entrance under Building 1

15.8 Mitigation

15.9 It is our intention to demolish the majority of buildings on the site and remove the floor slabs of Buildings 1 and 2 to open up the watercourse.

15.10 This should permit the free flow passage of water through the site and contain the 100 year climate change event within channel. It is important to demonstrate that such improvements to the watercourse do not simply push flooding elsewhere.

15.11 Whilst the proposal is very similar in surface water generation terms it is likely that replacement of the drainage system within the site will accelerate the rate at which water flows from the site to Long Clough Brook , therefore it will be necessary to incorporate a restricted outlet into the drainage system together with some form of surface water balancing.

15.12 This will ensure that there is no impact upon the drainage network and thus the Long Clough Brook.

16 FLOOD ASSESSMENT

16.0 Long Clough Brook is designated Main River through the site to its junction with Bray Clough Brook at the Southern Boundary of the development land considered in this report.

16.1 The Environment Agencies modelled data for Long Clough Brook indicates that the site is at risk of Flooding from the 100 year climate Change event at the southern end of the site, but this level of 170.14m AOD only just manages to breach the north bank at the entrance to the culvert under building 1.

16.2 It is clear from the dramatic difference in level between the 100 year climate change event and the 1000 year event, that the culvert has inadequate capacity to cater for such an event.

16.3 If such an event should occur the resulting flood waters will circumvent the culvert by travelling out of channel around Building 1, travelling north to Charlestown Road, where flood water would return into the watercourse at the downstream culvert opening, or travel west through the buildings on the site and return to the open section of watercourse adjacent the west boundary.

16.4 From discussions with the Environment Agency, they are keen to see the watercourse opened up as far as possible as this is in line with the Water Framework Directive and the Environment Agencies policy. In proposing to open up two sections of watercourse under buildings 1 and 2, the Environment Agency have requested that this proposal is modelled to ensure that flood risk is not increased elsewhere, upstream or downstream.

16.5 We have therefore taken the Environment Agencies ISIS model and adapted this to reflect the proposal and re-run various simulations. The node results for the site are tabulated for easy comparison and attached in Appendix G fig3.

16.6 From examination of these results it is clear that the majority of flood levels at each node point are reduced on the 100 year climate change event, with only one node showing a slight increase of 38mm.

16.7 Similar results are found on the 1000 year event with all nodes showing a dramatic reduction in flood level, only node 7 immediately downstream of the site shows an increase of 28mm.

16.8 Modelling has shown that with the removal of the existing culverted sections under Building 1 and 2, the proposal will significantly reduce the flood plain without causing any further burden to flood levels or flood risk upstream or downstream of the proposed development.

16.9 These results are largely due to the fact that floodwater from the site

17 Proposed Measures

It is recognised that in constructing the new development, a modern drainage system would normally be more efficient than the existing and could increase the impact on the local public sewers and the river.

Redevelopment of the site will produce similar impermeable areas of hard paving drained to the river.

In determining drainage arrangements for the site, the use of SUDS has been considered.

17.1 Soakaway's.

Ground conditions will preclude the use of soakaway's as there is a high content of clay sub soil and seasonally high water table levels are evident from recent site visits.

17.2 Recycling

At the present time, the proposed dwellings are unlikely to provide an opportunity to make significant savings via the use of rainwater recycling. Nevertheless, consideration should be given to provide each property with a rainwater collection butt to the rear of the property for use on garden areas.

17.3 Storage / Attenuation

For practical reasons, it is likely that this will form the basis of the proposed surface water drainage system to further reduce the impact on the surrounding network. It is envisaged that the site will drain foul direct into the 300 and 375 mm diameter Combined Sewer running in Charlestown Road and through the site at points to be agreed with United Utilities. Surface Water will drain into Long Clough Brook at two or three appropriate points at a maximum rate of discharge of 150Litres / second for the whole development site. Distribution of the proposed flow must replicate the existing as far as possible. This will require a surface water attenuation tank with a total volume in the order of 155m^3 to balance the flows and cater for the 100 year climate change event, without causing flooding on the site or adjacent property.

18 CONCLUSIONS

18.0 The nature of the watercourse is steep in gradient with narrow steep sided hard channels, it is considered that flood storage is not significant within this section of the watercourse system and that re-construction in the manner outlined on the proposal attached in Appendix B is not likely to significantly reduce or displace any flood plain storage volumes.

18.1 Modelling has shown that with the removal of the existing culverted sections under Building 1 and 2, the proposal will significantly reduce the flood plain without causing any further burden to flood levels or flood risk upstream or downstream of the proposed development.

18.2 Modelling concluded that the buildings along Charlestown Road are considered to be at low risk of flooding from Long Clough Brook and that the Brook only poses a significant threat to these buildings in the event of a culvert blockage.

18.3 There has historically been an issue of flooding from surface water run off flowing down Charlestown Road and ponding at the low point adjacent to the site. The existing road drainage becomes heavily silted and ineffective, unable to cope with the discharge of water accumulating in the low spot.

18.4 This will be substantially improved by controlled discharge of surface water run-off from the development proposal preventing the current, random, run-off from the buildings and hard standing areas on the current site which currently exacerbate this problem.

18.5 Improvements on the width and alignment of Charlestown Road will also include an upgrade of the highway drainage network.

18.6 The development will further accommodate flood flow paths such that in the event of failure of the highway drainage network, floodwater will be directed to the west and back into Long Clough Brook without affecting adjacent properties.

18.7 Further wide scale benefits to the surrounding community and environment will be achieved by removal of the culverted sections of the watercourse through the site, from the reduction of flood risk, and the continuity of watercourse habitats.

18.8 Subject to the implementation of the improvement works recommended in this report, there shall be no detrimental impact on flood risk which should preclude development.

19 RECOMMENDATIONS

19.1 The western bank of Long Clough Brook between long section chainage 2200 and 2220 has slipped into the watercourse restricting its width and capacity on the bend. Remedial works in the form of piles and toe boards or a stone wall are required to return this section to its typical width.

19.2 Open up the culvert currently under Building 1 by carefully removing the floor slab of the building and providing a flood bank or wall to either side of the watercourse to cater for the 100 year climate change flood level, plus 600mm freeboard. This will require a top of wall/ bund level of 169.77m upstream and 169.40m downstream.

19.3 Provide a galvanised mild steel raked screen on the culvert inlet structure under Charlestown Road and ensure the surrounding stone retaining wall height is at a minimum 168.1m AOD, equivalent to the 100 year climate change flood level +600mm freeboard.

19.4 Remove debris and rubble within the Charlestown Road culvert and remove all relict service cables and ducts from the previous buildings on the site.

19.5 Remove the small building bridging the culvert immediately downstream of the Charlestown Road culvert at Long section chainage 2020. Remove silt and debris deposited at this point.

19.6 Open up the culvert under Building 2 and provide a flood bank or wall to cater for the 100 year climate change flood level +600mm freeboard of 166.60m upstream and 165.35m at Long Section chainage 1965 and 164.71m at Long section chainage 1927m.