Kaya Consulting Limited

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Proposed Housing Development at Dechmont, West Lothian

Flood Risk Assessment and SuDS Strategy for Masterplan

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Table of Contents

List of Figures

List of Tables

List of Photographs

1 Introduction

Kaya Consulting Ltd. was commissioned by Colin Macfarlane and John Macfarlane through Clarendon Planning and Development Limited to undertake a flood risk assessment for a proposed development site at Dechmont, West Lothian.

The site is located on a greenfield site to the east of the village of Dechmont. A small watercourse flows through the southern part of the site and there is evidence of water ponding in low-lying land close to the watercourse. A flood risk assessment of the site would need to consider risk from the watercourse, surface water runoff and elevated groundwater levels.

The scope of work for this assessment included;

- Site Walkover Survey.
- Liaison with local council regarding local drainage features and known flooding risk at the site.
- Review of historical maps of the area.
- Hydrological estimation of design flows for unnamed watercourse.
- Calculation of 200 year flood levels within open watercourses adjacent to the site. We assume at this stage that this work would be based on simple hydraulic calculations or a simple model.
- Preparation of flood map for the site.
- Assessment of flood risk from surface water runoff from adjacent land, including assessment as to whether the site acts to store surface water runoff at present.
- Assessment of risk of flooding from other sources, including groundwater and flooding from Scottish Water system.
- Calculation of greenfield runoff rates.
- Identification of initial flood management measures, if required.
- Preparation of Flood Risk Assessment report suitable for submission with a planning application and consistent with SEPA guidance.
- Preparation of outline SuDS strategy for the site.

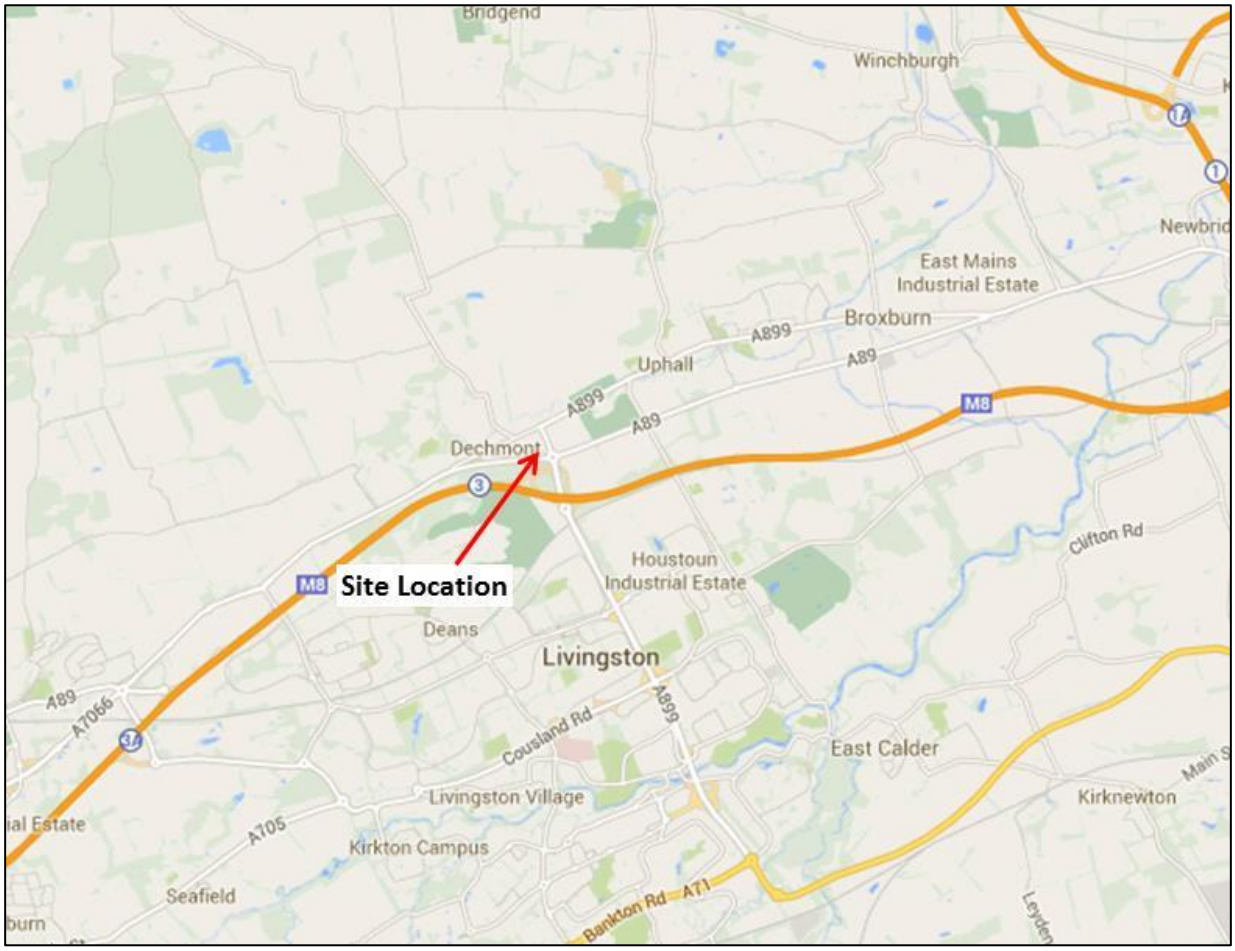
Information made available to Kaya Consulting Ltd for the study includes the following:

- Location plan;
- Scottish Water service drawings of the area; and
- 1m LiDAR topographical data;

A general location map of the site is shown in Figure 1.

The work carried out to assess the flooding risk of the site and main findings of the study are summarised in the following sections.

Figure 1: General site location



2 Legislative and Policy Aspects

2.1 National Planning Policy

Scottish Planning Policy (SPP) was published in February 2010 (and supersedes a number of Scottish Planning Policy documents, including SPP 7: Planning and Flooding and other National Planning Policy Guidance documents). SPP retains the main principle of SPP7 - that is new development should not have a significant probability of being affected by flooding and should not increase the probability of flooding elsewhere.

Some extracts from SPP are listed below:

"*Planning authorities must take the probability of flooding from all sources – (coastal, fluvial (water course), pluvial (surface water), groundwater, sewers and blocked culverts) and the risks involved into account when preparing development plans and determining planning applications.*"

"Development which would have a significant probability of being affected by flooding or would increase the probability of flooding elsewhere should not be permitted."

"Prospective developers should take flood risk into account before committing themselves to a site or project. The responsibility of the planning authority is to have regard to the risk of flooding when preparing development plans and determining the planning applications, but this does not affect the liability position of applicants and occupiers who have responsibilities for safeguarding their property. Planning authorities should avoid any indication that a grant of planning permission implies the absence of flood risk."

"Although ultimate responsibility for avoiding and managing flood risk still lies with land and property owners, certain public bodies are expected to take a proactive role in managing and, where achievable, lowering overall flood risk. The Flood Risk Management (FRM) (Scotland) Act 2009 places a duty on Scottish Ministers, SEPA, local authorities, Scottish Water and other responsible authorities to exercise their functions with a view to managing and reducing flood risk and to promote sustainable flood risk management. The main elements of flood risk management relevant to the planning system are assessing flood risk and undertaking structural and non-structural flood management measures."

"Section 42 of the FRM (Scotland) Act 2009 will, once commenced, amend the Town and Country Planning (Development Management Procedure) Regulations (Scotland) 2009 so that planning authorities will require applicants to provide an assessment of flood risk where a development is likely to result in a material increase in the number of buildings at risk of being damaged by flooding."

"For planning purposes the functional flood plain will generally have a greater than 0.5% (1:200) probability of flooding in any year. Built development should only take place on the functional flood

plains where it will not affect the ability of the flood plain to store and convey water, where the development will not be at risk of flooding and where the development will not increase the risk of flooding elsewhere. There may be exceptions for infrastructure if a specific location is essential for operational reasons or it cannot be located elsewhere."

"The risks associated with rising sea levels and coastal flooding should be taken into account when identifying areas that are suitable for development."

Similar to SPP7, SPP also proposes a Risk Framework approach which identifies flood risk in three main categories:

a. **Little or no risk area** (annual probability of flooding less than 0.1% (i.e. one in 1000 year flood). No constraints to development due to flood risk.

b. **Low to medium risk area** (annual probability between 0.1% and 0.5% (i.e. between one in 1000 and 200 year floods). Usually suitable for most development.

c. **Medium to high risk area** (annual probability greater than 0.5% (i.e. one in 200 year flood). Generally not suitable for essential civil infrastructure such as hospitals, fire stations, emergency depots etc., schools, care homes, ground-based electrical telecommunication equipment unless subject to an appropriate long term flood risk management strategy. The policy for development on functional flood plain applies. Land raising may be acceptable.

If built development is permitted, appropriate measures to manage flood risk will be required and the loss of flood storage capacity mitigated to produce a neutral or better outcome.

Residential, institutional, commercial and industrial development within built-up areas may be acceptable if flood prevention measures to the appropriate standard already exist, are under construction or are planned as part of a long term development strategy.

Undeveloped or sparsely developed areas are generally not suitable for additional development unless the location is essential for operational reasons and an alternative lower risk location is not achievable. Such infrastructure should be designed and constructed to remain operational during floods. These areas may also be suitable for some recreation, sport, amenity and nature conservation uses provided adequate evacuation procedures are in place. Job-related accommodation (e.g. caretakers and operational staff) may be acceptable. New caravan and camping sites should not be located in these areas.

"Landraising, which involves permanently elevating a site above the functional flood plain, may have a role in some circumstances."

Proposals for landraising should satisfy five strict criteria (as listed in Para 208 of SPP). These include the provision and maintenance of compensatory flood storage; have a neutral or better effect on probability of flooding elsewhere; not create a need for flood prevention measures elsewhere; not create ‘islands’ of new development but should adjoin developed areas outwit the functional floodplain; and be set back from the bank of the watercourse.

"*Major proposals for landraising should be promoted through the development plan."*

"Watercourses should not be culverted as part of a new development unless there is no practical alternative, and existing culverts should be opened where possible. If culverts are unavoidable, they should be designed to maintain or improve existing flow conditions and aquatic life. A culvert may be acceptable as part of scheme to manage flood risk or where it is used to carry a watercourse under a road or railway."

"The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended 2013) requires all surface water from new development to be treated by a sustainable drainage system (SUDS) before it is discharged into the water environment, except for single houses or where the discharge will be made into coastal water. Surface water drainage measures proposed as part of a planning application should have a neutral or better effect on the risk of flooding both on and off the site. Where flooding is an issue, SUDS should be designed to mitigate the adverse effects of a storm inflow into the watercourse or sewer."

Guidance on best practice in urban drainage in Scotland is given in Planning Advice Note (PAN) 61: Planning and Sustainable Urban Drainage Systems (2001) and PAN 69: Planning and Building Standards Advice on Flooding (2004).

2.2 National Indicative River and Coastal Flood Map (Scotland)

The SEPA third generation flood map shows the likely extent of flooding for high, medium and low likelihood for fluvial, pluvial (surface water) and coastal flows. Consultation of the map shows that the site is not within any fluvial or pluvial floodplains. However, the site is close to an area with 'High' to 'Medium' likelihood of surface runoff. It should be noted that SEPA flood maps are indicative and a detailed assessment of flooding risk is required for sites immediately outside or within the SEPA flood extent.

2.3 SEPA Technical Flood Risk Guidance & Flood Risk Management (Scotland) Act 2009

The latest version of SEPA 'Technical Flood Risk Guidance for Stakeholders' would need to be consulted when undertaking flood risk assessments (current version is 6, August 2010). In addition, SEPA's Interim Position Statement on Planning and Flooding (July 2009) would also need to be consulted. This details SEPA's role and policy position on flooding relative to land use planning and also the responsibility of the developer.

2.4 Flood Risk Management (Scotland) Act 2009

The Flood Risk Management (Scotland) Act 2009 was enacted on June 16, 2009. The Act repealed the Flood Prevention (Scotland) Act 1961 and introduces a more sustainable and streamlined approach to flood risk management, suited to present and future needs and to the impact of climate change. It encourages a more joined up and coordinated process to manage flood risk at a national and local level.

The Act brings a new approach to flood risk management including a framework for coordination and cooperation between all organisations involved in flood risk management, new responsibilities for SEPA, Scottish Water and local authorities in relation to flood risk management, a revised and streamlined process for flood protection schemes, new methods to enable stakeholders and the public to contribute to managing flood risk; and SEPA to act as a single enforcement authority for the safe operation of Scotland's reservoirs.

2.5 Controlled Activities Regulations

The Water Environment (Controlled Activities) (Scotland) Regulations *2011 (as amended 2013).* (CAR) brings new controls for discharges, abstractions, impoundments and engineering works in or near inland waters. Any such work requires authorisation (licence) from the Scottish Environment Protection Agency (SEPA) who are responsible for the implementation of the Act. The Regulations include a requirement that surface water discharge must not result in pollution of the water environment. It also makes Sustainable Drainage Systems (SuDS) a requirement for new development, with the exception of runoff from a single dwelling and discharges to coastal waters.

2.6 Climate Change

SPP (2010) states that:

> *"The design of new development should address the causes of climate change by minimising carbon and other greenhouse gas emissions and should include features that provide effective adaptation to the predicted effects of climate change. The changing climate will increase the risk of damage to buildings and infrastructure by flood, storm, landslip and subsidence. Development should therefore normally be avoided in areas with increased vulnerability to the effects of climate change, particularly areas at significant risk of flooding, landslip and coastal erosion and highly exposed sites at significant risk from the impacts of storms."*

SEPA recommend a 20% increase in peak flow for the 0.5% AEP (1:200) event, in accordance with DEFRA (Department of Environment, Food and Rural Affairs) research. The Scottish Executive Research Report '*Climate Change: Review of Levels of Protection Offered by Flood Prevention Schemes UKCIP02 Update (2003)' suggests 15 to 20 % increases in flows across Scotland.* The UK Climate Impacts Programme (UKCIP) on which the Scottish study is based, details a 20% and 25% increase in precipitation for the periods 2050 and 2080 respectively (based on the medium-high emissions scenario) for Central and South-West of Scotland. More recent climate change predictions

(UKCP2009) are now available. However, more research is required before practical guidance can be provided as to the impact that UKCP2009 will have on extreme rainfall and flooding across Scotland. However, for current studies a 20% increase in peak flows is assumed.

The Climate Change (Scotland) Act 2009 also makes reference to adaptation to climate change.

It is recommended that any site drainage design considers these future estimates of increased precipitation and adopts an adaptive approach.

3 Site Location and Description

The proposed development site is a greenfield site located at the east end of the village of Dechmont, West Lothian. Most of the site is a grassed field, although there is an area of wet ground towards the south-east corner of the site (Plates 1 and 2) and there are a few existing buildings in the north of the site.

The site is bounded to the north by a B-class road, to the east by the A899, to the west by existing development and to the south by an existing development and the A89, Figure 2.

LiDAR data for the area was obtained and 0.5 m contours based on the LiDAR are shown in Figure 3. The site is highest along the western boundary reaching above 137 m AOD, with ground levels falling to around 134 m towards the south-east and north-east ends of the site. The site drains to three locations so there are three main sub-catchments within the site, shown in Figure 3;

- The northern part of the site drains to the north-east corner of the site, from where runoff would overtop onto the main road and flow north-east.
- The middle part of the site drains to a low-point within the site along the eastern boundary. This area drains by way of a 0.5 m diameter culvert under the A899.
- The southern part of the site drains to the unnamed stream.

An unnamed watercourse flows through the site from west to east, along the southern end of the site. The watercourse exits the site to the south-east, under the Dechmont roundabout. Upstream of the culvert under the roundabout the channel is around 1 – 1.5 m wide (Plate 3). The channel bed appears to be lower than the culvert inlet, resulting in back watering into the channel upstream of the culvert, resulting in relatively deep slow moving water within the channel as visible in Plate 3. The inlet to the culvert under Dechmont roundabout is shown in Plate 4 and is a 800 mm diameter culvert.

To the north of the channel there is an area of wet ground in the low-lying area of the site (Plate 5 and Figure 2), with standing water observed during the site visit.

The unnamed watercourse enters the western end of the site where it flows adjacent to existing development (Plate 6). Immediately upstream of the site the banks and channel of the watercourse have recently been maintained (Plate 7). The stream originates within an existing development to the west of the site. The stream is an open channel through part of the development, with an approximate catchment area for the channel identified in Figure 3.

Historical Ordnance Survey maps of the area show the unnamed stream flowing in an open channel downstream of the Dechmont roundabout. However, the most recent maps show that the garden centre has been constructed on top of the stream (Figure 4), which is now culverted under the car park of the garden centre. The stream emerges at the eastern end of the car park by way of a culvert into an area that appears to have been designed to dissipate energy (Plate 8). The channel then passes under a minor road before flowing east in an open channel (Plate 9). A CCTV survey of the culvert has been undertaken for this study and is discussed in detail in Section 3.3.

The unnamed stream drains into Beugh Burn which is a tributary of the River Almond.

Figure 3 shows the middle part of the site draining to a low-lying area adjacent to the A899. Ordnance Survey maps of the area show a small pond in this area. This low-lying area drains by way of a 0.5 m diameter culvert under the A899 and into a drain on the other side of the road. This watercourse eventually drains towards unnamed stream and into the Beugh Burn.

The north part of the site drains towards the north-east corner of the site, whereupon excess surface water runoff would flow onto the road and then to the north towards Brox Burn.

3.1 Correspondence with West Lothian Council

The flooding officer of West Lothian Council was contacted regarding the site. The council response (G Hedger email of 27th February 2014, Appendix 1) noted that;

- There had been historical flooding of the southern part of the site as a result of partial obstruction of the culvert at the downstream end of the site (under Dechmont roundabout).
- Areas of the site lay within the SEPA Third Generation Flood Maps.
- Drainage options which relied on a culverted watercourse to convey runoff from the site could be a constraint on the development of the site.
- The developer would need to assess the structural integrity and hydraulic performance of the culvert downstream of the site as part of the planning process.

The council flooding officer also provided details of planning applications provided for the Dobbie's garden centre development to the south-east of the site.

3.2 SEPA Third Generation Flood Map

The site does not lie within the SEPA Third Generation river flood map of Brox Burn, Beugh Burn or any other watercourse. However, it is noted that the unnamed watercourse within the site is too small to have been considered in the SEPA mapping assessment.

Parts of the site are located within the SEPA surface water flood maps. A small area along the eastern boundary of the site is shown to lie within the 1 in 200 year surface water flood extent, with a larger area within the 1 in 1000 year flood extent.

3.3 CCTV survey of Unnamed Stream and Surface Water Management for Dobbie's Garden Centre

The unnamed watercourse flows out of the site under the Dechmont roundabout. The watercourse is culverted under the roundabout and then under the car park of a Dobbie's garden centre. The Dobbie's garden centre is a recent development. Prior to the development unnamed stream flowed in an open channel through the area that is now covered by the car park. Planning applications for the

garden centre were reviewed on the West Lothian Council web site to try and obtain information related to the culverting of the watercourse.

Aecom (2009) prepared a Surface Water Management Strategy for the original Dobbie's application. (*Land at Beuch Burn, Houstain Mains, Livingston, Surface Water Management Strategy and Foul Drainge Plan, July 2009*). However, the report did not comment on the capacity of the unnamed stream or on the necessity of culverting of the stream, although drawings within the report did show the site covering the line of the stream.

Goodson Associates (2009) in their site drainage impact assessment report note that the unnamed stream is not considered of 'hydrological importance'. According to the report the stream was connected into the site SUDS network via a silt trap, with the open channel of the ditch infilled as it crossed the site. No details of the proposals or culverting of the watercourse were provided.

Drawings of the site also did not provide details of the culverting of the watercourse.

The CAR license associated with the culverting of the watercourse was obtained from SEPA, but this also did not contain information on the nature of the culvert.

Given the lack of information a CCTV survey of the culverted section was obtained for the purpose of this study. The survey was undertaken by EEC on 25th March 2014 (Project No. B03-092-14). Figure 5 provides an outline summary of the results of the survey. The main features of the survey are;

- The culvert downstream of the site has a diameter of 800 mm. It is around 10% blocked
- The culvert increases in size under the roundabout to 900 mm diameter and then 1050 mm diameter, downstream of a flume inflow (875 mm diameter) to the culvert, anticipated to be from land to the south of the site, see Figure 4. The pipe is around 10% blocked.
- At the upstream end of the Dobbie's car park the culvert diameter decreases to 750 mm diameter and it continues as a 750 mm diameter culvert through the car park to its outfall.

The key issue with respect to the culvert is the dramatic decrease in culvert size under the Dobbie's car park where a 1050 mm diameter pipe decreases to 750 mm diameter. A long profile of the culvert is provided in Figure 5 and it shows that the gradient of the culvert under the car park is not steeper than sections upstream, which indicates a loss in pipeflow capacity. The capacity of the culvert is modelled in Section 5.1.

Figure 2: Detailed site location

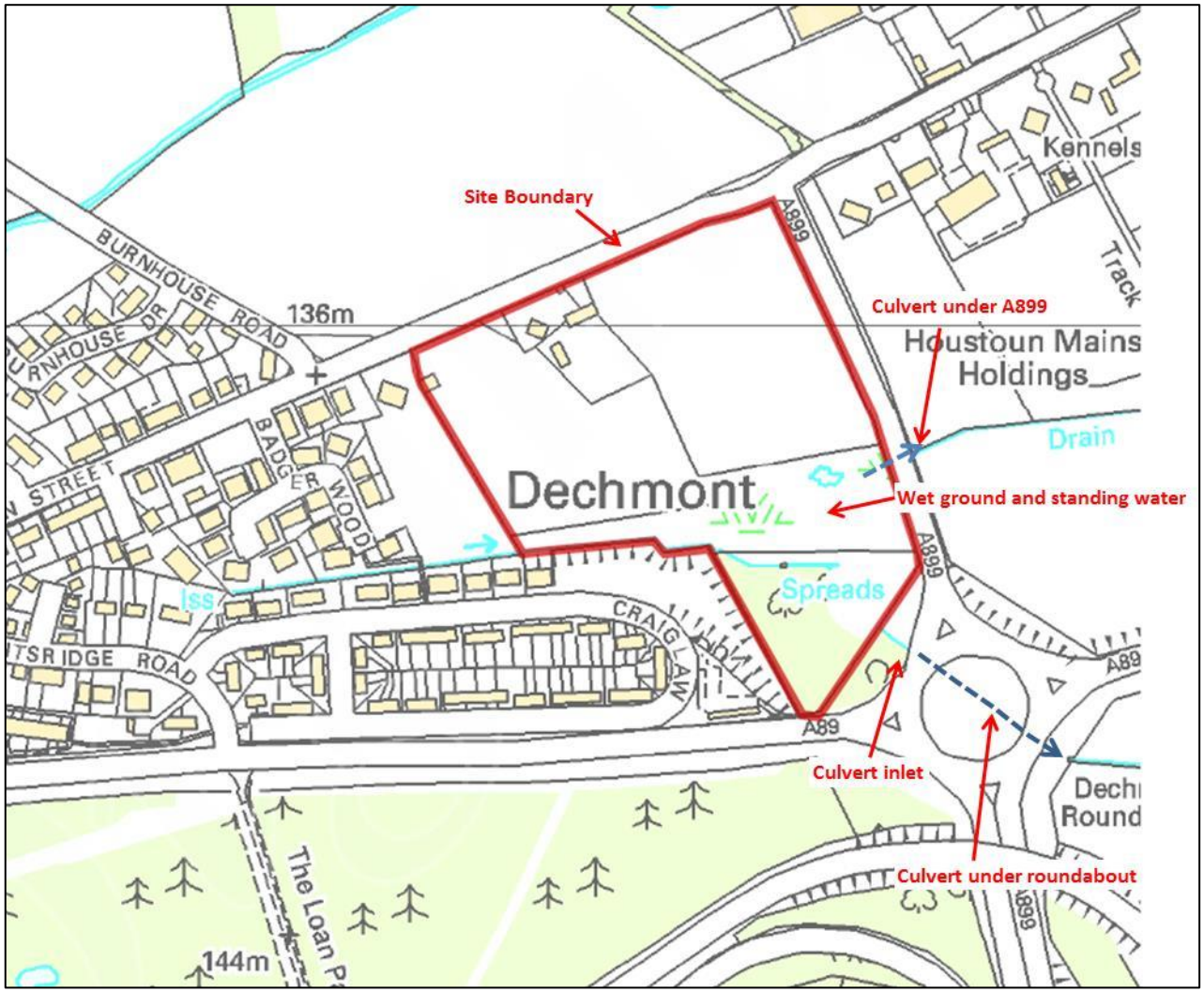


Figure 3: Topography and local sub-catchments within the site, based on LiDAR data

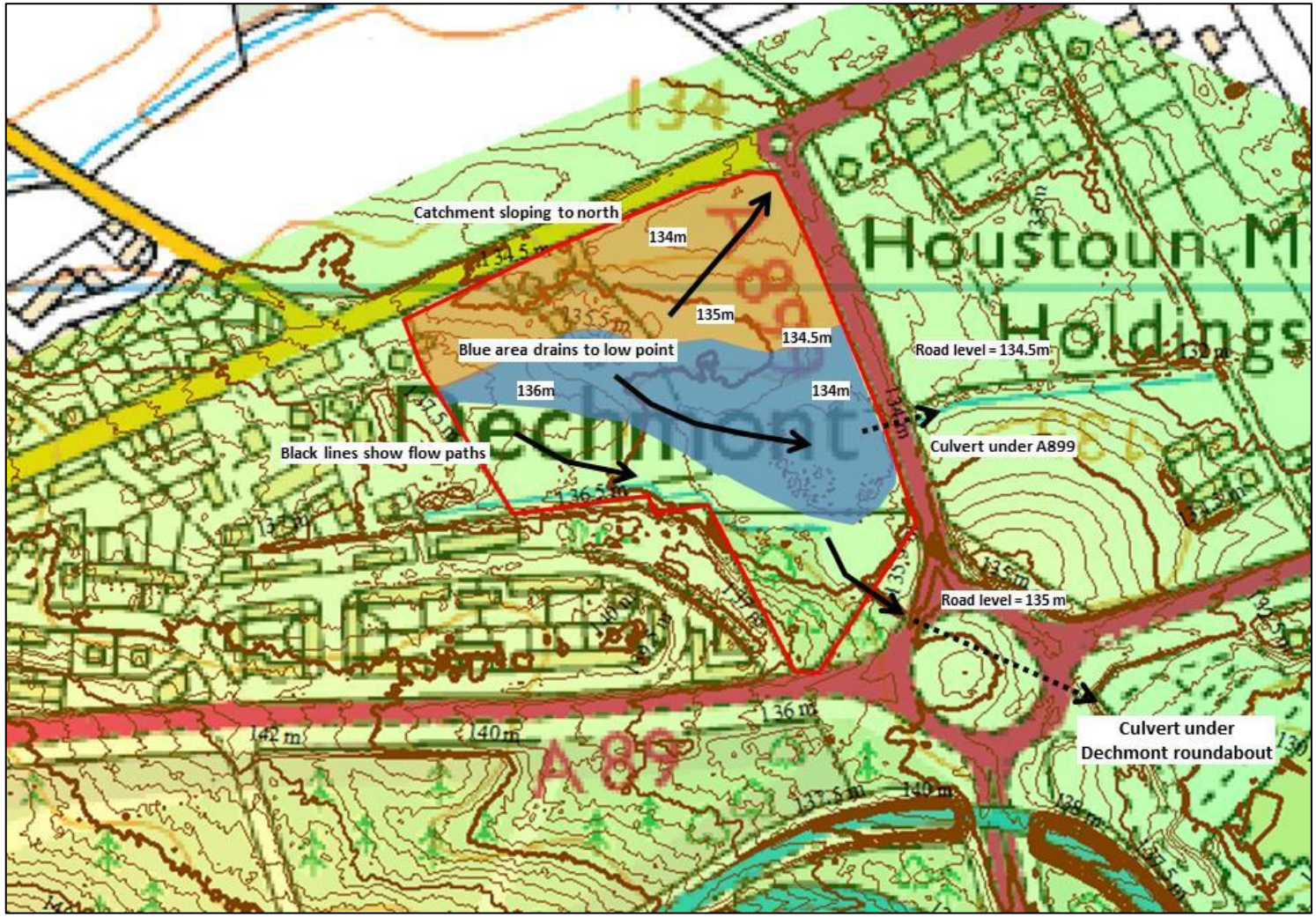


Figure 4: Local catchments

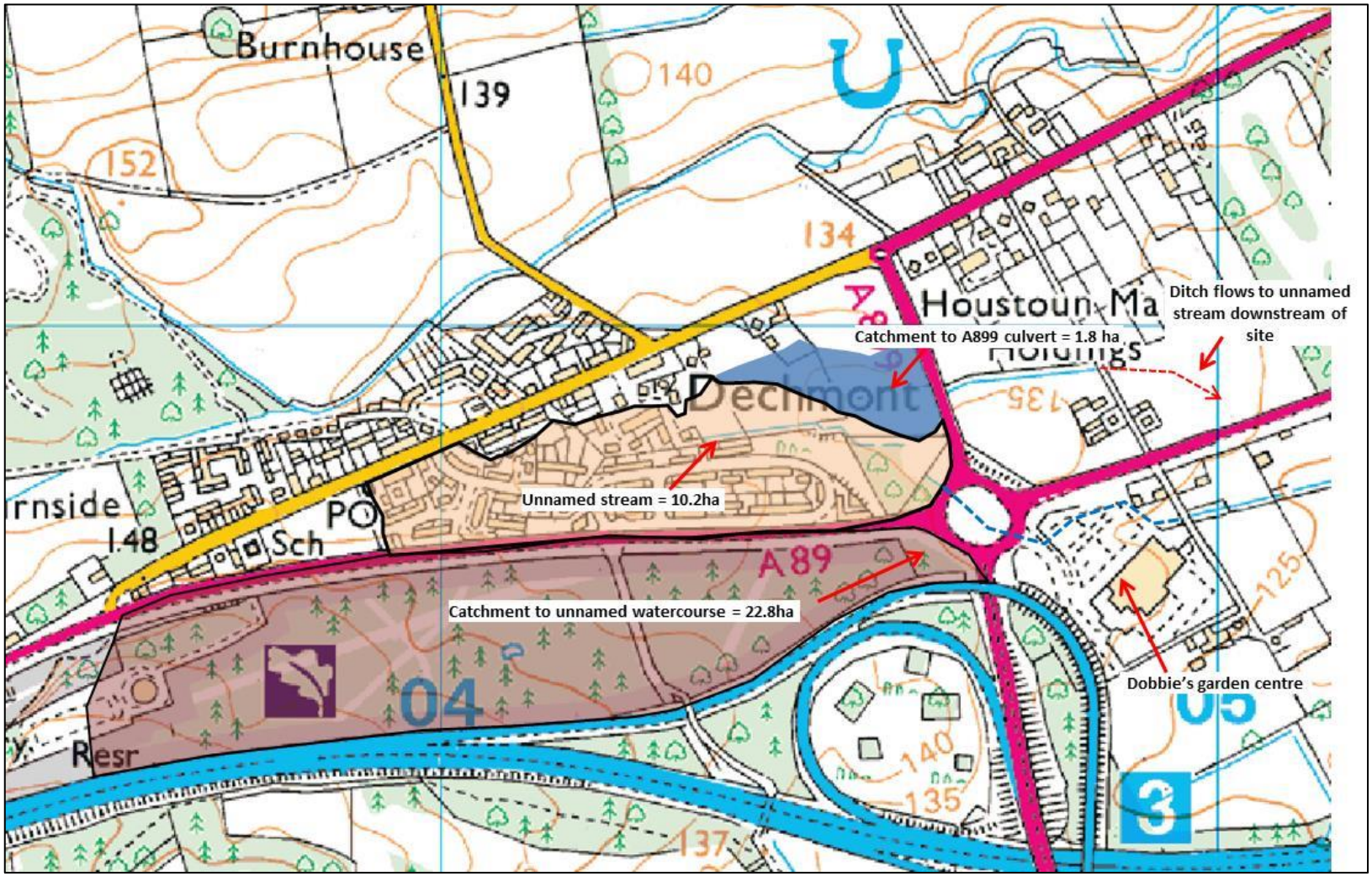
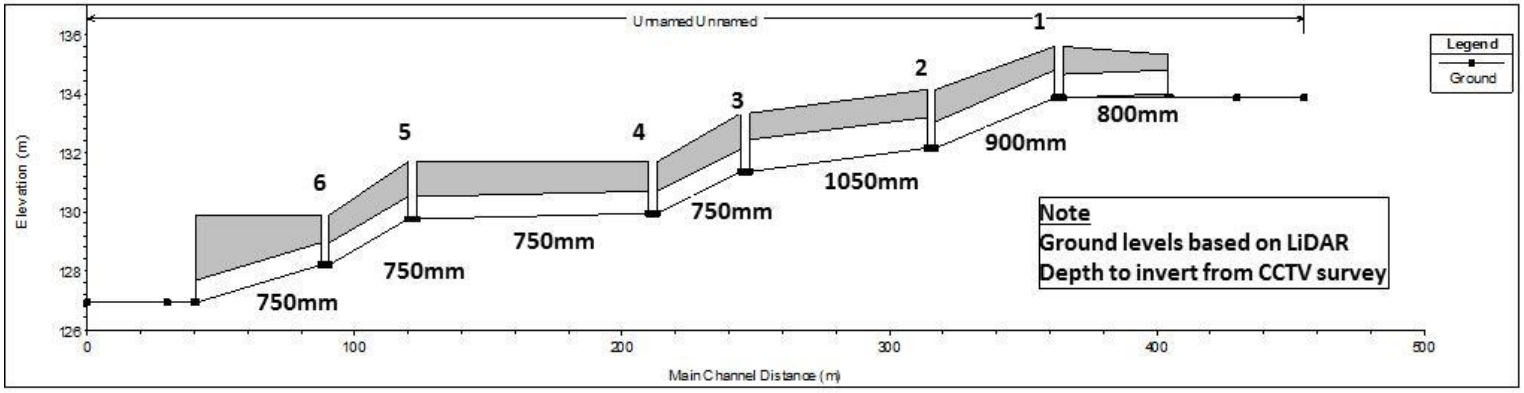


Figure 5: Location and Long profile of culvert of unnamed watercourse



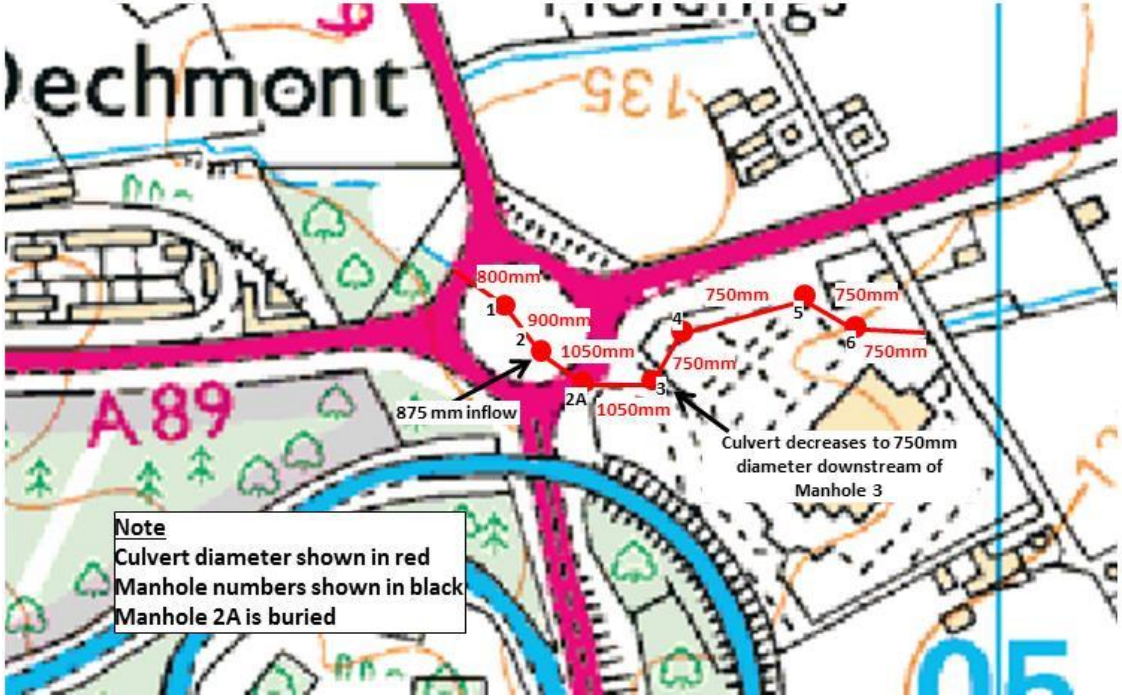


Plate 1: View of site, looking north from southern end of site

Plate 2: View of site looking south from northern boundary

Plate 3: Unnamed watercourse upstream of Dechmont roundabout culvert

Plate 4: Culvert inlet under Dechmont roundabout

Plate 5: Wet ground near Dechmont roundabout culvert inlet

Plate 6: View of unnamed stream at south-west edge of the site

Plate 7: View of unnamed stream just upstream of site

Plate 8: Outlet of unnamed stream at downstream end of Dobbie's Garden Centre car park

Plate 9: View of unnamed stream downstream of Dobbie's Garden Centre

4 Hydrology

This section derives return period flow estimates for the unnamed watercourse and greenfield runoff rates for the site.

4.1 Design flows for Unnamed Stream

The approximate catchment area of unnamed stream upstream of the Dechmont roundabout is shown in Figure 3. Scottish Water Service Drawings of the area show six 150 mm diameter pipe connections to the unnamed stream from the development to the west of the site. Surface water runoff unable to enter the drainage system within the development would also tend to flow towards the watercourse.

Design flows are calculated based on the IH124 method with urban correction, FEH Rainfall-Runoff method, a simple application of the Wallingford Procedure and based on an assessment of the potential flow able to enter the watercourse through piped connections, with results presented in Table 1.

The flow predictions have a high degree of uncertainty as a large percentage of the site is urbanised. The flow rate in the channel will depend on the connections between the urban areas and the watercourse, as well as flood storage within the developed areas. However, the results would indicate a theoretical peak flow of around 0.4 to 0.6 m^3/s in the stream, based on standard methods. A simple calculation based on the inflowing pipe capacities would suggest that the actual maximum flow in the stream would likely be less, at around 0.2 to 0.3 m^3/s.

Table 1: Design flows for unnamed stream, upstream of Dechmont roundabout

Method	1 in 200 year flow estimate (m^3/s)
FEH Rainfall-Runoff	0.45
[a]IH124	0.39
[b]Wallingford Procedure	0.60
[c]Based on inflowing culverts	~0.2 to 0.3

a Based on SAAR = 854 mm, SOIL = 0.45 and Urban Correction 2.0
b Based on Rational Method and 60 minute storm
c Based on inflows from 6 x 150 mm diameter culverts (as shown on Scottish Water drawings) + greenfield runoff from non-urbanised areas.

For the purpose of the modelling assessment a 200 year flow of 0.45 m^3/s (FEH Rainfall-Runoff method) is considered as the most appropriate. It is more conservative (high) than the estimates made using IH124 or the inflowing culvert capacities. The Wallingford Procedure is more suited for small urbanised sites and is likely to provide high flows.

Analysis of LiDAR data suggests that a catchment of around 22.8 ha, located south of the A89, likely flows into the culvert under Dechmont roundabout. There is an 875 mm diameter flume connection to the unnamed watercourse culvert under the roundabout. Based on IH124 this catchment would be expected to contribute a flow of around 0.4 m^3/s, assuming the greenfield runoff rate calculated in

Section 4.2. An 875 mm diameter pipe would be expected to be able to pass this flow into the unnamed watercourse culvert,

Within Dobbie's car park the CCTV survey indicated one 225 mm diameter pipe entering the culvert from the car park (Manhole 6). It is assumed that discharges from the Dobbie's site would be equivalent to the 2-year greenfield runoff rate for the site area = 5 L/s x 30 ha = 0.15 m^3/s. However, it is not known whether discharge rates from the garden centre are controlled.

There are three other 150 mm diameter piped connections to unnamed stream shown in the CCTV survey. However, these are typically of poor condition and it is not known if they are operational. A nominal inflow of 0.1 m^3/s is considered in the modelling for these inflows.

4.2 Greenfield Runoff Rates

Greenfield runoff rates for the existing site were estimated using the Institute of Hydrology (IH) small catchment method (IH124). Greenfield runoff rates for a range of return periods are provided in Table 2.

Table 2: Greenfield runoff rates

Return Period (years)	Flow (l/s/ha)
2	5.0
10	7.9
50	12.1
100	14.6
200	17.6

Note: Based on IH124 method with FSR scaling factors and SAAR = 854 mm and SOIL = 0.45

The 2-year greenfield runoff rate for the site has been calculated at 5.0 l/s/ha. It should be noted that many councils will require standard, council-wide greenfield runoff rates to be considered for any development that may be less than the calculated rate. The appropriate greenfield rate for the site should be agreed with West Lothian Council and Scottish Water.

As shown in Figure 4, around 1.8 ha of the site drains to a culvert under the A899. Based on the 200 year greenfield runoff rate in Table 2, the 200 year flow for this catchment is predicted to be 32 L/s.

As shown in Figure 4, around 1.2 ha of the site drains to the north-east of the site. Based on the 200 year greenfield runoff rate in Table 2, the 200 year flow for this catchment is predicted to be 21 L/s.

5 Flood Risk Assessment

This chapter assesses risk of flooding from:

- Unnamed watercourse, including blockage of culvert under Dechmont roundabout;
- Culvert under A899;
- Surface water runoff from adjacent land;
- Scottish Water sewers;
- Groundwater;
- Site drainage; and
- Site access.

5.1 Unnamed watercourse

An unnamed watercourse flows along the southern part of the site and enters a culvert under Dechmont roundabout at the south-east corner of the site. The watercourse has a small catchment (10.2 ha) that lies within a developed area of Dechmont to the west of the site. The culvert at the downstream end of the site is 800 mm in diameter.

A HEC-RAS model of the culverted watercourse was constructed based on the CCTV survey of the culvert. The model was then run assuming 200 year inflows at the upstream end (0.45 m^3/s) and inflows entering the culvert at Manhole 2 (200 year flow of 0.4 m^3/s), Dobbie's car park (attenuated runoff of 0.15 m^3/s) and assumed inflows for other minor piped inflows (0.1 m^3/s). The model was run in steady state with a long profile shown in Figure 6. Ground levels at manhole covers are based on LiDAR data, but depths to invert were measured during the CCTV survey. The invert level at the upstream end of the culvert (within site) is based on site observations and LiDAR data. This aspect of the model would need to be improved during detailed design.

The model predicts flooding from Manhole 4, which is the second manhole within the Dobbie's site and where the culvert slope decreases. The size of the culvert decreases from 1050 mm diameter to 750 mm diameter at Manhole 3, which lies upstream of this location.

The model was then adjusted for two different scenarios;

1. To consider a scenario where the Dobbie's culvert had been installed as a 1050 mm diameter culvert, i.e., a similar size to the inflowing culvert. Re-running the model indicated no flooding from the culvert within Dobbie's car park, Figure 6.
2. To consider the pre-Dobbie's scenario where the watercourse downstream of the Dechmont roundabout was an open channel. The open channel was assumed to be a ditch around 1 m wide and 1 m deep. Re-running the model indicated no flooding from the culvert.

The capacity of the culvert at its upstream end is predicted to be sufficient to pass the predicted 200 year flow in unnamed stream and the capacity issues downstream of the site (in Dobbie's car park) do not impact water levels within the site. Hence, the issues with the culvert do not impact flood level estimates for the site, but they will impact site drainage options as discussed in Section 6.

The inlet of the culvert of unnamed stream is located at a higher elevation than low-lying areas of the development site. This was obvious in the field with water-logged ground to the north of the culvert.

As a result, low-lying areas will act as floodplain and will store and attenuate surface water runoff from unnamed stream before it enters the unnamed stream culvert. Hence, consistent with SPP, we would recommend that there is no development within the low-lying area of the site.

Based on information available to date (LiDAR and CCTV survey) it is not possible to provide a definitive floodplain extent within the site. However, based on site observations and LiDAR data the area shown in Figure 7 should be left undeveloped at the Masterplan stage. When the study progresses to detailed design further modelling based on land survey within the site area (e.g., channel cross-sections and culvert invert) will allow this area to be refined and potentially reduced in size.

If the culvert were fully blocked then flood waters would flow towards the culvert under the A899. The emergency overspill level for the site is over the A899 to the east, where the road is at 134.5 m AOD level. Finished Floor Levels within the site will need to be set a suitable height above this spill level.

5.2 Culvert under A899

The entire catchment of the watercourse flowing to the culvert under the A899 (see Figures 3 and 4) lies within the development site. Hence, runoff from the catchment will be accommodated within the site drainage system and would be expected to be attenuated to greenfield runoff rates post-development. At present there is evidence of ponding and waterlogging in land upstream of the culvert entrance, due to some land being at a lower elevation than the culvert inlet. However, runoff able to reach this location will be managed by the site development. Assuming site runoff is attenuated to the 2-year greenfield rate for the site, this low-lying area is not considered as floodplain and development may be possible in this low-lying area.

The culvert should be retained post-development and it may be able to be considered as a sink for attenuated site runoff.

5.3 Surface Water Runoff from Adjacent Land

As illustrated in Figures 3 and 4, there is limited upstream catchment area draining to the site. As a result, the site is not considered as being at significant risk of flooding from runoff from adjacent land.

However, the development will sit on sloping land and as a result, there is a risk of surface water flooding within the site from runoff generated within the site boundaries, including excess runoff on the site access roads. This risk will need to be managed through the design of the surface water drainage system and through the inclusion of appropriate surface water flow pathways through the site.

5.4 Scottish Water infrastructure

Surface water sewers within the existing development to the west of the site discharge into the unnamed stream. If the surface water or foul sewers were blocked or events were in excess of design conditions, surface water would tend to flow to the unnamed stream, with flood risk from the stream considered in Section 5.1. Scottish Water service drawings show no sewers along the A899 to the east of the site and a single foul sewer along the road to the north of the site. The camber of this road is to the north away from the site, with ground levels to the north of the road lower than the road.

5.5 Groundwater

During the site visit standing water was observed at the south end of the site. Hence, it would appear that local groundwater levels are close to the surface in this part of the site. It is not known if these high levels reflect a local perched groundwater table (i.e., locally poorly drained ground resulting from main rods limiting shallow sub-surface flows) or raised regional groundwater table. From a site walkover survey it would appear ponding is due to areas of land within the site being located lower than the inverts of culvert draining the site.

The depth to groundwater throughout the site should be determined during site investigation works and if a shallow groundwater table is encountered, appropriate design measures should be taken, including raising of ground levels close to the SuDS pond (lowest part of site) if required.

5.6 Site drainage

The detailed design of the site drainage system or any SuDS measures which may be required is not part of this assessment. However, an outline SuDS strategy is provided in Section 6.

As the site is greenfield, development will increase surface water runoff from the site. As a result, runoff will need to be controlled and attenuated before discharge. Most of the site currently drains to the unnamed stream, so this will be an appropriate sink for attenuated site runoff.

5.7 Site access

The site is likely to be accessed from the north. The road is not considered to be at risk of flooding and sits at a higher elevation than surrounding land. Hence, although care will need to be taken in the design of the site so that any surface water entering the site is able to flow through the site without ponding or flooding properties, this risk is expected to be low.

Figure 6: Model predictions for unnamed stream culvert

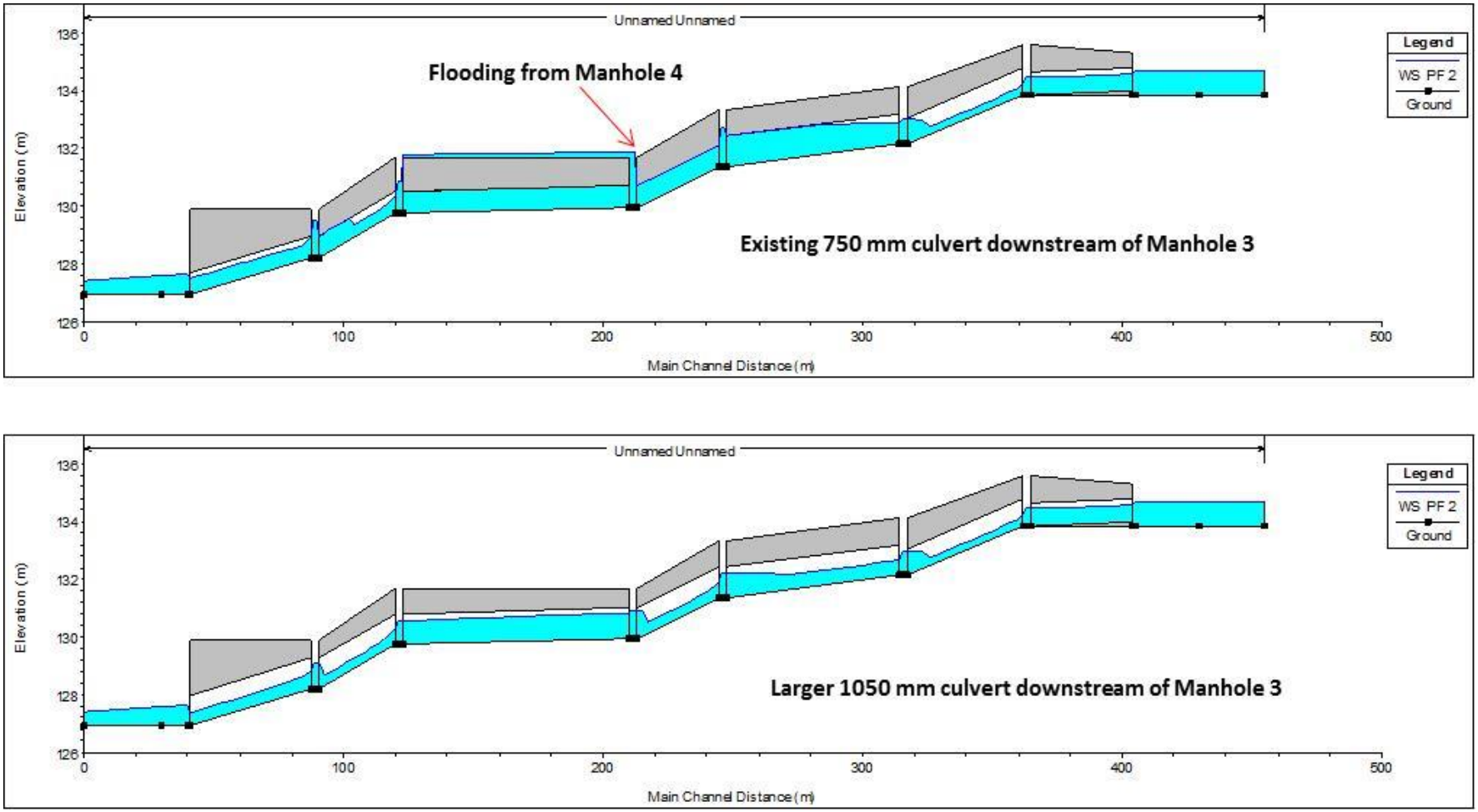
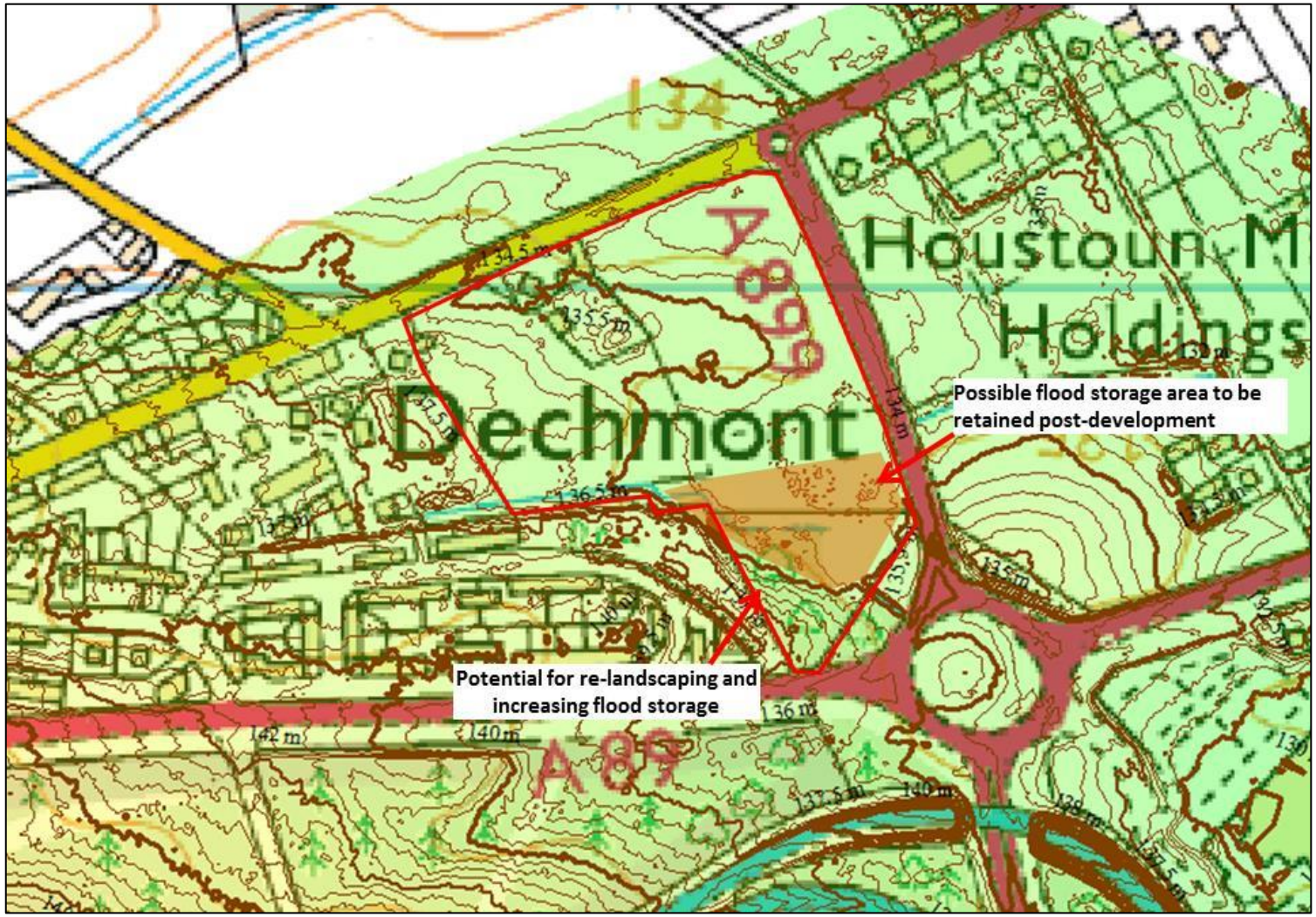


Figure 7: Approximate flood storage area



6 Outline SuDS strategy

6.1 SuDS requirements

Sustainable Drainage Systems (SuDS) are required under SPP. SuDS are regulated under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 or 'CAR'.

6.2 SuDS for surface water attenuation

The key requirements for surface water management at the site are;

- Attenuation of site runoff to greenfield rates.
- No development within existing floodplain areas of unnamed stream.

The approximate floodplain extent for the unnamed stream has been discussed in Section 5.1.

There are a number of options for discharge of attenuated surface water from the site. At present surface water runoff flows to three locations;

- The northern part of the site flows towards the north-east corner of the site and would eventually flow to the north towards Brox Burn.
- The central part of the site flows to a low-lying part of the site along the eastern boundary and drains under the A899 to an unnamed drain. The drain eventually joins Beugh Burn
- The southern part of the site flows to an unnamed steam that passes under Dechmont roundabout and eventually flows into Beugh Burn.

It appears that there are three options for the discharge of attenuated surface water runoff from the site, and these are discussed below.

6.2.1 Option 1: Single SuDS pond draining to unnamed stream

As shown in Figure 3, around 2 ha of the current site drains to unnamed stream. A further 1.8 ha of the site lies within the catchment of Beugh Burn, with runoff flowing to this watercourse by way of a field drain. Hence, in total around 3.8 ha of the site flows to Beugh Burn. Of this around 1 ha of the site close to unnamed stream will likely need to be left as floodplain. Hence, this leaves around 2.8 ha of the rest of the site that currently drains to Beugh Burn and 1.2 ha that drains to the north-east.

Post-development discharges from the site to unnamed stream should be limited to the current greenfield rate from the site to this watercourse. Hence, if a single SuDS pond is considered we would suggest that the discharge rate from the SuDS pond be set equal to the greenfield rate for the area of the site that currently drains towards unnamed stream and Beugh Burn, equal to 2.8 ha.

Based on the greenfield runoff rate in Table 2, the SuDS pond outflow rate is calculated as 2.8 ha x 5 l/s/ha = 14 l/s.

Based on a simple application of the Wallingford Procedure this would suggest that a SuDS pond would need to store around 1,800 m^3 for the full site area for the 200 year event. This would suggest a pond of around 2,300 m^2 in area if it were 1 m deep with a 3m wide access strip around the edge.

Given the slope of the land and the size of the unnamed stream compared to the smaller field ditch that currently drains part of the site to the east, draining the site to unnamed stream would appear to be the most practical option. However, modelling work undertaken in Section 5.1 indicated that the culvert of unnamed stream is under-capacity for a 1 in 200 year event downstream of the site within Dobbie's garden centre. This under-capacity has been caused by the recent culverting of unnamed watercourse within the Dobbie's site. Modelling indicated that prior to the culverting, or if the culvert had been installed at an appropriate size, there would have been no flooding issue and the culvert upstream of Dobbie's appears appropriately sized for the 1 in 200 year flow. Hence, without the Dobbie's development we would anticipate there would have been no restriction to the discharge of attenuated site runoff to the watercourse. As it stands discussions will need to be held with West Lothian Council to determine the rate at which site runoff would be allowed to discharge to the watercourse.

6.2.2 Option 2: Single SuDS pond draining to culvert under A899

An area of the site currently drains to a low-lying part of the site adjacent to the A899. Water ponding in this area passes under the A899 by way of a culvert. Runoff then flows through a series of field drains to Beugh Burn.

If attenuated site runoff is not able to be discharged to unnamed watercourse an option would be to provide a SuDS pond with outfall to the culvert under the A899. A similar sized pond would be required to that calculated in Section 6.2.1 above. If discharge rates are to be limited to the existing greenfield flow rate to this culvert, the pond may have to be larger. In addition, based on information available to date the downstream effects of discharging to this watercourse have not been assessed. However, if site runoff is attenuated to greenfield rates there is no reason why this option could not be implemented, but there will need to be additional assessments at the detailed planning stage if this is the preferred option.

6.2.3 Option 3: Two SuDS ponds or alternative onsite storage options

As there are currently two outfalls from the site (culvert under A899 and unnamed stream) it would be possible to two SuDS ponds, one outfalling to the unnamed stream and one to the culvert under the A899. This would limit the flow from the site to the two downstream watercourses and would mimic the existing situation. However, having two ponds has the potential to increase long term maintenance at the site and may not be desirable.

6.2.4 SuDS Summary

Given the site topography and the relative sizes of the watercourses, the most appropriate and practical sink for water discharged from a SuDS pond would be the unnamed stream that passes under Dechmont roundabout, Option 1. However, as discussed above there are issues related to discharging to this watercourse, due to the downstream flow restriction under Dobbie's car park. This option should be discussed in more detail with the local council if the under-capacity of the culvert under Dobbie's limits the discharge from the site to the unnamed stream.

There is the possibility of re-landscaping the flood storage area at the southern end of the site (Figure 7) to increase existing flood storage. This could decrease flows entering the unnamed stream and act to offset any effects of the decrease in capacity of the downstream culvert.

Alternatives exist that include discharging runoff to the culvert under the A899. Whichever option is chosen the discharge rate should be limited to the existing greenfield rate for the catchment draining to Beugh Burn.

Discussion should be held with West Lothian Council to discuss drainage options and restrictions placed upon the site by the Dobbie's development. Further work is required, including refinement of the size and location of the SuDS pond. However, at this Planning in Principle stage, the information available to date indicates that there is a drainage solution that would allow development of the site.

6.3 SuDS for water quality management

For developments of greater than 50 houses, SEPA typically require two stages of treatment through SuDS features before site runoff is discharged to the receiving water environment.

The SuDS manual identifies three main areas where control of runoff can be provided;

- Source Controls; where surface runoff is controlled at or close to where rainfall lands on a surface generating runoff. Source control measures include permeable paving, filter trenches or swales
- Site Controls; where local scale features such as storage or detention ponds are constructed within a site to receive surface water runoff from that site only; and
- Regional Controls; where larger scale ponds or wetlands are provided within or outside of the site area. These features receive runoff from multiple sites and are designed to manage surface runoff over wider areas. A regional control option is not available at this site.

In the current site, one stage of treatment will be able to be provided within the storage pond constructed to attenuate site runoff to greenfield rates. A second stage of treatment will need to be provided within the developed area of the site (source control) through the construction of combination of features such as swales or permeable paving. There is also the option of discharging attenuated surface water runoff from the SuDS pond into wet ground within the low-lying part of the site that will be left undeveloped for flood storage purposes, rather than discharging the water directly into the unnamed watercourse. Such an option could allow for further attenuation and treatment of site runoff, although such an option would need to be agreed with SEPA and the local council.

The detention basin, designed for flood storage purposes will be large enough to provide one level of treatment for surface water runoff.

The exact location of source control measures will be determined at the detailed planning and detailed site design stage.

7 Summary and Conclusion

This report describes a flood risk assessment for a proposed development site located at the east end of the village of Dechmont, West Lothian. The site is currently predominately greenfield with a few existing buildings on site. The development proposal is for a Planning Application in Principle.

An unnamed stream flows through the southern part of the site before passing into a culvert at the downstream (east) end of the site. Downstream of the site the culvert appears to be large enough to pass the calculated 200 year flow; however, there are areas of the existing site that are located at lower levels than the invert of the culvert, leading to ponding within the site. These areas are considered floodplains and an area of the site should be left undeveloped for flood storage. The exact areas will need to be determined at the detailed design stage; however, an approximate area is shown in Figure 7.

The site is not considered to be at significant risk of flooding from surface water runoff from adjacent land. However, it is noted that the development will sit on sloping land and as a result, there is a risk of surface water flooding within the site from runoff generated within the site boundaries, including excess runoff on the site access roads. This risk will need to be managed through the design of the surface water drainage system and through the inclusion of appropriate surface water flow pathways through the site.

There is not considered to be a significant risk of flooding of the site from the Scottish Water sewer system.

There is not expected to be a significant risk of flooding from groundwater within the developed areas of the site. However, groundwater should be assessed as part of site investigation works and if a shallow groundwater table is encountered, appropriate design measures should be taken, including raising of levels close to the SuDS pond (lowest part of site) if required.

The conclusions of this report (including size of floodplain area and Finished Floor Levels) will need to be reviewed at the detailed planning and detailed design stages.

Design of the site drainage system was not part of the current commission. However, an outline SuDS strategy is provided in Section 6. There are issues related to drainage of the site into Unnamed Stream, due to an under-capacity culvert installed in the Dobbie's garden centre site. More discussions of the drainage options will need to be undertaken with West Lothian Council, and SEPA. However, at this Planning in Principle stage, the information available to date indicates that there is a drainage solution that would allow development of the site.

It is good practice to design finished floor levels to an appropriate height above surrounding ground levels and arrange finished ground levels sloping away from buildings. It is also good practice to provide within the development site an appropriate overland flow route through which flood waters could escape in the event of the site being flooded during floods exceeding the design flows.

As with any design, maintenance is an important requirement for an effective drainage system. Regular maintenance programs need to be implemented for all components of the drainage system.

It should be noted that risk of flooding can be reduced but not totally eliminated, given the potential for events exceeding design conditions to occur and uncertainties associated with hydrological estimates.