This report provides an update on the investigations and remedial works to date at the Barry Burn Flood Prevention Scheme in Carnoustie, as a follow-up to the agreed Committee Report no. 181/09 which set out these proposals and their funding arrangement after the flooding incident in mid-August 2008. This report seeks approval of further and future development of the investigations and remedial works carried out in financial year 2010/11, and proposed for financial year 2011/12 and future years subject to the confirmation of the availability of funding.

**RECOMMENDATION**

1.1 It is recommended that the Committee

(i) notes the implementation of the investigations and remedial works which have been carried out in financial years 2008/09 and 2009/10 as outlined in this report; and

(ii) approves the further and future development of the investigations and remedial works carried out in financial years 2010/11, and proposed for 2011/12 and future years as outlined in this report.

**BACKGROUND**

2.1 Significant flooding occurred across Angus and, in particular, in Carnoustie in mid-August 2008. Committee Report No. 181/09 was prepared following this flooding incident on the proposed investigations and remedial works to prevent or alleviate future flooding occurrence.

2.2 On 3 & 4 September 2009 another flooding event occurred having a similar cause to the August 2008 flood (extremely intense rainfall followed by the high water-level generated in the Barry Burn by the flood flows).

Although, some garages, solums and gardens were flooded and some roads were disrupted, there was very limited internal flooding of property during the September 2009 flood. This was the main difference between this flood and that of August 2008, when three houses suffered internal flooding.

2.3 Almost two months later, on 1 November 2009, another flooding event occurred. This had the common cause of the extreme intensity of the rainfall during the storm and the high water level in the Barry Burn and Lochty Burn. Flooding to the back gardens of house odd nos 1 to 7 MacDonald Smith Drive; to commercial properties along the High Street and the lower section of Links Parade resulted. The flooding at the upper section of Links Parade occurred due to the combination of high water levels at the Barry Burn in conjunction with the high tide.

2.4 The above described flood events tested the remedial works already carried out at that time. In consequence further recommendations for additional investigations and remedial works are now detailed in this report.

**CURRENT POSITION**

3.1 A number of short-term and long-term recommendations were made following the flooding incident in mid August 2008 and were detailed in the “Report on Flooding Incident at
Carnoustie on 13/08/08, October 2008, Final Version” (August 2008 report), which was made available to this committee with Report 181/09. The Council has progressed the short term measures urgently required as described in Table 1 below and detailed in Appendix 1 to this report. The implementation of some of the previously recommended ‘Longer Term Measures’, which were reported to this committee previously, a number of which are dependent on the outcome of the short-term investigation measures, are described in section 4 of this report. The remainder of the Longer Term Measures previously reported to this committee will be considered at a later date and, as necessary and appropriate, will be the subject of future reports to Infrastructure Services Committee.

3.2 In addition to the above measures, a number of ‘new’ and additional recommendations have been made following the flooding incidents at the Barry Burn in Carnoustie in 2009. These are detailed in Tables 2 & 3 of this report respectively.

3.3 Collectively these measures represent significant improvements in the level of protection against flooding which is afforded to the properties in the western end of Carnoustie in the vicinity of the Barry Burn.

Table 1 Short-term Measures identified previously in Report 181/09

<table>
<thead>
<tr>
<th>Task Ref.*</th>
<th>Description</th>
<th>Completed</th>
<th>Remarks/Further Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>to <strong>carry out a CCTV survey</strong> at the culvert from the Waterybutts Ditch to the Barry Burn</td>
<td>yes</td>
<td>See Measure G of Table 3.</td>
</tr>
<tr>
<td>ii.</td>
<td>to fit a non return/reflux valve at the Waterybutts Ditch junction</td>
<td>yes</td>
<td>Works completed in August 2009.</td>
</tr>
<tr>
<td>iii.</td>
<td>to <strong>carry out dredging</strong> of the Barry Burn</td>
<td>yes</td>
<td>Dredging of 290m length and carry out 700m length of sediment removal completed February 2010.</td>
</tr>
<tr>
<td>iv.</td>
<td>to <strong>investigate</strong> allowing water to backflow through the existing culvert into the field northwest of the MacDonald Smith Drive road bridge</td>
<td>yes</td>
<td>See Measure F of Table 3.</td>
</tr>
<tr>
<td>v.</td>
<td>to <strong>investigate</strong> whether the curtilage drainage of the properties prone to flooding on the south side of MacDonald Smith Drive is connected to the surface water drainage system which connects to the pumping station in Harris Road and advise the respective residents accordingly</td>
<td>yes</td>
<td>Investigations with Scottish Water completed and letter issued in December 2010.</td>
</tr>
<tr>
<td>vi.</td>
<td>to <strong>investigate</strong> taking down the levee protecting the field on the south side of Waterybutts Ditch and west of MacDonald Smith Drive, to allow it to flood in preference to the residential area</td>
<td>yes</td>
<td>A topographical survey of the area has been carried out which shows that it is possible to create a floodwater storage area, however, given land ownership issues, it is proposed to defer pursuing this investigation further to allow more urgent measures to be given priority.</td>
</tr>
<tr>
<td>vii.</td>
<td>to <strong>ensure a system for monitoring</strong> the stage (water level) of the Barry Burn is in place, whereby a patrol team will monitor the condition of the levee during high stage (high water level) events</td>
<td>yes</td>
<td>During high flows/floods a patrol of the high risk areas is now in place. See Measure C of Table 3.</td>
</tr>
<tr>
<td>viii.</td>
<td>to <strong>review</strong> the emergency maintenance access routes and arrangements to ensure that all parts of the levee are accessible in an emergency</td>
<td>yes</td>
<td>A plan of emergency access points has been drawn up and is now included in the emergency plan for the Barry Burn. See Measure D of Table 3.</td>
</tr>
<tr>
<td>ix.</td>
<td>to <strong>ascertain the predicted peak stage</strong> of the burn from the existing hydraulic model of the burn for the peak 1 in 25 year flood event and compare this with the actual recorded peak stage for this flood</td>
<td>on-going</td>
<td>See Measure E of Table 3.</td>
</tr>
<tr>
<td>x.</td>
<td>to <strong>request a report</strong> from the Meteorological Office stating the storm rainfall return period for the night of 12 – 13 August 2008</td>
<td>on-going</td>
<td>Met Office reports have been received and reviewed. See Measure E of Table 3.</td>
</tr>
<tr>
<td>xi.</td>
<td>to <strong>carry out any remedial works resulting from investigation specifically to allow water to backflow through the existing culvert into the field northwest of the MacDonald Smith Drive road bridge</strong></td>
<td>not feasible</td>
<td>Alternative remedial works, as described in task iv above. See Measure F of Table 3.</td>
</tr>
<tr>
<td>xii.</td>
<td>to <strong>consider removal of sections of the existing levee protecting the (potato) field from flooding on the south side of Waterybutts Ditch</strong></td>
<td>yes</td>
<td>Not considered feasible due to land ownership.</td>
</tr>
<tr>
<td>xiii.</td>
<td>to <strong>provide advice to homeowners whose properties have been affected by seepage (i.e. those on the south side of the Barry Burn) on how to improve the resilience of these properties to seepage flooding</strong></td>
<td>yes</td>
<td>Advice provided via leaflets and public meetings. Intervention measure of sheet piles as alternative to previous proposed filter drain. See Measure A of Table 3.</td>
</tr>
<tr>
<td>xiv.</td>
<td>to <strong>investigate</strong> utilising the low lying playing fields to the northeast of the footbridge over the Barry Burn as a floodwater storage area</td>
<td>yes</td>
<td>Investigation has been completed, which concluded that the proposal should not be implemented and other measures should be given priority.</td>
</tr>
<tr>
<td>xv.</td>
<td>to <strong>ensure</strong> that Waterybutts Ditch is included in the annual watercourse inspection regime and that any debris found in the reach adjacent to the houses prone to flooding will be promptly cleared</td>
<td>yes</td>
<td>Now included in annual watercourse inspection regime and clearance works completed.</td>
</tr>
<tr>
<td>xvi.</td>
<td>to <strong>ensure</strong> that the length of levee identified as being prone to significant seepage should be the subject of regular annual inspection and inspection after high flows in the Barry Burn for any signs of instability or damage</td>
<td>yes</td>
<td>The whole flood prevention scheme is included in the annual inspection regime.</td>
</tr>
</tbody>
</table>
xvii. to **arrange** for Scottish Water’s drainage plans to be uploaded onto the Council’s GIS and be updated as necessary in conjunction with Scottish Water

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**Angus Council** has external access to Scottish Water’s GIS system and the necessary drainage plans have been obtained for the Barry Burn area of Carnoustie.

xviii. to **request** SEPA to deliver its Floodline Information Packs to all addresses whose properties or accesses were affected in the recent flooding incident in Carnoustie (August ‘08)

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**Yes** A press release was issued to inform residents how to obtain SEPA’s Floodline Information Packs.

3.4 Further to the September 2009 flooding incident a ‘new’ recommendation was made in addition to the short-term measures reported previously to the committee (Report 181/09). This measure is described below in Table 2, and detailed in Appendix 1 to this report, as item xix and has been progressed as follows:

**Table 2 Additional Short-term Measures not previously identified**

<table>
<thead>
<tr>
<th>Task Ref.*</th>
<th>Description</th>
<th>Completed</th>
<th>Remarks/Further Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>xix.</td>
<td>to install a suitable non-return valve and end-wall arrangement at the outlet of the previously unknown drainage pipe out-falling to the Barry Burn on the north side of the burn which is connected to the Ravensby Road surface water drainage system</td>
<td>yes</td>
<td>Investigations determined that this was a Scottish Water sewer, which was subsequently sealed to prevent any backflows from the Barry Burn occurring when its stage is high.</td>
</tr>
</tbody>
</table>

4 PROPOSALS

4.1 Further to the investigations and remedial works at the Barry Burn following the last three flooding incidents, the following on-going current and future measures are proposed to be carried out during financial years 2010/11 and 2011/12, see Table 3.

**Table 3 Current and Future Measures**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Cost Estimate</th>
<th>Proposed Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>To design and install sheet piles along the length of levee identified as being prone to significant seepage to protect the properties liable to flooding on the south side of MacDonald Smith Drive. It is proposed that the installation of the sheet piles will be undertaken in March 2011 and may be phased to run into financial year 2011/12 (see task xiii of Table 1).</td>
<td>£160,000</td>
<td>2010/11 &amp; 2011/12</td>
</tr>
<tr>
<td>B</td>
<td>To carry out remedial works to underpin the undermined flood wall at the north-west end of the FPS, identified as part of the inspection regime now being implemented (see task xvi of Table 1). Extensive scouring has caused the bed of the burn to drop below the footing of the flood wall, so undermining the footing for some 60m length of wall.</td>
<td>£45,000</td>
<td>2010/11</td>
</tr>
<tr>
<td>C</td>
<td>To continue the investigations to implement a multifunction flood warning system (see task vii of Table 1).</td>
<td>£15,000</td>
<td>2010/11</td>
</tr>
</tbody>
</table>
To create an Emergency Operational Flood Plan for the Barry Burn that includes contact details, emergency maintenance access routes, potential vulnerable areas and solutions that could be implemented in case of an emergency. The Emergency Operational Flood Plan should be available to: Angus Council Civil Contingencies Manager, Angus Council Roads Maintenance Manager and Angus Council Roads Supervisors.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>To determine the return periods of the flood events (i.e. using the catchment antecedent, rainfall and flow stage data which can be gathered for the storm events of August 2008, September 2009 and November 2009 and the resulting flooding incidents) in order to verify the existing river model and be satisfied that the FPS would provide flood protection from critical peak fluvial flows of 1 in 200 year return period (see tasks ix and x of Table 1).</td>
</tr>
<tr>
<td>E</td>
<td>To clean and fit a non-return valve and an end-wall at the outlet of the pipe through which the ditch discharges to the Barry Burn from the field northwest of the MacDonald Smith Drive road bridge. In addition and on completion of the cleaning of this pipe, arrangements should be made with the landowner to remove the embankment such that any overflow is not diverted onto the public road (reference alternative recommendation made in tasks iv and xi of Table 1).</td>
</tr>
<tr>
<td>F</td>
<td>To investigate and carry out remedial works to protect the exposed steel reinforcement from corrosion identified at the Waterybutts Ditch culvert by the CCTV operation (see task i of Table 1).</td>
</tr>
</tbody>
</table>
| G | To investigate the possibility of constructing a de-siltation pond upstream of the FPS and/or to develop a Barry Burn catchment management plan in conjunction with major landowners and other stakeholders, particularly SEPA. These studies are recommended in view of the high cost of and restrictions imposed by SEPA in the dredging operation carried out in February 2010 (see task iii of Table 1). It should also be noted that a condition of the complex licence granted by SEPA for the dredging operation required that “a report outlining the steps to be taken and the timescales involved to implement a more sustainable sediment management regime shall be submitted to SEPA by 31 December 2011”.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>To complete the investigations and implement a multifunction flood warning system for the Barry Burn (see task vii of Table 1 and Measure C of Table 3).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>To investigate and carry out remedial works to protect the exposed steel reinforcement from corrosion identified at the Waterybutts Ditch culvert by the CCTV operation (see task i of Table 1).</td>
</tr>
<tr>
<td>J</td>
<td>To resolve the issue of vegetation management on the levee channel of the Barry Burn during the bird nesting season and on the steep embankments (a health and safety concern) by ensuring the FPS has sufficient capacity to allow for this lower level of maintenance over the spring and summer months.</td>
</tr>
</tbody>
</table>

| Total Estimated Cost | £365,000 |

4.2 Measures C and D detailed above in Table 3, identified previously in Report 181/09, and Measures A and B have been subject to ongoing development throughout 2010.
4.3 Further investigations and studies may result from some of the measures detailed in Table 3 above, the costs of which cannot be estimated at present. In addition, the remainder of the Longer Term Measures reported to this committee previously remain under consideration, and as necessary and appropriate will be the subject of future reports to Infrastructure Services Committee.

5 FINANCIAL IMPLICATIONS

5.1 The total estimated cost of the proposed works identified in the preceding is £365,000. The cost of the measures being carried out within this financial year (2010/2011), as detailed in Table 3 above, including Council staff time, is estimated to be £190,000 and will be funded from available Roads Division budgets.

5.2 The cost of the measures identified to be carried out next financial year (2011/2012), as detailed in Table 3 above, including Council staff time, is estimated to be £175,000. These measures will be investigated, prioritised and implemented based on affordability and deliverability, and on available Roads Division budgets. Further consideration of future years funding to be allocated to those measures not implemented in financial year 2011/12 will be reported to a future meeting of the Infrastructure Services Committee.

5.3 As indicated in item 4.2 above the financial implications of further investigations and studies resulting from some of the measures detailed in Table 3 and others reported previously to this committee as Longer Term Measures cannot be estimated at present. Details of these any further costs arising will be presented to Committee in due course.

6 HUMAN RIGHTS IMPLICATIONS

6.1 The right to respect for private and family life, home and correspondence (Article 8) and peaceful enjoyment of property (Article 1 of the First Protocol) under the European Convention of Human Rights are now applicable under Scots’ Law.

Whilst flooding incidents undoubtedly impact upon individuals’ home, life and property rights, the proposals in this report do not result in any infringement by the Council of those Convention rights. Rather, they seek to allocate the Council’s resources towards protecting communities (and individuals’ Convention rights) from flooding insofar as those resources permit.

7 EQUALITIES IMPLICATIONS

7.1 The issues dealt with in this report have been the subject of consideration from an equalities perspective (as required by legislation). An equalities impact assessment is required.

8 SINGLE OUTCOME AGREEMENT

8.1 This report contributes to the following local outcomes contained within the Single Outcome Agreement for Angus.

- Good quality housing is available throughout Angus.
- Crisis response for homeless households is provided.
- The importance and benefits to society of the environment is recognised.

9 CONSULTATION

9.1 The Chief Executive, Director of Corporate Services, Head of Finance, Head of Law and Administration, and Head of Property were consulted in the preparation of this report.
10 CONCLUSION

10.1 To improve confidence in the flood protection provided by the Carnoustie (Barry Burn) Flood Prevention Scheme, a number of measures have been undertaken during the 2008/09 and 2009/10 financial years and further work has been identified to be undertaken within financial years 2010/11, and 2011/12 and future years subject to funding. It is estimated that the cost of these investigations and remedial works will be of the order of £190,000 in financial year 2010/11, and £175,000 in financial year 2011/12. It is likely that the work described will result in the identification and costing of further work required in the future.

ERIC S LOWSON
DIRECTOR OF INFRASTRUCTURE SERVICES

NOTE:
The following background papers, as defined by Section 50D of the Local Government (Scotland) Act 1973 (other than any containing confidential or exempt information), were relied on to any material extent in preparing this Report:-

Report 181/09 - Carnoustie (Barry Burn) Flood Prevention Scheme Investigations and Associated Proposed Works - Infrastructure Services Committee 3 March 2009

Roads/JG/WS/JS/GK
Further details of short-term measures

i. to carry out a CCTV survey at the culvert from the Waterybutts Ditch to the Barry Burn - COMPLETED;

A CCTV survey was commissioned in February 2009, but was then abandoned due to the depth of silt in the culvert. It was then re-commissioned following the dredging operation (see item (iii) of Appendix 1) and was successfully completed in March 2010. The CCTV survey showed that the culvert is in relatively good condition; the only minor defect recorded is the exposure of some steel reinforcement at one location on the top side of the culvert. As part of this measure, the accumulated silt was removed from the culvert.

Remedial works to protect the exposed steel reinforcement from corrosion are proposed to be carried out in the financial year 2011/12 (see measure G of Table 3).

ii. to fit a non return/reflux valve at the Waterybutts Ditch junction - COMPLETED;

During the flooding incident in August 2008, the field ditch, known as the Waterybutts Ditch, to the south of 8-32 MacDonald Smith Drive, overflowed due to a backflow up the Waterybutts Ditch from its culverted confluence with the Barry Burn, combined with the discharge from the ditch backing up. This resulted in flooding above the finished floor levels of house nos. 16, 20 & 24 and the gardens, garages and possibly solums of nos. 8-14, 18, 22 & 26-32 MacDonald Smith Drive. These appeared to have been the worst flooded properties of this flooding incident.

The report recommended the importance of a non-return valve being refitted to the outlet of the ditch culvert to prevent any more backflows occurring in the future (a non-return valve had been fitted under the original FPS but had been removed).

Following an in-depth investigation on the types of suitable non-return valves, an in-line rubber check valve was selected to be installed in the Waterybutts Ditch culvert outfall manhole to the Barry Burn. Works were satisfactorily completed in August 2009.

The performance of the valve has been successfully tested twice since its installation; during the 4 September and 1 November 2009 floods, with no backflow from the Barry Burn into Waterybutts Ditch occurring and no internal flooding of housing.

iii. to carry out dredging of the Barry Burn (dredge 290m length and carry out 700m length of sediment removal - i.e. for one half of the burn channel transversely) (as allowed by SEPA) - COMPLETED;

A number of problems and delays were encountered during the arrangement of the dredging works at the Barry Burn; these related to the licence that Angus Council had to obtain from the Scottish Environmental Protection Agency (SEPA) for the works. There were constraints in terms of the length and width of the channel that it would allow to be dredged, as well as to the disposal method of sediment that could potentially contain Himalayan Balsam seed (an invasive weed species). Despite this, Angus Council satisfactorily addressed these issues and the dredging works commenced on site at the beginning of December 2009 and were successfully completed by the end of February 2010.

iv. to investigate allowing water to backflow through the existing culvert into the field northwest of the MacDonald Smith Drive road bridge - COMPLETED;
This measure involved looking into utilising the field northwest of the MacDonald Smith Drive road bridge as a flood storage area by allowing water from the Barry Burn to backflow to this field via an existing culvert that links the Barry Burn with the field.

It was considered that the close proximity of the field would make it an ideal flood storage area at times of heavy rainfall when the stage of the Barry Burn is very high. However, the investigation showed that allowing water to backflow through the existing culvert into the field northwest of the MacDonald Smith Drive road bridge would not make an appreciable difference to the stage in the Barry Burn without the pipe diameter of the culvert being significantly increased. This is estimated to be very costly, at some 87m length, to be laid primarily beneath the paved road.

Initial discussions have taken place with the land owner to allow water to backflow through the existing culvert into his field northwest of the MacDonald Smith Drive road bridge. However, it seems he would rather have the field drained than have it as a flood storage area. It should be noted that the Council have recently been consulted on behalf of the landowner regarding the potential retail development of this field. From this and from initial discussions held, it would seem that the landowner would require a high value of compensation. It is therefore deemed that this measure is unlikely to be cost effective.

Although without the construction of additional containment embankments this field would only store approximately 1,900 m³ of flood water it may be that in the future this field could be utilised for flood storage, on its own or in conjunction with other potential areas (see Longer Term Measure No. 8 of the Aug-08 report).

In the meantime, it is recommended that the pipe through which the ditch discharges is cleaned out and has a non-return valve and protective end-wall fitted to its outlet. In addition and on completion of the cleaning of this pipe, arrangements should be made with the landowner to remove the embankment that he appears to have constructed along MacDonald Smith Drive such that any overflow from the ditch is not diverted onto the public road (see Measure F of Table 3).

v. to investigate whether the curtilage drainage of the properties prone to flooding on the south side of MacDonald Smith Drive is connected to the surface water drainage system which connects to the pumping station in Harris Road and advise the respective residents accordingly - COMPLETED;

Initial investigations have taken place on the above properties that established that the curtilage drainage of house nos. 26 to 32 is connected to the surface water drainage system which connects to the pumping station in Harris Road; however, the connection of the curtilage drainage of house nos. 16 to 24 has not been established yet. Both the planning department and the building control department of Angus Council as well as Scottish Water have been consulted. However, none of these organisations hold records or plans of the drainage arrangements/connections of these properties. Although it would seem logical that house nos. 16 to 24 are also connected to the surface water drainage system, as all the houses seem to have been built around the same time, there is no evidence of any such connections. Nor, for that matter, are there any visible connections to the Waterybutts Ditch.

As a result of the above investigations, a letter has been sent to house nos. 16 to 24 to inform them of the results of these investigations and to advise them to forward copies of any drainage plans of their property to Angus Council. Alternatively, they have been advised to contact Scottish Water to make arrangements for their properties to be connected to the surface water drainage system which connects to the pumping station in Harris Road.

vi. to investigate taking down the levee protecting the field on the south side of Waterybutts Ditch and west of MacDonald Smith Drive, to allow it to flood ahead of the residential area - COMPLETED .
With respect to this investigation, a topographical survey of the area has been carried out that shows that it is possible to create a floodwater storage area. Also initial discussions have taken place with the current landowner who, contrary to allowing this field to be utilised as a flood storage area, wishes to develop the field for residential use. It is estimated that same 1500m$^3$ of flood storage is available when the stored floodwater level reaches 20cm below the finished floor level of the lowest adjacent homes. However, given the apparent opposition of the landowner (including the high value of compensation likely to be required) as well as the apparent success of the non-return valve, installed in the Waterybutts Ditch culvert in protecting housing from flooding, it is proposed to defer pursuing this investigation further to allow more urgent measures to be given priority.

vii. to ensure a system for monitoring the stage (water level) of the Barry Burn is in place, whereby a patrol team will monitor the condition of the levee during high stage (high water level) events - COMPLETED;

During high flows/floods a continuous patrol of the high risk areas is in place. Angus Council’s Civil Contingencies Manager co-ordinates the council’s relevant departments (e.g. Roads Division, who in turn contact the emergency works contractor, Tayside Contracts, TC for the supply of sandbags and signs) Police, Fire & Rescue Service, SW and SEPA. Both incidents in 2009 tested the emergency procedures that were in place at the time of the incidents.

However, as suggested in item 8 (iii) of the Aug-08 report, it is now recommended that Longer Term Measure No. 2, to “investigate implementing a multifunction flood warning system” be carried out. Such a system could both warn better the levee monitoring patrol team that the river stage is high and provide useful hydrological (flow and rainfall) data with which to verify the hydrology on which the FPS standard of protection is based (see also items (ix) and (x) of Appendix 1). In furthering Longer Term Measure No. 2 therefore, initial discussions and site visits have taken place with SEPA and a specialist flood warning and hydrology data system supplier. Early problems identified are: finding a system that would significantly increase the period of flood warning prior to a potential flood; that would be simple and relatively low cost to calibrate, operate and maintain; and finding a suitable, safe and accessible location to site the system apparatus with the approval of the relevant landowners (see Measure J of Table 3).

viii. to review the emergency maintenance access routes and arrangements to ensure that all parts of the levee are accessible in an emergency, particularly the levee between the MacDonald Smith Drive road bridge and the footbridge. Actions would then be planned to ensure that all lengths of the levees will be accessible for emergency repair works and the findings of this review could then be incorporated into the recommended Emergency Flood Plan for the Barry Burn, as per item 1 of the Longer Term Measures (“Aug-08” report) – see Measure D of Table 3 - COMPLETED;

The emergency maintenance access routes have been reviewed in order to ensure that all parts of the levee are accessible in an emergency. In particular, a plan of emergency access points has been drawn up and is now included in the emergency plan for the Barry Burn (see Aug-08 report Longer Term measure no. 1)

ix. to ascertain the predicted peak stage of the burn from the existing hydraulic model of the burn for the peak 1 in 25 year flood event and compare this with the actual recorded peak stage for this flood. Should the predicted burn stage be significantly lower than the observed peak stage, it is recommended that the return period of the flood event be verified by carrying out the more thorough flood study recommended in Longer Term Measures, item 3 (“Aug-08” report) – ONGOING INVESTIGATIONS;

Although the peak flow, from the flow records for the nearby Monikie Burn, was estimated by SEPA to be very roughly equivalent to that of the 1 in 25 year return period, the river model of the Barry Burn, still needs to be simulated for the August 2008 flood event for comparison of the observed and predicted water levels. It is recommended that this study be expanded to cover the flood events of 3rd – 4th September 2009 and 1st
November 2009; the return periods of these flood events were estimated by SEPA very roughly to be 1 in 16 and 1 in 5 year return period, respectively. A topographic survey has been carried out to verify the current model of the burn.

This measure is linked with longer term measure 3 in the “Aug-08” report and is proposed to be carried out in the next financial year (see Measure E of Table 3).

t. to request a report from the Meteorological Office stating the storm rainfall return period for the night of 12 – 13/08/08. Should the Met Office report find that the rainfall return period is significantly shorter than that which is expected for the storm in question (i.e. approximately 1 in 25 year return period for the Aug-08 event) it is again recommended that the return period of the flood event be verified as recommended in item 3 of the Longer Term Measures (“Aug-08” report) - ONGOING INVESTIGATIONS;

The reports from the Met Office have now been received and they include data for the Aug-08, Sept-09 and Nov-09 flooding incidents. Although, the rainfall return periods for all the storm events appear to be significantly shorter than that which was expected for the storms in question there are significant anomalies both in the rainfall radar data and in the measured rainfall given for all three storm events which need to be clarified with the Met Office. It should also be noted that in order to proceed with the now recommended Longer Term Measure No. 3 (in view of the additional 2 flood events which occurred only a year later than the Aug-08 event) the anomalies with the rainfall data supplied by the Met Office also need to be clarified, as this data is a fundamental requirement in determining the flood events’ return periods (see Measure E of Table 3).

xi. to carry out any remedial works resulting from this year’s investigation to allow water to backflow through the existing culvert into the field northwest of the MacDonald Smith Drive road bridge, in consultation with the affected landowner (see item (iv) of Appendix 1) – THIS PROPOSAL IS NOT DEEMED TO BE FEASIBLE;

Alternative remedial works, as described in item (iv) of Appendix 1, are proposed to be carried out within the next financial year (see Measure F of Table 3).

xii. to consider removal of sections of the existing levee protecting the potato field from flooding on the south side of Waterybutts Ditch, in consultation with the landowner, in order to improve the level of flood protection to the housing opposite. This is dependent on the outcome of this year’s investigation into the benefit of so doing - (see item (vi) of Appendix 1) - THIS PROPOSAL IS NOT DEEMED TO BE FEASIBLE;

This measure cannot be taken forward primarily due to the apparent unwillingness of the new landowner to allow this field to be used for flood storage (see item (vi) of Appendix 1).

xiii. to provide advice to homeowners whose properties have been affected by seepage (i.e. those on the south side of the Barry Burn) on how to improve the resilience of these properties to seepage flooding - COMPLETED;

In addition to the informing homeowners of how they can obtain SEPA’s Floodline Information Packs, meetings were organised with individual homeowners to discuss how best they could alleviate flood risk to their properties from seepage flooding. It should also be noted that a Carnoustie Flooding Issues – Information update meeting was held on 25/10/10 at which a presentation was given by the Head of Roads and a further Carnoustie Flood Information Event was held on 24/05/10 in conjunction with the Carnoustie Community Council, at which a representative of the Scottish Flood Forum was available to address seepage concerns.

With respect to the seepage problem, particular the increasing extent of seepage witnessed in the 2009 floods, and in view of the narrow width of the levee located on the south side of the Barry Burn between MacDonald Smith Drive Road Bridge and the western end of the plastic sheet piles (about 100m upstream of the footbridge) it has now
been decided to install steel sheet piles along this length (see Measure A of Table 3). This is an alternative to carrying out Longer Term Measure No. 10 (investigating the possibility of installing a filter drain along this reach).

xiv. to investigate utilising the low lying playing fields to the northeast of the footbridge over the Barry Burn as a floodwater storage area, and then devise and implement a proposal to do the same, should it be found feasible to do so - THIS PROPOSAL IS NOT DEEMED COST EFFECTIVE;

Preliminary investigations have shown that these fields, adjacent to Burnside Primary School, could store some 300m$^3$ of floodwater. However, there are health and safety issues with respect to the depth of water being potentially stored (approximately 1m) and the potential contamination of this floodwater with raw sewage, as occurred in the September 2009 flood, that would be difficult to solve in a cost effective manner. Given that the major cause of flooding to the Ravensby Road and Thomas Street areas for the August 2008 and September 2009 floods was rectified prior to the November 2009 flood it has been decided not to proceed with this investigation so that more urgent measures can be given priority.

xv. to ensure that Waterybutts Ditch is included in the annual watercourse inspection regime and that any debris found in the reach adjacent to the houses prone to flooding will be promptly cleared - COMPLETED;

The collapsed fence at the end of the cul-de-sac has now been removed and this reach of the Barry Burn is now included in the annual inspection regime.

xvi. to ensure that the length of levee identified as being prone to significant seepage should be the subject of regular annual inspection and inspection after high flows in the Barry Burn for any signs of instability or damage - COMPLETED;

The length of levee identified as being prone to significant seepage was inspected after the August 2008 flood and again after the September and November 2009 flood events. The whole flood prevention scheme is included in the annual inspection regime (see Measure A of Table 3).

xvii. to arrange for Scottish Water’s drainage plans to be uploaded onto the Council’s GIS and be updated as necessary in conjunction with Scottish Water – ONGOING DISCUSSIONS; and

A digital data request form has been submitted to Scottish Water on 22 July 2009 to upload Scottish Water’s GIS data into Angus Council’s GIS system. A reply has not been received yet. A request has been made for Angus Council’s GIS Data Co-ordinator to follow this up.

Currently, Angus Council has external access to Scottish Water’s GIS system and the necessary drainage plans have been obtained for the Barry Burn area of Carnoustie. This measure is therefore no longer a priority with respect to addressing the flooding problems associated with the Barry Burn in Carnoustie.

xviii. to request SEPA to deliver its Floodline Information Packs to all addresses whose properties or accesses were affected in the recent flooding incident in Carnoustie (August ’08) - COMPLETED.

A press release was made by Angus Council to inform residents how to get SEPA’s Floodline Information Packs. This is thought to be sufficient to fulfil this measure.

xix. Install a suitable non-return valve and end-wall arrangement at the outlet of the previously unknown drainage pipe out-falling to the Barry Burn on the north side of the burn which is connected to the Ravensby Road surface water drainage system to
prevent any backflows from the Barry Burn occurring when its stage is high - COMPLETED;

Preliminary remedial measures were taken to temporarily block this pipe when it was discovered shortly after the Sept-09 flood which proved successful in significant reducing the extent of flooding on the north side of the burn during the November 2009 flood.

Following the investigation of this drainage pipe and discussions with Scottish Water, it was established that this pipe was part of Scottish Water’s drainage system, though it was not shown on Scottish Water’s plans. Scottish Water then permanently sealed this pipe with a ‘pipe stopper’ as it was superfluous to its drainage requirements. This should now prevent any back flows from the Barry Burn to the Ravensby Road surface water drainage system.