



OFFICE OF PUBLIC WORKS

REVIEW OF THE SOUTH GALWAY FLOOD STUDY REPORT

REVIEW OF THE RECOMMENDATIONS & CONCLUSIONS OF THE MANNIN CROSS, KILCHREEST & TERMON 2003 FLOOD ALLEVIATION SCHEMES

FINAL – DECEMBER 2010

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OFFICE OF PUBLIC WORKS

REVIEW OF THE RECOMMENDATIONS & CONCLUSIONS OF THE MANNIN CROSS, KILCHREEST & TERMON 2003 FLOOD ALLEVIATION SCHEMES

EXECUTIVE SUMMARY

Jennings O'Donovan & Partners (JOD) were appointed in July 2010 by the Office of Public Works (OPW) as Consulting Engineers to Review the recommendations of the South Galway Flood Study Report dated April 1998. Included in the brief was the review of the recommendations and conclusions of the February 2003 Report on Mannin Cross, Kilchreest and Termon Flood Alleviation Schemes.

BACKGROUND

The area in the immediate vicinity of Termon Lough referred to as Termon South in this Report and an extensive area north of Termon Lough in the townlands of Termon, Ballyboy and Lisheen, referred to as Termon North in this Report, have been subjected to flooding over extended periods of time. A possible Drainage Scheme was first investigated under the April 1998 South Galway Flood Study Report for both the Termon North basin and the Termon South basin and subsequently refined under Design Review Reports carried out in May 2000 and February 2003. However, it was not proceeded with at the time because of concerns in relation to potential environmental constraints. Under this Report which follows severe flooding in November 2009, the Termon Flood Alleviation Scheme is further investigated and in particular, a possible alternative Drainage Scheme at Termon North identified by local landowners is considered. At Termon South, a piped and open channel system was recently constructed by local landowners following the November 2009 floods. This Termon South piped and open channel system is also investigated under this Report.

As part of the April 1998 South Galway Flood Study Reports, several possible localised flood alleviation schemes were also identified throughout the Slieve Aughty Catchment including the Mannin Cross Flood Alleviation Scheme and the Kilchreest Flood Alleviation Scheme. These schemes were refined under the Design Review Reports carried out in May 2000 and February 2003. The possibility of diverting water directly from both the Mannin Cross and the Kilchreest areas to the Aggard Stream Tributary was investigated but not proceeded with at the time because of concerns in relation to hydrological constraints. More recently, a flood study on the Aggard Stream and the Dunkellin River system was carried out by Tobin Consulting Engineers following the November 2009 floods and finalised in June 2010. The Mannin Cross and Kilchreest Flood Alleviation Schemes were further investigated under this report based on the findings of the June 2010 flood study.

ASSESSMENT OF THE TERMON FLOOD ALLEVIATION SCHEMES

A survey was carried out on the 1st of October 2010 to assess the piped and open channel system recently constructed by the local landowners to drain Termon South. At the upstream end, the channel starts at Termon South adjacent to the local road. The high level overflow at the intake structure is set at a level of 22.75mOD Malin Head. An inspection chamber located across the road was assessed as having an invert level of 22.47mOD. There is a 450mm diameter piped outlet from the chamber which extends out from the chamber in a southerly direction for a distance of approximately 135 metres and discharges then into a newly constructed open channel. The channel embankments are formed from excavated material and the bed shows evidence of rock excavation in places. The bed profile of the channel indicates that the overall gradient is 1 in 129 approximately. The associated peak flow was assessed as being 283 l/s. Another survey carried out on the 13th of December 2010 indicated that the piped and open channel system drains excess waters from Termon South to Lough Attyslany and Lough Bunny which are both located within designated areas. A peak flow of 283 l/s is considered significant and could alter the frequency/duration pattern on Lough Attyslany and, to a smaller extent, on Lough Bunny. An alteration of the frequency/duration pattern of water levels and the mixing of waters could have ecological impacts on both lakes which are located within designated areas. Further assessment indicated that the newly built piped and open channel system at Termon South could feasibly be extended to discharge to Lough Doo as originally investigated under the April 1998 South Galway Flood Study Report.

At Termon North, a possible alternative Flood Alleviation Scheme was identified by landowners. It involves the construction of a high level overflow structure which could be located at the southeastern part of the Termon North basin. Based on a survey of the High Water Mark carried out by JOD in October 2010, the upstream overflow structure could be set at a level of 22.90 mOD which is 1.5m higher than the originally proposed intake level of 21.40mOD (February 2003 Design Review). From the overflow structure, excess waters could feasibly discharge to a 375mm diameter gravity pipe 600 metres in length. This pipe would subsequently discharge into an existing open channel which is a tributary to the Lurga River. The vertical profile shows that excavations of up to 6.1 metres would be required at the upstream section of the possible alternative scheme. This represents significant depths and as a result, increased excavation costs. As an alternative, a pumped option was considered and found technically feasible. It would involve an alteration of the intake structure to allow for a pump sump. Two mobile diesel pumps would be stored at the OPW offices and brought on site when required.

ASSESSMENT OF THE MANNIN CROSS & KILCHREEST FLOOD ALLEVIATION SCHEMES

It has been identified in the 2000 Design Report on the Mannin Cross Flood Alleviation Scheme that the possible drainage channel would allow a discharge of 1.30 m³/s at peak times into the Aggard Stream. The June 2010 Tobin Report design model allows for a contributory flow of 21.60 m³/s from the Aggard Stream to the Dunkellin River System. The flow of 21.60 m³/s does not include the proposed 1.30 m³/s discharge from Mannin Cross referenced above. Allowing for a design flow of 21.60 m³/s from the Aggard Stream, the June 2010 Tobin Report concludes that water levels in the Dunkellin River System will remain high particularly at the downstream end. The addition of a further 1.30 m³/s from the proposed Mannin Cross Scheme could increase water levels on the Dunkellin River System. The proposed additional amount of inflow of 1.30 m³/s could impact negatively on the Aggard Stream and on the Dunkellin River System.

Similarly, for the proposed Kilchreest Flood Alleviation Scheme, additional discharges could have downstream effects on the Dunkellin River System.

In addition to the possible negative hydrological impacts for both the Mannin Cross and the Kilchreest Flood Alleviation Schemes, the mixing of water could have possible ecological impacts on the Rahasane turlough SAC located within the Dunkellin catchment.

COST ESTIMATES & COST BENEFIT ANALYSIS

Costs estimates for Termon, Mannin Cross and Kilchreest Flood Alleviation Schemes were revised from the original estimates carried out in previous studies to reflect 2010 prices and alterations in the designs. Estimates were subsequently assessed from a cost benefit point of view based on the detailed assessment of benefits carried out as part of the April 1998 South Galway Flood Study Report. The cost benefit analysis carried out at the time involved the calculation of the net benefit over a 52 year project life cycle. The construction costs are assumed to be incurred in Year 1. This is followed by 50 years of benefits and a residual value for the capital works was included in the final year. The results, revised to reflect 2010 prices and changes in the design, are as follows :

	Possible Flood Alleviation Schemes	Capital Costs (includes VAT)	Benefit
1.	Original Termon North to Termon South to Lough Doo Alleviation Scheme	€771,500.00	POSITIVE
2.	Alternative Drainage Scheme at Termon North <u>Gravity Option</u>	€361,270.00	POSITIVE
3.	Alternative Drainage Scheme at Termon North <u>Pumped Option</u>	€347,460.00	POSITIVE
4.	Termon South to Lough Doo – extension of the piped and open channel system	€384,853.00	POSITIVE
5.	Mannin Cross Flood Alleviation Scheme	€1,258,500.00	POSITIVE
6.	Kilchreest Flood Alleviation Scheme <u>Option 1</u> - Open Channel Route from Owenshree River to Aggard Stream Tributary	€2,866,600.00	POSITIVE
7.	Kilchreest Flood Alleviation Scheme <u>Option 2</u> - Open Channel and Closed Culvert Route from Owenshree River to Aggard Stream Tributary	€4,093,900.00	NEGATIVE
8.	Kilchreest Flood Alleviation Scheme <u>Option 3</u> - Kilchreest Control and Diversion Structure	€8,545,800.00	NEGATIVE

As can be seen above, benefits were found to be positive for all schemes apart from Kilchreest – Option 2 and Kilchreest – Option 3.

CONCLUSION & RECOMMENDATIONS

Termon Flood Alleviation Schemes :

The proposals to drain Termon North and Termon South were found to be technically feasible and beneficial from a financial point of view.

At Termon South, it is recommended that the piped and open channel system recently constructed by the landowners be monitored and that further ecological investigation be carried out on Lough Attyslany and Lough Bunny. Should negative ecological impacts be found, the newly built piped and open channel system constructed by the local landowners at Termon South could feasibly be extended to discharge to Lough Doo as originally proposed under the April 1998 South Galway Flood Study Report.

At Termon North, an alternative drainage scheme was identified and deemed technically feasible. It is also recommended that further ecological assessment be carried out prior to advancing to construction.

Mannin Cross & Kilchreest Flood Alleviation :

The proposals for Mannin Cross and Kilchreest (Option 1) Flood Alleviation Schemes were found to be technically feasible and beneficial from a financial point of view.

It has been identified that the proposed additional amount of inflow from both schemes could have possible downstream effect on the Aggard Stream and on the Dunkellin River System. It is therefore proposed that the model built under the June 2010 Flood Study on the Dunkellin catchment by Tobin Consulting Engineers be re-run to assess the hydrological impacts of the Mannin Cross and Kilchreest possible flood alleviation schemes prior to advancing to construction. It is also proposed to carry out an ecological assessment to assess potential impacts on the Dunkellin catchment.



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APPENDIX B: PHOTOS

1. INTRODUCTION & BACKGROUND / HISTORICAL FLOODING EVENTS

1.1 INTRODUCTION

Jennings O'Donovan & Partners (JOD) were appointed in July 2010 by the Office of Public Works (OPW) as Consulting Engineers to Review the recommendations of the South Galway Flood Study Report dated April 1998. Included in the brief was the review of the recommendations and conclusions of the February 2003 Report on Mannin Cross, Kilchreest and Termon Flood Alleviation Schemes.

1.2 SCOPE OF WORKS

This report focuses on Items 1.2 and 1.3.4 of the Scope of Works. Under Item 1.2, JOD are required to review the recommendations and conclusions of the February 2003 Report on Mannin Cross, Kilchreest and Termon Flood Alleviation Schemes. The specific requirements for JOD as outlined in Item 1.2 of the scope of works are as follows :

- “Review the Design Report for the Mannin Cross Flood Alleviation Scheme.
- Review the Design Report and the three options outlined for the Kilchreest Flood Alleviation Scheme.
- Review the Preliminary Design Report and Preliminary Ecological Assessment for the Termon Flood Alleviation Scheme.
- Assess works carried out by landowners in Termon, and also consider the viability of a pumped alternative option.
- Review the conclusions for the Mannin Cross Flood Alleviation Scheme, Kilchreest Flood Alleviation Scheme and Termon Scheme as presented to the Steering Committee in February 2003.
- Bring forward proposals for minor works scheme at Termon if appropriate. (This does not include Habitats Directive Assessment or the planning aspects of a new works scheme as any such scheme is not defined at this stage).
- Preparation of report and recommendations with outline drawings as necessary.
- Identification of environmental constraints, if any.”

Under Item 1.3.4, JOD are required to update the 2003 cost estimates and develop new cost estimates for Mannin Cross, Kilchreest and Termon Flood Alleviation Schemes.

1.3 BACKGROUND / HISTORICAL FLOODING EVENTS

Based on the information on flooding available on the OPW website www.floodmaps.ie, there are records in relation to historic flood events in the Mannin Cross and Termon areas:

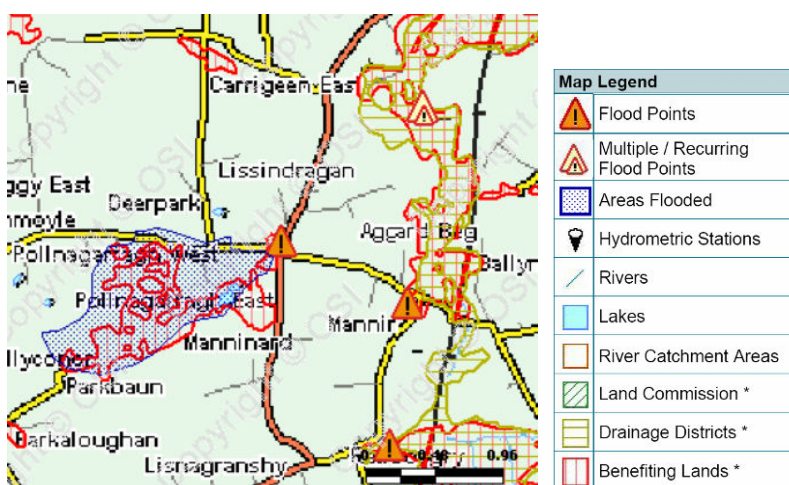


Figure 1.1 : Mannin Cross Area



Figure 1.2 : Termon Area

As can be seen above, large areas in Termon and Mannin Cross are prone to flooding. Based on the Report on Flooding in South Galway in 1994 prepared by the Office Of Public Works in May 1994, 81 hectares of lands were flooded in Termon and flood levels were recorded as follows :

Location	1990 Flood level	1994 Flood level	2009 Flood level (Estimation)
Termon – Between Termon North & Termon South adjacent	23.93m OD Malin	23.95m OD Malin	>23.68m OD Malin

Based on the Report on Flooding in South Galway in 1994 and on discussions with local landowners in Termon, it is understood that one house flooded during the 1990 and 1994 floods. The same house flooded again in 1995 and in November 2009 and a newly built house was also at risk of flooding in November 2009 which indicates that flood levels in November 2009 were above the 23.68m OD Malin mark. In Termon as well as in Mannin Cross, a number of local roads were impassable in 1990, 1994, 1995 and 2009, causing detours of up to five miles and as a result, disruptions for the local community. School bus services were affected and farmers experienced difficulties in accessing agricultural lands adjacent to the flooded areas both in the 1990s floods and in the 2009 floods.

In relation to the Kilchreest area, a site was identified under the April 1998 South Galway Flood Study Report as being technically suitable for the construction of a water retaining structure on the Owenshree River, for the purpose of alleviating flooding downstream. The Owenshree River is one of the three main rivers draining to the Coole / Caherglassaun / Kinvarra system via Kiltartan adjacent to Gort. Flooding at Kiltartan and between Coole and Kinvarra is being investigated under a separate report.

2. DATA AVAILABLE AND METHODOLOGY USED

2.1 COLLECTION OF DATA

Information on historic flood events was sourced from the OPW National Flood Hazard Mapping website (www.floodmaps.ie) as well as from the following studies and surveys :

- An Investigation of the Flooding Problems in the Gort – Ardrahan Area of South Galway – April 1998 Final Report – Jennings O’Donovan & Partners / Southern Water Global
- Study to identify practical measures to address flooding on the Dunkellin River including the Aggard Stream – June 2010 – TOBIN Consulting Engineers
- Presentation to the Steering Committee – 21 February 2003 – Mannin Cross Flood Alleviation Scheme – Kilchreest Flood Alleviation Scheme – Termon Flood Alleviation Scheme
- A Report on the Flooding in the Gort – Ardrahan Area – January 1992 – Geological Survey of Ireland
- Report on Flooding in South Galway in 1994 – May 1994 – OPW
- Report on the November 2009 rainfall in Ireland – Met Eireann website (www.met.ie)

Aerial photographs of the November 2009 floods as well as the mid and late 1990s floods in the study area were provided by the OPW.

2.2 METHODOLOGY

In addition to the data collected from previous studies and surveys as outlined above, JOD carried out a detailed topographical survey in the Termon Area using a GPS ProMark 500. The survey was carried out on the 1st of October 2010. The following was recorded :

- **Invert levels, left & right bank levels as well as cross sectional geometry of :**

- **Drainage pipework & channel recently constructed by local landowners at Termon South,**
- **Existing drainage channel discharging into the Lurga River to the Southeast of Termon.**
- **Condition of the above channels (blockages, structural restrictions and over grown areas).**
- **High water mark contour survey at Termon North.**
- **Water levels on the day of the survey (01/10/2010).**
- **Ground levels to the Southeast of Termon North to design a technically possible drainage route identified by landowners.**

An additional survey was carried out on the 13th of December 2010 between Termon Lough and Lough Bunny to further investigate the drainage pipework & channel recently constructed by local landowners at Termon South.

The above data was subsequently processed and an assessment of the current drainage characteristics in the Termon area was carried out in conjunction with a team led by Mr. Paul Johnston, Trinity College Dublin (TCD).

The possible Mannin Cross and Kilchreest drainage alleviation schemes are assessed from an hydrological point of view in this Report based on a recently published Flood Study Report entitled “Study to identify practical measures to address flooding on the Dunkellin River including the Aggard Stream – June 2010 – TOBIN Consulting Engineers”. The Mannin Cross and Kilchreest drainage alleviation schemes are also investigated from an environmental point of view under this Report.

3. **TERMON FLOOD ALLEVIATION SCHEME**

The area in the immediate vicinity of Termon Lough referred to as Termon South in this Report and an extensive area north of Termon Lough in the townlands of Termon, Ballyboy and Lisheen, referred to as Termon North in this Report, have been subjected to flooding over extended periods of time, particularly in the last 20 years. The location of both the Termon North and Termon South basins is shown in Figure No.3.1 below.

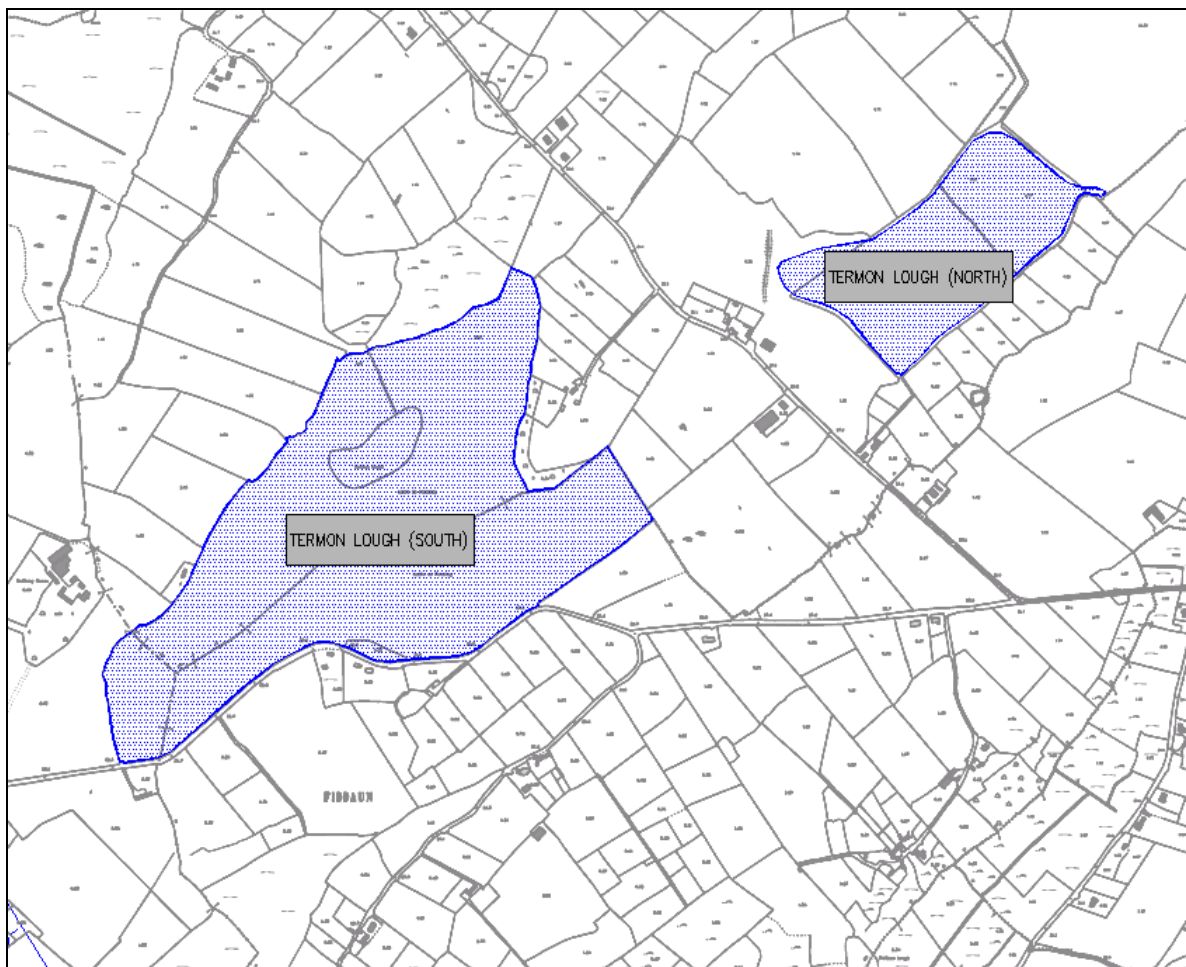


Figure No.3.1 – Location of Termon North and Termon South basins

3.1 ASSESSMENT OF THE DRAINAGE WORKS CARRIED OUT BY LANDOWNERS AT TERMON SOUTH

3.1.1 Channel Alignment Description

The horizontal alignment of this channel recently constructed by the local landowners to drain Termon South is shown on Drawing 4721/EP/02 attached as Appendix A. At the upstream end, the channel starts at Termon South adjacent to the local road. At the time of the first site survey carried out on the 1st of October 2010, the outlet structure was not built yet and it is believed that pipes were left with a blank end buried under a significant amount of material as shown on Photo No4 below. On the 13th of December site survey, the outlet structure had been built as shown on Photo No33 below :

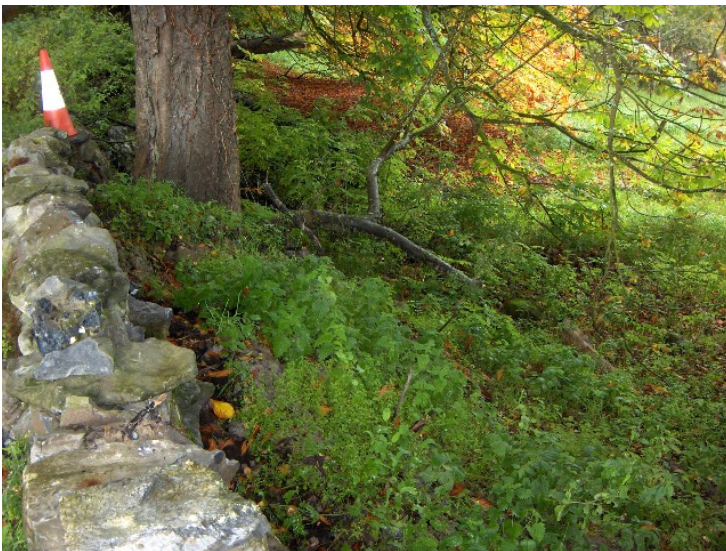


Photo No4 – Looking upstream at the location of the overflow structure on the 1st of October 2010

Refer to Drawing No. 4721/EP/02 for the exact location



Photo No33 – Looking upstream at the location of the overflow structure on the 13th of December 2010

Refer to Drawing No. 4721/KB/02 for the exact location

A chamber located across the road from the overflow structure was inspected on the 1st of October 2010 :



*Photo No5 – Inspection Chamber located
across the road from the overflow structure
Refer to Drawing No. 4721/EP/02 for the exact
location*



*Photo No6 – 450mm outlet PE pipe from the
chamber
Refer to Drawing No. 4721/KB/02 for the exact
location*

At the time of the second site survey carried out on the 13th of December 2010, further works had been carried out and the above chamber was found buried as shown on the photographs overleaf :



Photo No34 – Inspection Chamber located across the road from the overflow structure. The cover of the chamber was found buried on the 13th of December 2010.

Refer to Drawing No. 4721/EP/02 for the exact location

There is a 450mm diameter piped outlet from the chamber as may be seen on Photo No.6. The 450mm diameter PE pipe extends out from the chamber in a southerly direction for a distance of approximately 135 metres and discharges then into a newly constructed open channel as illustrated in the photographs overleaf :



*Photo No11 – Open channel downstream from the
piped section – Upstream end*

*Refer to Drawing No. 4721/EP/02 for the exact
location*



*Photo No7 – Open channel downstream from the
piped section – Downstream end*

*Refer to Drawing No. 4721/KB/02 for the exact
location*

The open channel is 0.5 metres in depth and 2.0 to 2.5 metres wide with side slopes on average at 1/1. It is approximately 190 metres long and discharges into low lying grounds. Overgrowth in these low lying areas primarily consists of rushes and other vegetation associated with wetlands.

3.1.2 Assessment Of Drainage Scheme Flow Transfer Capacity

The channel embankments are formed from excavated material. The bed shows evidence of rock excavation in places, particularly along the upstream part of the open channel section.

The bed profile of the channel ranges from a height of 22.47mOD at the upstream inspection chamber adjacent to the local road, to 19.89mOD at the downstream section. The overall length of the channel is 334 metres which gives an overall gradient of 1 in 129 approximately. Table 3.1 below gives an indication of flow transfer capacity at this particular gradient of 1 in 129 :

	Flow Transfer Capacity (l/s)
Piped Section / 450mm dia. PE Pipe	283 l/s
Open Channel Section	1,060 l/s
Overall Flow Transfer Capacity	283 l/s

Table 3.1 : Flow Transfer Capacity – Termon South Drainage Channel

The Termon South piped and open channel system built during the second half of 2010 by the local landowners has been assessed as having a flow transfer capacity controlled by the underground section at 283 l/s. The high level overflow at the Termon South intake structure is set at a level of 22.75m O.D. Malin Head.

3.1.3 Impacts of the drainage works at Termon South on Lough Attyslany & Lough Bunny

In order to identify the ultimate discharge point of the Termon South piped and open channel system, further surveying works were carried out on the 13th of December 2010. The route and results of this survey are available on Drawings 4721/EP/02 and 4721/EP/05 appended. The newly built Termon South piped and open channel system discharges to a local depression which is waterlogged throughout the year and prone to flooding in winter as illustrated in the photographs overleaf.



Photo No06 – Local depression / area prone to flooding at the downstream end of the piped and open channel system

Refer to Drawing No. 4721/EP/02 for the exact location



Photo No35 – Local depression / area prone to flooding further downstream

Refer to Drawing No. 4721/KB/02 for the exact location

This depression is drained by a number of ditches generally orientated in a southeasterly direction and ultimately discharging to lough Attyslany located approximately 2,350 metres from Termon South. As indicated on the ground profile detailed on Drawing 4721/EP/05, there are a number of depressions and areas liable to flooding between Termon South and Lough Attyslany ; top water levels taken at various locations showed a gradual drop between Termon North and Lough Attyslany and further investigation in the area on the 13th of December 2010 did not find any possible alternative surface water outlet. There is a road crossing halfway between Termon South and Lough Attyslany and although no culvert was found to cross under the road, there is evidence that water drains through the road and overgrown vegetation could hide an old culvert :



*Photo No36 – Pond immediately upstream from a local road crossing –
Movement of water towards the road indicates that an old culvert / drainage
structure could be underwater or hidden within overgrown vegetation
Refer to Drawing No. 4721/EP/02 for the exact location*

Lough Attyslany covers an area of 2.8 hectares. Although no outlet was found on the 13th of December 2010, there is evidence on a road adjacent to the lake that water occasionally flows over a local road to Creggaunycahill in a southeasterly direction as shown on photograph No.38 overleaf.



Photo No38 – One of the 22 water passes recently cleaned and unblocked on the side of the local road to Creggaunycahill (adjacent to Lough Attyslany).

Refer to Drawing No. 4721/EP/02 for the exact location

As illustrated on photograph No.38, 22 “water passes” were identified on the local road from Lough Bunny to Creggaunycahill. Under heavy and/or prolonged rainfall events, excess waters from Lough Attyslany flow over the road and reach a flood plain surrounding Lough Bunny.

3.1.4 Summary

The survey carried out on the 13th of December 2010 indicates that the piped and open channel system constructed by the local landowners drains excess waters from Termon South to Lough Bunny. The associated peak flow was assessed as being 283 l/s. This is considered significant and could alter the frequency/duration pattern on Lough Attyslany and, to a smaller extent, on Lough Bunny. An alteration of the frequency/duration pattern of water levels and the mixing of waters could have ecological impacts on both lakes which are located within designated areas as stated under Section 3.3.

It is therefore recommended that this piped and open channel system be monitored until the ecological impact downstream on Lough Attyslany and Lough Bunny be investigated. Should negative ecological impacts be found, the newly built piped and open channel system constructed by the local landowners at Termon South could feasibly be extended to discharge to Lough Doo as originally proposed under the April 1998 South Galway Flood Study Report. Should this option be considered, it is recommended that an ecological assessment be also carried out on Lough Doo as previous studies referenced under Section 2.1 identified potential ecological impacts for the Termon South to Lough Doo Scheme.

The environmental impacts of the newly built piped and open channel system upstream at Termon South are discussed separately under Section 3.3.

3.2 FEASIBILITY OF A DRAINAGE SCHEME AT TERMON NORTH

A Drainage Scheme for both Termon North and Termon South was originally investigated as part of the April 1998 South Galway Flood Study Report and is shown on Drawings 4721/EP/02 and 4721/EP/03.

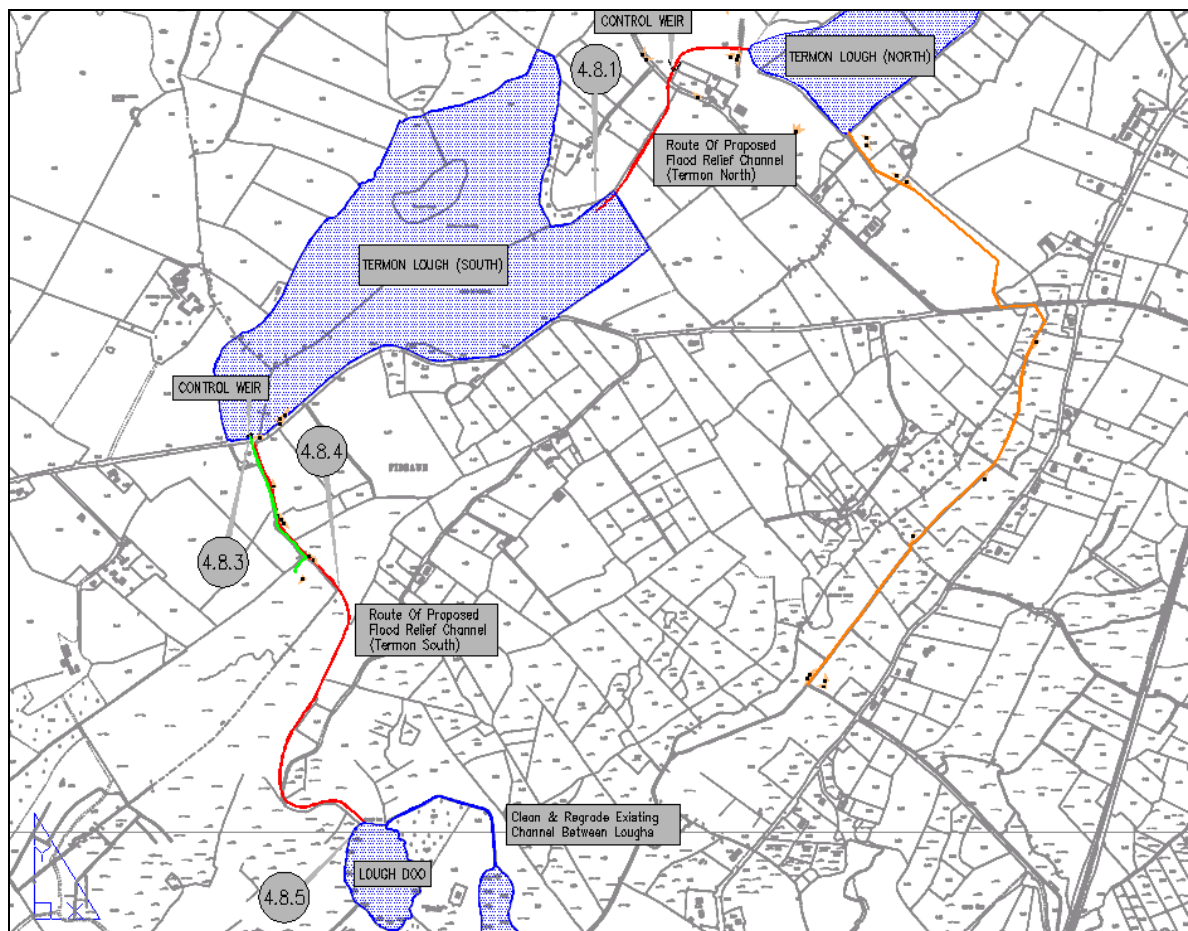


Figure No.3.2 – Original possible drainage Scheme shown red (newly built piped and open channel system shown green)

This Termon Flood Alleviation Scheme proposal which was further developed in 2003 was found to be technically possible.

As part of this current report, JOD are required to investigate an alternative drainage scheme identified by local landowners and shown orange in Figure No.3.2. A detailed

layout and longitudinal section of this alternative scheme is shown on Drawings 4721/EP/02 and 4721/EP/04 appended.

3.2.1 Upstream Section – Possible Alternative Drainage Scheme Alignment

3.2.1.1 Gravity Option

As can be seen on Drawing 4721/EP/02, a high level overflow structure could be located at the southeastern part of the Termon North basin. Based on a survey of the High Water Mark carried out by JOD in October 2010, the upstream overflow structure could be set at a level of 22.90 mOD which is 1.5m higher than the originally proposed intake level of 21.40m OD (February 2003 Design Review). A level sensor was recently placed by a team led by Paul Johnston, Trinity College Dublin at Termon North to monitor water levels variations and rainfall impact on top water levels. The data which is being collected over the six months Winter period 2010 / 2011 was not available as part of this final report. Accordingly, the possible overflow level of 22.90 mOD as well as the sizing of the drainage scheme may require to be adjusted following assessment of the data retrieved from the level and rainfall sensor. It is anticipated that the data will be available in the second quarter of 2011.

Based on an upstream level of 22.90 mOD, Drawing No. 4721/EP/04 shows that excavations of up to 6.1 metres would be required over a distance of 600 metres at the upstream section of the possible alternative scheme. This represents significant depths and as a result, increased excavation costs.

The option of raising the intake level of 22.90 mOD was considered in an attempt to reduce excavations. However, as the finished floor level of the lowest house in the Termon North area is set at 23.68 mOD only, this option was not developed.

3.2.1.2 Pumped Option

In order to avoid deep excavations, it would be required to construct a pump sump adjacent to the proposed overflow structure at Termon North. The sizing of the structure and associated pumps is dependent on the flow pattern at Termon North. Preliminary flow data was generated based on an assessment of the Termon North basin volume carried out by a team led by Paul Johnston, Trinity College Dublin. The following values were considered :

- Termon North basin volume of 140,000m³ at a control level of circa 22.9mOD
- Termon North wetted area of 200,500m² at a control level of circa 22.9mOD
- Rainfall of 272mm (16 days duration) – Source : Met Eireann Report on the November 2009 rainfall in Ireland

Based on the above data the preliminary design flow is estimated to be between 150 and 200 m³/h. This is an average flow only and the actual recommended peak flow for the purpose of sizing the pumps should be at least 300m³/h. This preliminary sizing of the pumps will require to be adjusted following assessment of the data retrieved from the level and rainfall sensor.

Given that the pumps will not usually be running for long periods of time in spring and summer particularly, it is recommended that they be stored in the OPW offices in Headford. Regular monitoring of water levels in Termon North by the OPW as well as the local community is recommended to inform the need to bring the pumps set on site. Two options are available in relation to the type of pumps :

- Option No.1 : Two mobile diesel pumps with a flow capacity of 300m³/h each – Flygt drainage pumps BW series – Power at shaft 20kW each – Delivery pipework 355mm OD HPPE PE100 EXCEL SDR11 Rising Main
- Option No.2 : Two portable submersible pumps – Bibo drainage pumps 2600 series (Model 2670MT226) – Power at shaft 18kW each – Delivery pipework 355mm OD HPPE PE100 EXCEL SDR11 Rising Main

Although the submersible pumps are less expensive, they require a mobile generator and the provision of a lifting device on site, adjacent to the proposed sump for installation and removal. Capital costs are therefore marginally higher under option No.1. From an operational and maintenance point of view, submersible pumps are considered more reliable, more efficient and therefore substantially less costly.

3.2.2 Downstream Section – Possible Improvement Works on Existing Drainage Channel

The alternative possible drainage scheme would discharge into an existing channel which is a tributary to the Lurga River. The condition of the existing channel was assessed during the site visit on the 1st of October 2010.

The channel is 907 metres long and is characterised by flat gradients resulting in significant weed growth particularly at the downstream end. This channel would need to be cleaned and regraded and it may need to be upsized based on the flow pattern at Termon North which will be available in the second quarter of 2011 upon completion of the level and rainfall survey currently being carried out by a team led by Paul Johnston, Trinity College Dublin.

3.2.3 Summary

An Alternative Drainage Scheme from Termon North to the Lurga River was identified by the local landowners and further investigated under this report. A gravity option and a pumped option were developed and found to be feasible technically. A water level and rainfall sensor was placed at Termon North to assess the duration / frequency pattern of this body of water. It is anticipated that this data will be available in the second quarter of 2011. The design of both the gravity and the pumped option may have to be revisited if deemed required upon completion of the water level and rainfall survey.

3.3 ECOLOGICAL CONSTRAINTS

The South Galway Flood Study Report dated April 1998 stated in Section 4 that the extent to which any flood levels could be alleviated is fundamentally and primarily determined by the flora and fauna encountered within any given body of water / flood plain. Both Termon North and Termon South were identified in the April 1998 report as well as in the February 2003 Report as being of significant ecological value. A number of Designated Sites are located within the study area, namely :

- **Termon North and surrounding lands : Special Area of Conservation**
- **Termon South and surrounding lands : Special Area of Conservation**
- **Termon South and surrounding lands : Proposed Natural Heritage Area**

In addition, a number of Designated Sites are less than 1 to 2km away from the study area and could be affected by any drainage scheme at Termon North and Termon South :

- **Lough Bunny and surrounding lands : Special Area of Conservation**
- **Lough Bunny and surrounding lands : Proposed Natural Heritage Area**
- **Lough Attyslany and surrounding lands : Special Area of Conservation**
- **Lough Attyslany and surrounding lands : Proposed Natural Heritage Area**
- **Castlelodge River downstream from Tubber : Special Area of Conservation**
- **Castlelodge River downstream from Tubber : Proposed Natural Heritage Area**
- **Newtown and surrounding lands : Special Area of Conservation**
- **Newtown and surrounding lands : Proposed Natural Heritage Area**

The original ecological assessment specifically considered the botanical impacts, ornithological impacts and the impacts on the aquatic invertebrates. There are three

locations which are considered to be impacted by the drainage works : Termon North, Termon South and Rosemeade which is linked to Termon North.

There are two aspects considered particularly relevant, the stabilisation of the upper level of both Termon North and Termon South turloughs and the opening of channels between them which is the case only for the original flood alleviation scheme. Most turloughs have a variable top level as their height is controlled by the watertable and in different years this rises to different levels. At Termon North and Termon South, the top water level would operate every year and prevent a water level rise over a significant part of the upper basin.

Both the original drainage proposal and the alternative proposal at Termon North, if carried through would have a negative affect on the upper vegetation in Termon North by restricting its extent. The proposal would also result in vegetation changes at the new shoreline. The more interesting communities occur below the control height and are unlikely to be much affected. However, the aquatic invertebrate community would be considerably altered and would lose most of its significance, The new situation would benefit the breeding bird populations by reducing the flooding of nests.

At Termon South, ecological impacts would be less significant. There would be some contraction of wetland vegetation on the fringes but nutritional impacts and species change are considered unlikely. Little change is likely in terms of invertebrates and birds. If the site remains isolated and experiences the same flooding pattern as currently occur, no impacts would accrue to invertebrates.

3.4 CONCLUSION

Based on the above information, sourced from the April 1998 South Galway Flood Study Reports, and on the 2003 Report on Termon Flood Alleviation Scheme, it was found that the proposals to drain Termon North and Termon South, although technically feasible as stated in Sections 3.1 and 3.2 of this Report, could affect the ecological dynamics within and in the vicinity of the study area.

It is therefore recommended that the Termon South piped and open channel system recently constructed by the landowners be monitored and that further ecological investigation be carried out on Lough Attyslany and Lough Bunny. Should negative ecological impacts be found, the newly built piped and open channel system constructed by the local landowners at Termon South could feasibly be extended to discharge to Lough Doo as originally proposed under the April 1998 South Galway Flood Study Report.

At Termon North, although an alternative drainage scheme was identified and deemed technically feasible, it is also recommended that further ecological assessment be carried out. Should the alternative drainage scheme be ruled out, flood alleviation measures in the Termon area could focus on flood defences for individual houses flooded in the past or at risk of flooding. In order to assess the feasibility of such flood defences, localised sub soil investigations would have to be carried out to quantify ground water flows. Should low sub soil permeabilities be encountered, individual defences such as embankments and land drainage could feasibly be constructed to locally lower ground water levels. Based on information available in the April 1998 South Galway Flood Study Report and in the Report on Flooding in South Galway in 1994 prepared by the OPW, one house was flooded in the past (25 to 30cm of water above the finished floor level) and one house was at risk of flooding. The local roads have been raised following the November 2009 floods and could be further raised if necessary to avoid any disturbance for the local community.

4. MANNIN CROSS & KILCHREEST FLOOD ALLEVIATION SCHEMES

4.1 DESCRIPTION OF THE MANNIN CROSS & KILCHREEST POSSIBLE FLOOD ALLEVIATION SCHEMES

4.1.1 Mannin Cross Flood Alleviation Scheme

As part of the April 1998 South Galway Flood Study Reports, several possible localised high level flood alleviation schemes were identified throughout the Slieve Aughty Catchment including the Mannin Cross Flood Alleviation Scheme. The area to the southwest of Mannin crossroads is liable to significant flooding, extending as far west as Castletaylor. Jennings O'Donovan & Partners prepared a Design Report in relation to a proposed Mannin Cross Flood Alleviation Scheme which was presented in July 2000 to a Steering Committee comprising representatives from the Office of Public Works and the South Galway IFA. The proposal identified the need for a flow control structure at Parkslevbaun Lough in Pollnagarragh East to confine floodwaters to the area immediately to the south and east of the lough. From the structure, the possible scheme involved the construction of 945m of 1.2m diameter concrete culvert and 814m of channel regrading and widening, a total channel length of 1,759m. The route identified for the drainage channel was in a northeasterly direction to discharge the excess waters into the Aggard Stream, a tributary of the Dunkellin River. The proposal was to set the flow control structure level at 30.50mOD (Poolbeg). In conjunction with the Design Report, the hydraulic impact of the proposal was investigated by Dr. Paul Johnston, of Trinity College Dublin.

The scope of the hydraulic study included consideration of the downstream impacts on the Aggard Stream and the Dunkellin River as well as the effectiveness of the flow control structure to adequately retain the floodwaters. The design capacity of the proposed drainage channel would allow it to discharge some 1.3m³/s at peak times into the Aggard Stream. Dr. Johnston concluded that the proposed additional amount of influx could present an unacceptable downstream affect both on the Aggard Stream and on the Dunkellin River. At the time, the Aggard Stream and Dunkellin River system was not

assessed from an hydrological point of view and no definitive conclusion could be established.

An hydrological study on the Aggard Stream and the Dunkellin River system was carried out by Tobin Consulting Engineers following the November 2009 floods and finalised in June 2010. The findings of this study are discussed under Section 4.2 of this Report and provide more information on the hydrological dynamics of the Aggard Stream and Dunkellin River system.

4.1.2 Kilchreest Flood Alleviation Scheme

The April 1998 South Galway Flood Study Reports identified another possible high level flood alleviation scheme to mitigate flooding on the Owenshree River at Kilchreest. In December 1999, it was suggested to the Office of Public Works by representatives of the IFA that it may be possible to divert water directly from the Owenshree River to the Aggard Stream Tributary without constructing the high level overflow proposed in the April 1998 South Galway Flood Study Report. A subsequent Design Report of May 2000, prepared by Jennings O'Donovan & Partners, outlined three options for flood relief at Kilchreest :

- Option 1 : Open channel from the Owenshree River to the Aggard Stream tributary,
- Option 2 : Open channel and closed culvert from the Owenshree River to the Aggard Stream tributary,
- Option 3 : Kilchreest flow control and diversion structure.

4.1.2.1 Option 1 – Open Channel Route from Owenshree River to Aggard Stream Tributary

It was considered technically possible to construct an open channel to fall from the Owenshree River to the Aggard Stream Tributary. The route of this channel is as outlined

on Drawings 4721/EP/05 & 4721/EP/06. However, several issues arose which merited further consideration :

- The resultant channel width at ground level would be over 10 metres for an extended length because of the depth of excavation required. This would impact on land use, giving rise to severance of existing lands.
- There would be a significant visual impact associated with this channel.
- Safety issues would arise with an open excavation of this depth.
- Permanent fencing would require to be provided and maintained.
- Environmental impacts would require to be assessed.
- Downstream Impacts on the Aggard Stream and on the Dunkellin River would have to be assessed.

The preliminary estimated construction cost was €1,714,895 incl. VAT (Cost Base Date May 2000). This is equivalent to €2,866,500.00 incl. VAT at November 2010 prices.

4.1.2.2 Option 2 – Open Channel and Closed Culvert Route from Owenshree River to Aggard Stream Tributary

This Open Channel/ Enclosed Culvert Proposal is effectively along the same route as described above for the Open Channel Route and outlined on Drawing 4721/EP/05 & 4721/EP/06. It is also considered technically possible to construct. Because of the enclosed culvert proposal, there would not be a resulting channel width of over 10 metres for any length. However, again several issues arose with this proposal :

- Major civil works involving the construction of chambers required to provide safe access to the enclosed culvert for maintenance.
- More expensive to construct than the Open Channel Alternative to effectively achieve the same hydraulic benefit.
- Downstream Impacts on the Aggard Stream and on the Dunkellin River would have to be assessed.

The preliminary estimated construction cost was €2,449,128 incl. VAT (Cost Base Date May 2000). This is equivalent to €4,093,700.00 incl. VAT at November 2010 prices.

4.1.2.3 Option 3 – Kilchreest Control and Diversion Structure

This proposal, involves the construction of a zoned embankment dam of the local county road and a high level overflow from the embankment to the Aggard Stream. A primary disadvantage of this proposal is its preliminary estimated construction cost of €5,329,800 incl. VAT (Cost Base Date May 2000). This is equivalent to €8,545,800.00 incl. VAT at November 2010 prices. It was not possible at the time of preparation of the Design Report in May 2000 to justify this cost of €5,329,800.00 in a cost benefit analysis. There has been no significant change in the intervening period which would lead to a change in this conclusion in cost benefit terms. Other issues which arose with the proposal included :

- The lack of available information on existing ground conditions. This is particularly relevant given the proposal to construct a zoned embankment dam.
- Impact on land use resulting from intermittent flooding.
- Significant visual impacts of embankment.
- Environmental impacts.
- Downstream Impacts on the Aggard Stream and on the Dunkellin River, although not as significant as for the Open Channel or for Open Channel Enclosed Culvert Alternatives, would have to be assessed.

4.2 HYDROLOGICAL CONSTRAINTS / AGGARD STREAM & DUNKELLIN RIVER

Both the proposed Mannin Cross and Kilchreest Flood Alleviation Schemes involve the diversion of excess flood waters to the Dunkellin River via the Aggard Stream. A study of the Dunkellin catchment was carried out by Tobin Consulting Engineers following the November 2009 floods and finalised in June 2010. This study enabled JOD to further investigate the feasibility of the Mannin Cross and Kilchreest Schemes based on the hydrological characteristics of the Dunkellin catchment.

The Dunkellin catchment covers an area of 373km² and was severely effected by the November 2009 flooding as illustrated in Figure 4.1 below.

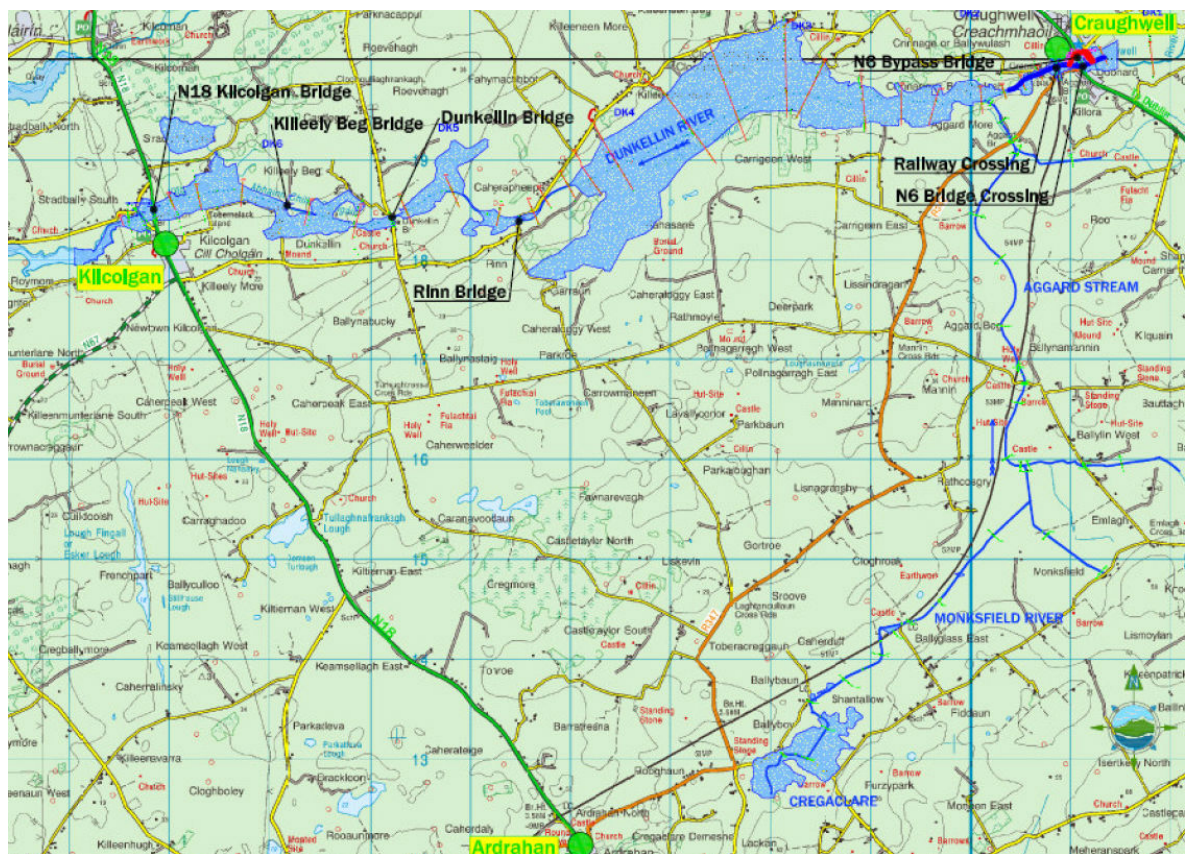


Figure 4.1 : Extents of the November 2009 Floods – Dunkellin Catchment / Aggard Stream
 – Sourced from the June 2010 Flood Study Report by Tobin Consulting Engineers Ltd.

Flood waters covered extensive areas and caused disruption and distress for the local community. A number of houses flooded while others were at risk of flooding. Many roads and bridges were flooded as detailed below :

- Flooding upstream of Craughwell along the R349, Athenry to Loughrea Road north of Craughwell.
- The N6 road bridges were overtopped at Craughwell.
- The railway bridge at Craughwell.
- The Rinn Bridge was overtopped.
- The Dunkellin Bridge and Killeely Beg Bridge were overtopped.

The November 2009 flooding event was assessed as part of the June 2010 Flood Study and the data was used to calibrate an hydrological model. The design flows considered by Tobin Consulting Engineers and input into the model are as follows :

Location	Craughwell	Rahasane Turlough	Kilcolgan	Aggard Stream
Dunkellin Catchment Design Flows m ³ /s	71.64	81.46	81.46	21.60
Estimated November 2009 Flows m ³ /s	65.74	75.14	79.37	21.46

A range of proposed flood alleviation measures were subsequently considered as part of the June 2010 Flood Study and the model was re-run to select the most suitable flood alleviation works. Figure 4.2 overleaf shows the predicted change in water levels taken from the model and based on the preferred flood alleviation measures for the above design flows.

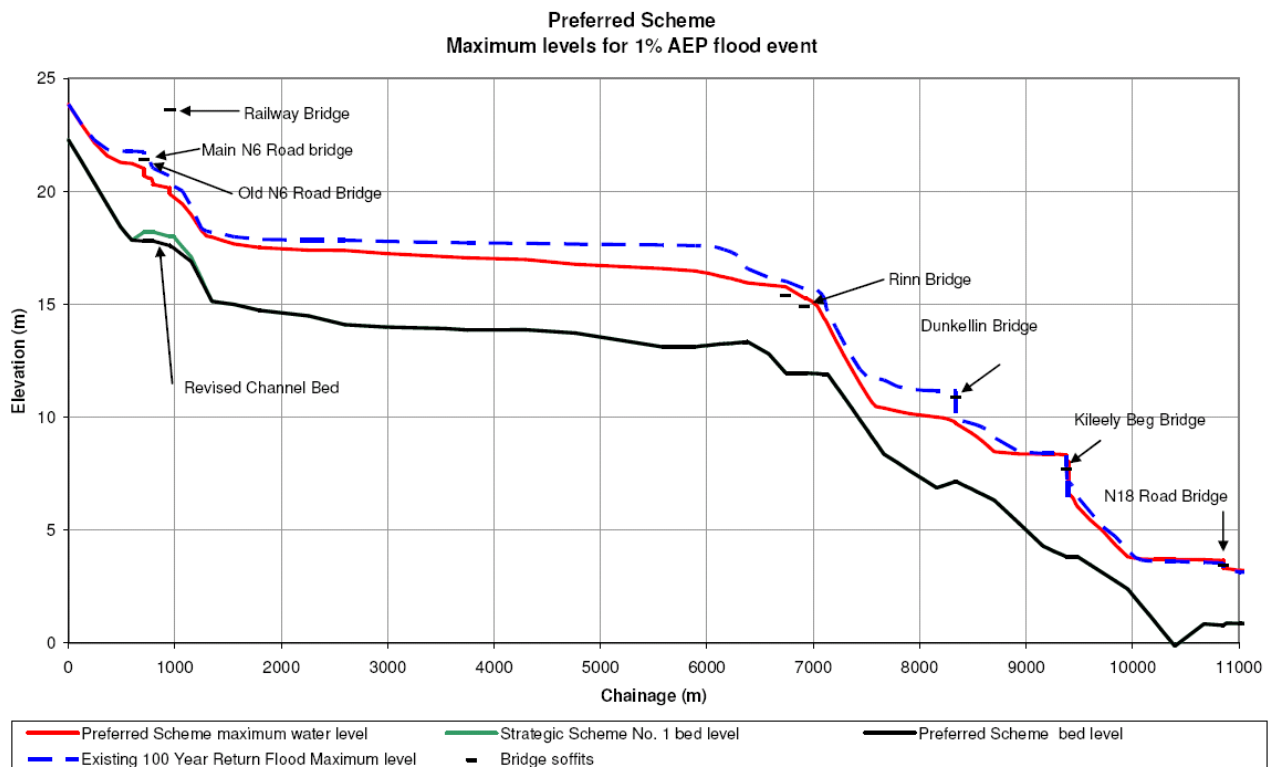


Figure 4.2 : Predicted drop in water levels following implementation of flood relief works – Sourced from the June 2010 Flood Study Report by Tobin Consulting Engineers Ltd.

As can be seen in Figure 4.2 above, a significant drop in water levels was predicted for “the preferred scheme” by the model built under the June 2010 Tobin Flood Study on the Dunkellin catchment. While the drop in levels is notable along most of the upstream part of the Dunkellin River, it can be noted that the River levels will remain high at the downstream end as flood levels are controlled by high tides and cannot therefore be decreased using the traditional methods considered in the June 2010 Tobin Flood Study. It can also be noted that the predicted water levels will still be higher than the soffit of a number of bridges.

4.3 CONCLUSION

It has been identified in the 2000 Design Report on the Mannin Cross Flood Alleviation Scheme that the proposed drainage channel would allow a discharge of 1.30 m³/s at peak times into the Aggard Stream. The June 2010 Tobin Report design model allows for a contributory flow of 21.60 m³/s from the Aggard Stream to the Dunkellin River System. The flow of 21.60 m³/s does not include the proposed 1.30 m³/s discharge from Mannin Cross referenced above. Allowing for a design flow of 21.60 m³/s from the Aggard Stream, the June 2010 Tobin Report concludes that water levels in the Dunkellin River System will remain high particularly at the downstream end. The addition of a further 1.30 m³/s from the proposed Mannin Cross Scheme could increase the level of water on the Dunkellin River System. The proposed additional amount of inflow of 1.30 m³/s could therefore present a negative downstream effect on the Aggard Stream and on the Dunkellin River System.

Similarly, for the proposed Kilchreest Flood Alleviation Scheme, additional discharges could present a negative downstream effect on the Dunkellin River System.

It is proposed that the model built under the June 2010 Flood Study on the Dunkellin catchment by Tobin Consulting Engineers be re-run to fully assess the hydrological impacts of the Mannin Cross and Kilchreest possible flood alleviation schemes.

In addition to the potential hydrological impacts summarised above for both the Mannin Cross and the Kilchreest Flood Alleviation Schemes, the mixing of water could lead to negative ecological impacts on the Rahasane turlough SAC located within the Dunkellin catchment. An ecological assessment is therefore also recommended.

5. **CONCLUSION & RECOMMENDATIONS / COST ESTIMATE & COST BENEFIT**

5.1 **COST ESTIMATES & COST BENEFIT**

5.1.1 **Termon**

5.1.1.1 Original Termon North to Termon South to Lough Doo Alleviation Scheme

The estimated construction cost of the possible original drainage scheme at Termon as proposed under the April 1998 South Galway Flood Study Report and the February 2003 Report on Termon Flood Alleviation Scheme is €771,500.00 at November 2010 prices (€679,700.00 nett plus €91,800.00 in respect of VAT at 13.5%). The following Table 5.1.1 provides a detailed breakdown of the cost estimation for the possible works considered at Termon under this report.

Ref.	Description:	Cost
1.	Excavation	€82,600.00
2.	Concrete Pipe Culverts	€184,100.00
3.	Strip Topsoil	€29,000.00
4.	Imported Topsoil	€34,800.00
5.	Preparing, Sloping, Trimming	€29,700.00
6.	Fencing (temporary & permanent)	€44,700.00
7.	Landscaping	€58,900.00
8.	Backfilling	€55,500.00
9.	Control Structures at Termon North & South	€71,700.00
10.	Sub-Total	€591,000.00
11.	Add Preliminaries and General Items at 15%	€88,700.00
12.	Nett Total	€679,700.00
13.	Add VAT at 13.5%	€91,800.00
14.	Total Estimated Cost	€771,500.00

Table 5.1.1 : Breakdown of Cost Estimate – Termon North to Termon South to Lough Doo Alleviation Scheme

5.1.1.2 Alternative Drainage Scheme at Termon North

Gravity Option :

The estimated construction cost of the possible alternative drainage scheme at Termon North (gravity option) as identified by the landowners and further investigated under this Report is €361,270.00 (€318,300.00 nett plus €42,970.00 in respect of VAT at 13.5%). The following Table 5.1.2 provides a detailed breakdown of the cost estimation for the possible works considered at Termon North (gravity option) under this report.

Ref.	Description:	Cost
1.	Excavation	€62,000.00
2.	Concrete Pipe Culverts	€46,100.00
3.	Strip Topsoil	€17,700.00
4.	Imported Topsoil	€15,700.00
5.	Preparing, Sloping, Trimming	€17,900.00
6.	Fencing (temporary & permanent)	€24,600.00
7.	Landscaping	€26,000.00
8.	Backfilling	€41,600.00
9.	Control Structure at Termon North	€25,100.00
10.	Sub-Total	€276,700.00
11.	Add Preliminaries and General Items at 15%	€41,600.00
12.	Nett Total	€318,300.00
13.	Add VAT at 13.5%	€42,970.00
14.	Total Estimated Cost	€361,270.00

Table 5.1.2 : Breakdown of Cost Estimate – Alternative Termon Alleviation Scheme – Gravity option

Pumped Option :

The estimated construction cost of the possible alternative drainage scheme at Termon North (pumped option) as identified by the landowners and further investigated under this Report is €347,460.00 (€306,130.00 nett plus €41,330.00 in respect of VAT at 13.5%). The following Table 5.1.3 provides a detailed breakdown of the cost estimation for the possible works considered at Termon North (pumped option) under this report.

Ref.	Description:	Cost
1.	Set of 2 No. diesel pumps @ 300m ³ /h each	€36,000.00
2.	Excavation	€36,900.00
3.	Rising Main & downstream Pipe Culverts	€34,700.00
4.	Strip Topsoil	€17,700.00
5.	Imported Topsoil	€15,700.00
6.	Preparing, Sloping, Trimming	€17,900.00
7.	Fencing (temporary & permanent)	€24,600.00
8.	Landscaping	€26,000.00
9.	Backfilling	€24,550.00
10.	Control Structure & Sump at Termon North	€32,150.00
11.	Sub-Total	€266,200.00
12.	Add Preliminaries and General Items at 15%	€39,930.00
13.	Nett Total	€306,130.00
14.	Add VAT at 13.5%	€41,330.00
15.	Total Estimated Cost	€347,460.00

Table 5.1.3 : Breakdown of Cost Estimate – Alternative Termon Alleviation Scheme – Pumped option

5.1.1.2 Drainage Scheme at Termon South

The cost analysis detailed in Table 5.1.1 relates to the original Termon North to Termon South to Lough Doo Drainage Scheme investigated under the April 1998 South Galway Flood Study Report. These costs were revised under this Section 5.1.1.2 to show the costs associated with Termon South to Lough Doo only. The estimated construction cost of the possible drainage scheme at Termon South only is €384,853.00 at November 2010 prices (€339,077.50 nett plus €45,775.50 in respect of VAT at 13.5%). The following Table 5.1.4 provides a detailed breakdown of the cost estimation for the possible works at Termon South under this report.

Ref.	Description:	Cost
1.	Excavation	€36,700.00
2.	Concrete Pipe Culverts	€134,400.00
3.	Strip Topsoil	€15,400.00
4.	Imported Topsoil	€14,700.00
5.	Preparing, Sloping, Trimming	€15,450.00
6.	Fencing (temporary & permanent)	€16,100.00
7.	Landscaping	€27,700.00
8.	Backfilling	€34,400.00
9.	Sub-Total	€294,850.00
10.	Add Preliminaries and General Items at 15%	€44,227.50
11.	Nett Total	€339,077.50
12.	Add VAT at 13.5%	€45,775.50
13.	Total Estimated Cost	€384,853.00

Table 5.1.4 : Breakdown of Cost Estimate – Termon South to Lough Doo Alleviation Scheme – Extension of the Works recently carried out by landowners

5.1.1.3 Termon – Cost benefit Analysis

A detailed cost benefit analysis was carried out as part of the April 1998 South Galway Flood Study Report. The rates in relation to each of the nine categories of benefit showed in Table 5.1.5 were revised to reflect November 2010 prices and compared with the above cost estimates. The benefits are detailed in the following table :

Ref.	Description:	Benefits At April 1998 prices	Benefits At November 2010 prices
1.	Damage to property	€40,781.40	€68,533.30
2.	Agricultural losses	€78,250.10	€131,499.50
3.	Capital depreciation	€722,607.90	€1,214,344.00
4.	Traffic costs	€0.00	€0.00
5.	Accidents	€0.00	€0.00
6.	Infrastructure costs	€0.00	€0.00
7.	Evacuation	€0.00	€0.00
8.	Emergency services	€2,872.10	€4,826.60
9.	Intangible costs	€841,639.50	€1,414,376.90
10.	TOTAL	€1,686,151.20	€2,833,880.40

Table 5.1.5 : Summary of cost benefits – Termon

The cost benefit analysis carried out as part of the April 1998 South Galway Flood Study involved the calculation of the net benefit over a 52 year project life cycle. This means that the overall benefit of €2,833,880.40 over 52 years represents an average of €54,500 per year. The construction costs are assumed to be incurred in Year 1. This is followed by 50 years of benefits and a residual value for the capital works is included in the final year. Details of the calculations with yearly figures are included as Appendix C.

It should be noted that the above overall benefit for the Termon area of €2,833,880.40 was split as follows between the Termon North area and the Termon South area :

- Cost benefit at Termon North : €1,949,626.90 over 52 years or €37,500 per year
- Cost benefit at Termon South : €1,057,530.20 over 52 years or €20,340 per year

Annual maintenance costs of €5,228 at November 2010 prices are included in the 52 year analysis.

The net present value or NPV at November 2010 prices is as follows :

- Original Termon North to Termon South to Lough Doo Flood Alleviation Scheme identified in the April 1998 South Galway Flood Study Report :
 - **NPV €2,082,002.00 – POSITIVE**
- Alternative Drainage Scheme at Termon North as identified by the landowners :
 - **Gravity Option NPV €1,458,556.00 – POSITIVE**
 - **Pumped Option NPV €1,467,336.00 – POSITIVE**
- Drainage Scheme at Termon South – extension of the piped and open channel system recently constructed by local landowners to discharge to Lough Doo :
 - **NPV €551,466.00 – POSITIVE**

Cost benefits are found to be positive at Termon. This is consistent with the April 1998 South Galway Flood Study Report.

5.1.2 Mannin Cross

The estimated construction cost of the possible drainage scheme at Mannin Cross is €1,258,500.00 at November 2010 prices (€1,108,800.00 nett plus €149,700.00 in respect of VAT at 13.5%). The following Table 5.2 provides a detailed breakdown of the cost estimation for the possible works considered at Mannin Cross under this report.

Ref.	Description:	Cost
1.	Excavation	€122,600.00
2.	1.2m diameter Concrete Pipe Culvert	€273,400.00
3.	Strip Topsoil	€43,100.00
4.	Imported Topsoil	€51,600.00
5.	Preparing, Sloping, Trimming	€44,100.00
6.	Fencing (temporary & permanent)	€66,400.00
7.	Landscaping	€87,400.00
8.	Backfilling	€82,400.00
9.	Control Structure at C1/98/23/11	€106,400.00
10.	Raising Road Levels	€86,800.00
11.	Sub-Total	€964,200.00
12.	Add Preliminaries and General Items at 15%	€144,700.00
13.	Nett Total	€1,108,800.00
14.	Add VAT at 13.5%	€149,700.00
15.	Total Estimated Cost	€1,258,500.00

Table 5.2 : Breakdown of Cost Estimate – Works at Mannin Cross

A detailed cost benefit analysis was carried out as part of the April 1998 South Galway Flood Study Report. The rates in relation to each of the nine categories of benefit showed in Table 5.3 were revised to reflect November 2010 prices and compared with the above cost estimates. The benefits are detailed in the following table :

Ref.	Description:	Benefits At April 1998 prices	Benefits At November 2010 prices
1.	Damage to property	€0.00	€0.00
2.	Agricultural losses	€70,136.50	€117,864.50
3.	Capital depreciation	€542,813.00	€912,198.30
4.	Traffic costs	€65,376.30	€109,865.00
5.	Accidents	€3,474.00	€5,838.10
6.	Infrastructure costs	€11,536.80	€19,387.60
7.	Evacuation	€0.00	€0.00
8.	Emergency services	€975.20	€1,638.80
9.	Intangible costs	€612,949.60	€1,030,063.00
10.	TOTAL	€1,307,261.40	€2,196,855.30

Table 5.3 : Summary of cost benefits – Mannin Cross

The cost benefit analysis carried out as part of the April 1998 South Galway Flood Study involved the calculation of the net benefit over a 52 year project life cycle. This means that the overall benefit of €2,196,855.30 over 52 years represents an average of €42,250 per year. The construction costs are assumed to be incurred in Year 1. This is followed by 50 years of benefits and a residual value for the capital works is included in the final year. Details of the calculations with yearly figures are included as Appendix C.

Annual maintenance costs of €8,215 at November 2010 prices are included in the 52 year analysis.

The net present value or NPV at November 2010 prices is as follows :

- **NPV €985,996.00 – POSITIVE**

Cost benefits are found to be positive for the possible Mannin Cross Scheme.

5.1.3 Kilchreest

5.1.3.1 Option 1 – Open Channel Route from Owenshree River to Aggard Stream Tributary

The estimated construction cost of the possible drainage scheme at Kilchreest – Option No.1 is €2,866,600.00 at November 2010 prices (€2,525,600.00 nett plus €341,000.00 in respect of VAT at 13.5%). The following Table 5.4 provides a detailed breakdown of the cost estimation for the possible works considered at Kilchreest – Option No.1 under this report.

Ref.	Description:	Cost
1.	Excavation	€1,137,800.00
2.	Preparing, Sloping & Trimming of Channel	€184,400.00
3.	Imported Topsoil	€55,600.00
4.	Strip Topsoil	€40,000.00
5.	Fencing (temporary & permanent)	€213,900.00
6.	Landscaping	€89,200.00
7.	Bridge at Kilchreest/Craughwell Road	€103,300.00
8.	Footbridges (7 No.)	€165,300.00
9.	Control Structure at Owenshree River	€206,600.00
10.	Sub-Total	€2,196,100.00
11.	Add Preliminaries and General Items at 15%	€329,500.00
12.	Nett Total	€2,525,600.00
13.	Add VAT at 13.5%	€341,000.00
14.	Total Estimated Cost	€2,866,600.00

Table 5.4 : Breakdown of Cost Estimate – Works at Kilchreest – Option No.1

5.1.3.2 Option 2 – Open Channel and Closed Culvert Route from Owenshree River to Aggard Stream Tributary

The estimated construction cost of the possible drainage scheme at Kilchreest – Option No.2 is €4,093,900.00 at November 2010 prices (€3,606,900.00 nett plus €487,000.00 in respect of VAT at 13.5%). The following Table 5.5 provides a detailed breakdown of the cost estimation for the possible works considered at Kilchreest – Option No.2 under this report.

Ref.	Description:	Cost
1.	Excavation	€926,800.00
2.	Preparing, Sloping & Trimming of Channel	€41,400.00
3.	Concrete Culverts	€1,412,900.00
4.	Imported Topsoil	€157,700.00
5.	Strip Topsoil	€40,400.00
6.	Fencing (temporary & permanent)	€143,400.00
7.	Landscaping	€106,100.00
8.	Backfilling	€39,100.00
9.	Footbridges (2 No.)	€62,000.00
10.	Control Structure at Owenshree River	€206,600.00
11.	Sub-Total	€3,136,400.00
12.	Add Preliminaries and General Items at 15%	€470,500.00
13.	Nett Total	€3,606,900.00
14.	Add VAT at 13.5%	€487,000.00
15.	Total Estimated Cost	€4,093,900.00

Table 5.5 : Breakdown of Cost Estimate – Works at Kilchreest – Option No.2

5.1.3.3 Option 3 – Kilchreest Control and Diversion Structure

The estimated construction cost of the possible drainage scheme at Kilchreest – Option No.3 is €8,545,800.00 at November 2010 prices (€7,529,300.00 nett plus €1,016,500.00 in respect of VAT at 13.5%). The following Table 5.6 provides a detailed breakdown of the cost estimation for the possible works considered at Kilchreest – Option No.3 under this report.

Ref.	Description:	Cost
1.	<u>Earth/Rockfill Embankment</u> Excavation; Rockfill to embankment; Earthfill to embankment; Drainage blanket; Grout Curtain; Landscaping & Stream Diversion	€4,500,000.00
2.	<u>Concrete Spillway/Discharge Chute</u> Spillway; Stilling basin; Stilling basin walls and baffles; Excavation & Grout curtain	€1,692,600.00
3.	<u>Culvert to Aggard Stream</u> Clearing, regrading, excavating existing channel; Pipes & Concrete control structure	€354,600.00
4.	Sub-Total	€6,547,200.00
5.	Add Preliminaries and General Items at 15%	€982,100.00
6.	Nett Total	€7,529,300.00
7.	Add VAT at 13.5%	€1,016,500.00
8.	Total Estimated Cost	€8,545,800.00

Table 5.6 : Breakdown of Cost Estimate – Works at Kilchreest – Option No.3

5.1.3.4 Kilchreest – Cost benefit Analysis

A detailed cost benefit analysis was carried out as part of the April 1998 South Galway Flood Study Report. The rates in relation to each of the nine categories of benefit showed in Table 5.7 were revised to reflect November 2010 prices and compared with the above cost estimates. The benefits are detailed in the following table :

Ref.	Description:	Benefits At April 1998 prices	Benefits At November 2010 prices
1.	Damage to property	€66,292.00	€111,404.00
2.	Agricultural losses	€86,181.00	€144,827.00
3.	Capital depreciation	€960,896.00	€1,614,788.00
4.	Traffic costs	€33,640.30	€56,533.00
5.	Accidents	€1,788.00	€3,005.00
6.	Infrastructure costs	€36,454.80	€61,262.00
7.	Evacuation	€1,333.00	€2,240.00
8.	Emergency services	€3,413.00	€5,736.00
9.	Intangible costs	€1,113,368.00	€1,871,017.00
10.	TOTAL	€2,303,366.10	€3,870,812.00

Table 5.7 : Summary of cost benefits – Kilchreest

The cost benefit analysis carried out as part of the April 1998 South Galway Flood Study involved the calculation of the net benefit over a 52 year project life cycle. This means that the overall benefit of €3,870,812.00 over 52 years represents an average of €74,440 per year. The construction costs are assumed to be incurred in Year 1. This is followed by 50 years of benefits and a residual value for the capital works is included in the final year. Details of the calculations with yearly figures are included as Appendix C.

Annual maintenance costs of €33,287 at November 2010 prices are included in the 52 year analysis.

The net present value or NPV at November 2010 prices is as follows :

- Option 1 – Open Channel Route from Owenshree River to Aggard Stream Tributary :
 - NPV **€383,992.00 – POSITIVE**
- Option 2 – Open Channel and Closed Culvert Route from Owenshree River to Aggard Stream Tributary :
 - NPV **-€396,277.00 – NEGATIVE**
- Option 3 – Kilchreest Control and Diversion Structure :
 - NPV **-€3,226,617.00 – NEGATIVE**

Cost benefits are found to be positive in relation to Option 1 – Open Channel Route from Owenshree River to Aggard Stream Tributary. Benefits are marginally negative over the 50 years analysis in relation to Option 2 – Open Channel and Closed Culvert Route from Owenshree River to Aggard Stream Tributary. Benefits are significantly negative in relation to Option 3 – Kilchreest Control and Diversion Structure.

5.2 SUMMARY OF FINDINGS & RECOMMENDATIONS

5.2.1 Termon

The proposals to drain Termon North and Termon South were found to be technically feasible and beneficial from a financial point of view.

At Termon South, it is recommended that the piped and open channel system recently constructed by the landowners be monitored and that further ecological investigation be carried out on Lough Attyslany and Lough Bunny. Should negative ecological impacts be found, the newly built piped and open channel system constructed by the local landowners at Termon South could feasibly be extended to discharge to Lough Doo as originally proposed under the April 1998 South Galway Flood Study Report.

At Termon North, an alternative drainage scheme was identified and deemed technically feasible. It is also recommended that further ecological assessment be carried out prior to advancing to construction.

5.2.2 Mannin Cross & Kilchreest

The proposals for Mannin Cross and Kilchreest (Option 1) Flood Alleviation Schemes were found to be technically feasible and beneficial from a financial point of view.

It has been identified that the proposed additional amount of inflow from both schemes could have possible downstream effect on the Aggard Stream and on the Dunkellin River System. It is therefore proposed that the model built under the June 2010 Flood Study on the Dunkellin catchment by Tobin Consulting Engineers be re-run to assess the hydrological impacts of the Mannin Cross and Kilchreest possible flood alleviation schemes prior to advancing to construction. It is also proposed to carry out an ecological assessment to assess potential impacts on the Dunkellin catchment.

APPENDIX A:

DRAWINGS

APPENDIX B:

PHOTOS

Photos - On site visit 01/10/2010

Photo No01



Photo No02



Photo No03



Photo No04



Photo No05



Photo No06



Photo No07



Photo No08



Photos - On site visit 01/10/2010

Photo No09



Photo No10



Photo No11



Photo No12



Photo No13



Photos - On site visit 01/10/2010

Photo No14



Photo No15



Photo No16



Photo No17



Photo No18



Photo No19



Photo No20



Photo No21



Photos - On site visit 01/10/2010

Photo No22



Photo No23



Photo No24



Photo No25



Photo No26



Photo No27



Photo No28



Photo No29



Photos - On site visits 01/10/2010 & 13/12/2010

Photo No30



Photo No31



Photo No32



Photo No33



Photo No34



Photo No35




Photo No36



Photo No37



Photos - On site visits 01/10/2010 & 13/12/2010			
<div>Photo No38</div> <div></div>	<div>Photo No39</div> <div></div>	<div>Photo No40</div> <div></div>	<div>Photo No41</div> <div></div>
<div>Photo No42</div> <div></div>	<div>Photo No43</div> <div></div>	<div>Photo No44</div> <div></div>	<div>Photo No45</div> <div></div>

APPENDIX C:

COST BENEFIT ANALYSIS – DETAILED CALCULATION TABLE

Original Termon North to Termon South to Lough Doo Scheme

Year		Total benefits	Capital costs	benefits less costs
1	2010	0.00	771500.0	-771500.00
2	2011	76009.69	5227.8	70781.90
3	2012	76009.69	5227.8	70781.90
4	2013	76009.69	5227.8	70781.90
5	2014	76009.69	5227.8	70781.90
6	2015	76009.69	5227.8	70781.90
7	2016	76009.69	5227.8	70781.90
8	2017	76009.69	5227.8	70781.90
9	2018	76009.69	5227.8	70781.90
10	2019	76009.69	5227.8	70781.90
11	2020	76009.69	5227.8	70781.90
12	2021	76009.69	5227.8	70781.90
13	2022	76009.69	5227.8	70781.90
14	2023	76009.69	5227.8	70781.90
15	2024	76009.69	5227.8	70781.90
16	2025	76009.69	5227.8	70781.90
17	2026	76009.69	5227.8	70781.90
18	2027	76009.69	5227.8	70781.90
19	2028	76009.69	5227.8	70781.90
20	2029	76009.69	5227.8	70781.90
21	2030	76009.69	5227.8	70781.90
22	2031	76009.69	5227.8	70781.90
23	2032	76009.69	5227.8	70781.90
24	2033	76009.69	5227.8	70781.90
25	2034	76009.69	5227.8	70781.90
26	2035	76009.69	5227.8	70781.90
27	2036	76009.69	5227.8	70781.90
28	2037	76009.69	5227.8	70781.90
29	2038	76009.69	5227.8	70781.90
30	2039	76009.69	5227.8	70781.90
31	2040	76009.69	5227.8	70781.90
32	2041	76009.69	5227.8	70781.90
33	2042	76009.69	5227.8	70781.90
34	2043	76009.69	5227.8	70781.90
35	2044	76009.69	5227.8	70781.90
36	2045	76009.69	5227.8	70781.90
37	2046	11569.44	5227.8	6341.64
38	2047	11569.44	5227.8	6341.64
39	2048	11569.44	5227.8	6341.64
40	2049	11569.44	5227.8	6341.64
41	2050	11569.44	5227.8	6341.64
42	2051	11569.44	5227.8	6341.64
43	2052	11569.44	5227.8	6341.64
44	2053	11569.44	5227.8	6341.64
45	2054	11569.44	5227.8	6341.64
46	2055	11569.44	5227.8	6341.64
47	2056	11569.44	5227.8	6341.64
48	2057	11569.44	5227.8	6341.64
49	2058	11569.44	5227.8	6341.64
50	2059	11569.44	5227.8	6341.64
51	2060	11569.44	5227.8	6341.64
52	2061	0.00	-281011.2	281011.20
TOTALS		2833880.8	751878.7	2082002.1

Possible Termon North Scheme identified by local landowners
Gravity Option

		Total benefits	Capital costs	benefits less costs
1	2010	0.00	361270.0	-361270.00
2	2011	52870.74	5227.8	47642.94
3	2012	52870.74	5227.8	47642.94
4	2013	52870.74	5227.8	47642.94
5	2014	52870.74	5227.8	47642.94
6	2015	52870.74	5227.8	47642.94
7	2016	52870.74	5227.8	47642.94
8	2017	52870.74	5227.8	47642.94
9	2018	52870.74	5227.8	47642.94
10	2019	52870.74	5227.8	47642.94
11	2020	52870.74	5227.8	47642.94
12	2021	52870.74	5227.8	47642.94
13	2022	52870.74	5227.8	47642.94
14	2023	52870.74	5227.8	47642.94
15	2024	52870.74	5227.8	47642.94
16	2025	52870.74	5227.8	47642.94
17	2026	52870.74	5227.8	47642.94
18	2027	52870.74	5227.8	47642.94
19	2028	52870.74	5227.8	47642.94
20	2029	52870.74	5227.8	47642.94
21	2030	52870.74	5227.8	47642.94
22	2031	52870.74	5227.8	47642.94
23	2032	52870.74	5227.8	47642.94
24	2033	52870.74	5227.8	47642.94
25	2034	52870.74	5227.8	47642.94
26	2035	52870.74	5227.8	47642.94
27	2036	52870.74	5227.8	47642.94
28	2037	52870.74	5227.8	47642.94
29	2038	52870.74	5227.8	47642.94
30	2039	52870.74	5227.8	47642.94
31	2040	52870.74	5227.8	47642.94
32	2041	52870.74	5227.8	47642.94
33	2042	52870.74	5227.8	47642.94
34	2043	52870.74	5227.8	47642.94
35	2044	52870.74	5227.8	47642.94
36	2045	52870.74	5227.8	47642.94
37	2046	6610.07	5227.8	1382.27
38	2047	6610.07	5227.8	1382.27
39	2048	6610.07	5227.8	1382.27
40	2049	6610.07	5227.8	1382.27
41	2050	6610.07	5227.8	1382.27
42	2051	6610.07	5227.8	1382.27
43	2052	6610.07	5227.8	1382.27
44	2053	6610.07	5227.8	1382.27
45	2054	6610.07	5227.8	1382.27
46	2055	6610.07	5227.8	1382.27
47	2056	6610.07	5227.8	1382.27
48	2057	6610.07	5227.8	1382.27
49	2058	6610.07	5227.8	1382.27
50	2059	6610.07	5227.8	1382.27
51	2060	6610.07	5227.8	1382.27
52	2061	0.00	-131589.0	131589.00
TOTALS		1949626.9	491070.9	1458556.0

**Possible Termon North Scheme identified by local landowners
Pumped Option**

		Total benefits	Capital costs	benefits less costs
1	2010	0.00	347460.0	-347460.00
2	2011	52870.74	5227.8	47642.94
3	2012	52870.74	5227.8	47642.94
4	2013	52870.74	5227.8	47642.94
5	2014	52870.74	5227.8	47642.94
6	2015	52870.74	5227.8	47642.94
7	2016	52870.74	5227.8	47642.94
8	2017	52870.74	5227.8	47642.94
9	2018	52870.74	5227.8	47642.94
10	2019	52870.74	5227.8	47642.94
11	2020	52870.74	5227.8	47642.94
12	2021	52870.74	5227.8	47642.94
13	2022	52870.74	5227.8	47642.94
14	2023	52870.74	5227.8	47642.94
15	2024	52870.74	5227.8	47642.94
16	2025	52870.74	5227.8	47642.94
17	2026	52870.74	5227.8	47642.94
18	2027	52870.74	5227.8	47642.94
19	2028	52870.74	5227.8	47642.94
20	2029	52870.74	5227.8	47642.94
21	2030	52870.74	5227.8	47642.94
22	2031	52870.74	5227.8	47642.94
23	2032	52870.74	5227.8	47642.94
24	2033	52870.74	5227.8	47642.94
25	2034	52870.74	5227.8	47642.94
26	2035	52870.74	5227.8	47642.94
27	2036	52870.74	5227.8	47642.94
28	2037	52870.74	5227.8	47642.94
29	2038	52870.74	5227.8	47642.94
30	2039	52870.74	5227.8	47642.94
31	2040	52870.74	5227.8	47642.94
32	2041	52870.74	5227.8	47642.94
33	2042	52870.74	5227.8	47642.94
34	2043	52870.74	5227.8	47642.94
35	2044	52870.74	5227.8	47642.94
36	2045	52870.74	5227.8	47642.94
37	2046	6610.07	5227.8	1382.27
38	2047	6610.07	5227.8	1382.27
39	2048	6610.07	5227.8	1382.27
40	2049	6610.07	5227.8	1382.27
41	2050	6610.07	5227.8	1382.27
42	2051	6610.07	5227.8	1382.27
43	2052	6610.07	5227.8	1382.27
44	2053	6610.07	5227.8	1382.27
45	2054	6610.07	5227.8	1382.27
46	2055	6610.07	5227.8	1382.27
47	2056	6610.07	5227.8	1382.27
48	2057	6610.07	5227.8	1382.27
49	2058	6610.07	5227.8	1382.27
50	2059	6610.07	5227.8	1382.27
51	2060	6610.07	5227.8	1382.27
52	2061	0.00	-126558.8	126558.85
TOTALS		1949626.9	482291.0	1467335.9

Possible Termon South Scheme
Extension of the newly built piped and open channel system to Lough Doo

		Total benefits	Capital costs	benefits less costs
1	2010	0.00	384853.0	-384853.00
2	2011	28089.70	5227.8	22861.91
3	2012	28089.70	5227.8	22861.91
4	2013	28089.70	5227.8	22861.91
5	2014	28089.70	5227.8	22861.91
6	2015	28089.70	5227.8	22861.91
7	2016	28089.70	5227.8	22861.91
8	2017	28089.70	5227.8	22861.91
9	2018	28089.70	5227.8	22861.91
10	2019	28089.70	5227.8	22861.91
11	2020	28089.70	5227.8	22861.91
12	2021	28089.70	5227.8	22861.91
13	2022	28089.70	5227.8	22861.91
14	2023	28089.70	5227.8	22861.91
15	2024	28089.70	5227.8	22861.91
16	2025	28089.70	5227.8	22861.91
17	2026	28089.70	5227.8	22861.91
18	2027	28089.70	5227.8	22861.91
19	2028	28089.70	5227.8	22861.91
20	2029	28089.70	5227.8	22861.91
21	2030	28089.70	5227.8	22861.91
22	2031	28089.70	5227.8	22861.91
23	2032	28089.70	5227.8	22861.91
24	2033	28089.70	5227.8	22861.91
25	2034	28089.70	5227.8	22861.91
26	2035	28089.70	5227.8	22861.91
27	2036	28089.70	5227.8	22861.91
28	2037	28089.70	5227.8	22861.91
29	2038	28089.70	5227.8	22861.91
30	2039	28089.70	5227.8	22861.91
31	2040	28089.70	5227.8	22861.91
32	2041	28089.70	5227.8	22861.91
33	2042	28089.70	5227.8	22861.91
34	2043	28089.70	5227.8	22861.91
35	2044	28089.70	5227.8	22861.91
36	2045	28089.70	5227.8	22861.91
37	2046	4959.37	5227.8	-268.43
38	2047	4959.37	5227.8	-268.43
39	2048	4959.37	5227.8	-268.43
40	2049	4959.37	5227.8	-268.43
41	2050	4959.37	5227.8	-268.43
42	2051	4959.37	5227.8	-268.43
43	2052	4959.37	5227.8	-268.43
44	2053	4959.37	5227.8	-268.43
45	2054	4959.37	5227.8	-268.43
46	2055	4959.37	5227.8	-268.43
47	2056	4959.37	5227.8	-268.43
48	2057	4959.37	5227.8	-268.43
49	2058	4959.37	5227.8	-268.43
50	2059	4959.37	5227.8	-268.43
51	2060	4959.37	5227.8	-268.43
52	2061	0.00	-140178.9	140178.88
TOTALS		1057530.2	506064.0	551466.2

**Possible Kilchreest Scheme
Option No1**

		Total benefits	Capital costs	benefits less costs
1	2010	0.00	2866600.0	-2866600.00
2	2011	76087.50	33287.0	42800.50
3	2012	76141.13	33287.0	42854.13
4	2013	76199.32	33287.0	42912.32
5	2014	76255.08	33287.0	42968.08
6	2015	76312.98	33287.0	43025.98
7	2016	76377.56	33287.0	43090.56
8	2017	76437.60	33287.0	43150.60
9	2018	76499.76	33287.0	43212.76
10	2019	76568.61	33287.0	43281.61
11	2020	76635.05	33287.0	43348.05
12	2021	76684.70	33287.0	43397.70
13	2022	76734.06	33287.0	43447.06
14	2023	76781.29	33287.0	43494.29
15	2024	76830.65	33287.0	43543.65
16	2025	76880.01	33287.0	43593.01
17	2026	76931.51	33287.0	43644.51
18	2027	76985.14	33287.0	43698.14
19	2028	77036.64	33287.0	43749.64
20	2029	77094.82	33287.0	43807.82
21	2030	77150.58	33287.0	43863.58
22	2031	77206.35	33287.0	43919.35
23	2032	77268.80	33287.0	43981.80
24	2033	77326.70	33287.0	44039.70
25	2034	77384.60	33287.0	44097.60
26	2035	77449.18	33287.0	44162.18
27	2036	77511.35	33287.0	44224.35
28	2037	77573.51	33287.0	44286.51
29	2038	77642.36	33287.0	44355.36
30	2039	77706.66	33287.0	44419.66
31	2040	77777.65	33287.0	44490.65
32	2041	77812.08	33287.0	44525.08
33	2042	77848.64	33287.0	44561.64
34	2043	77880.64	33287.0	44593.64
35	2044	77917.20	33287.0	44630.20
36	2045	77953.76	33287.0	44666.76
37	2046	77992.46	33287.0	44705.46
38	2047	78031.15	33287.0	44744.15
39	2048	78063.16	33287.0	44776.16
40	2049	78101.85	33287.0	44814.85
41	2050	78140.54	33287.0	44853.54
42	2051	78179.24	33287.0	44892.24
43	2052	78220.07	33287.0	44933.07
44	2053	78258.76	33287.0	44971.76
45	2054	78299.59	33287.0	45012.59
46	2055	78340.41	33287.0	45053.41
47	2056	78376.69	33287.0	45089.69
48	2057	78417.52	33287.0	45130.52
49	2058	78460.48	33287.0	45173.48
50	2059	78501.31	33287.0	45214.31
51	2060	78544.27	33287.0	45257.27
52	2061	0.00	-1044130.5	1044130.52
TOTALS		3870810.9	3486819.5	383991.5

**Possible Kilchreest Scheme
Option No2**

		Total benefits	Capital costs	benefits less costs
1	2010	0.00	4093900.0	-4093900.00
2	2011	76087.50	33287.0	42800.50
3	2012	76141.13	33287.0	42854.13
4	2013	76199.32	33287.0	42912.32
5	2014	76255.08	33287.0	42968.08
6	2015	76312.98	33287.0	43025.98
7	2016	76377.56	33287.0	43090.56
8	2017	76437.60	33287.0	43150.60
9	2018	76499.76	33287.0	43212.76
10	2019	76568.61	33287.0	43281.61
11	2020	76635.05	33287.0	43348.05
12	2021	76684.70	33287.0	43397.70
13	2022	76734.06	33287.0	43447.06
14	2023	76781.29	33287.0	43494.29
15	2024	76830.65	33287.0	43543.65
16	2025	76880.01	33287.0	43593.01
17	2026	76931.51	33287.0	43644.51
18	2027	76985.14	33287.0	43698.14
19	2028	77036.64	33287.0	43749.64
20	2029	77094.82	33287.0	43807.82
21	2030	77150.58	33287.0	43863.58
22	2031	77206.35	33287.0	43919.35
23	2032	77268.80	33287.0	43981.80
24	2033	77326.70	33287.0	44039.70
25	2034	77384.60	33287.0	44097.60
26	2035	77449.18	33287.0	44162.18
27	2036	77511.35	33287.0	44224.35
28	2037	77573.51	33287.0	44286.51
29	2038	77642.36	33287.0	44355.36
30	2039	77706.66	33287.0	44419.66
31	2040	77777.65	33287.0	44490.65
32	2041	77812.08	33287.0	44525.08
33	2042	77848.64	33287.0	44561.64
34	2043	77880.64	33287.0	44593.64
35	2044	77917.20	33287.0	44630.20
36	2045	77953.76	33287.0	44666.76
37	2046	77992.46	33287.0	44705.46
38	2047	78031.15	33287.0	44744.15
39	2048	78063.16	33287.0	44776.16
40	2049	78101.85	33287.0	44814.85
41	2050	78140.54	33287.0	44853.54
42	2051	78179.24	33287.0	44892.24
43	2052	78220.07	33287.0	44933.07
44	2053	78258.76	33287.0	44971.76
45	2054	78299.59	33287.0	45012.59
46	2055	78340.41	33287.0	45053.41
47	2056	78376.69	33287.0	45089.69
48	2057	78417.52	33287.0	45130.52
49	2058	78460.48	33287.0	45173.48
50	2059	78501.31	33287.0	45214.31
51	2060	78544.27	33287.0	45257.27
52	2061	0.00	-1491162.3	1491162.33
TOTALS		3870810.9	4267087.7	-396276.7

**Possible Kilchreest Scheme
Option No3**

		Total benefits	Capital costs	benefits less costs
1	2010	0.00	8545800.0	-8545800.00
2	2011	76087.50	33287.0	42800.50
3	2012	76141.13	33287.0	42854.13
4	2013	76199.32	33287.0	42912.32
5	2014	76255.08	33287.0	42968.08
6	2015	76312.98	33287.0	43025.98
7	2016	76377.56	33287.0	43090.56
8	2017	76437.60	33287.0	43150.60
9	2018	76499.76	33287.0	43212.76
10	2019	76568.61	33287.0	43281.61
11	2020	76635.05	33287.0	43348.05
12	2021	76684.70	33287.0	43397.70
13	2022	76734.06	33287.0	43447.06
14	2023	76781.29	33287.0	43494.29
15	2024	76830.65	33287.0	43543.65
16	2025	76880.01	33287.0	43593.01
17	2026	76931.51	33287.0	43644.51
18	2027	76985.14	33287.0	43698.14
19	2028	77036.64	33287.0	43749.64
20	2029	77094.82	33287.0	43807.82
21	2030	77150.58	33287.0	43863.58
22	2031	77206.35	33287.0	43919.35
23	2032	77268.80	33287.0	43981.80
24	2033	77326.70	33287.0	44039.70
25	2034	77384.60	33287.0	44097.60
26	2035	77449.18	33287.0	44162.18
27	2036	77511.35	33287.0	44224.35
28	2037	77573.51	33287.0	44286.51
29	2038	77642.36	33287.0	44355.36
30	2039	77706.66	33287.0	44419.66
31	2040	77777.65	33287.0	44490.65
32	2041	77812.08	33287.0	44525.08
33	2042	77848.64	33287.0	44561.64
34	2043	77880.64	33287.0	44593.64
35	2044	77917.20	33287.0	44630.20
36	2045	77953.76	33287.0	44666.76
37	2046	77992.46	33287.0	44705.46
38	2047	78031.15	33287.0	44744.15
39	2048	78063.16	33287.0	44776.16
40	2049	78101.85	33287.0	44814.85
41	2050	78140.54	33287.0	44853.54
42	2051	78179.24	33287.0	44892.24
43	2052	78220.07	33287.0	44933.07
44	2053	78258.76	33287.0	44971.76
45	2054	78299.59	33287.0	45012.59
46	2055	78340.41	33287.0	45053.41
47	2056	78376.69	33287.0	45089.69
48	2057	78417.52	33287.0	45130.52
49	2058	78460.48	33287.0	45173.48
50	2059	78501.31	33287.0	45214.31
51	2060	78544.27	33287.0	45257.27
52	2061	0.00	-3112722.6	3112722.60
TOTALS		3870810.9	7097427.4	-3226616.5

Possible Mannin Cross Scheme

		Total benefits	Capital costs	benefits less costs
1	2010	0.00	1258500.0	-1258500.00
2	2011	41495.58	8215.1	33280.47
3	2012	41595.87	8215.1	33380.75
4	2013	41698.29	8215.1	33483.18
5	2014	41800.71	8215.1	33585.60
6	2015	41911.67	8215.1	33696.56
7	2016	42022.62	8215.1	33807.51
8	2017	42137.85	8215.1	33922.74
9	2018	42255.21	8215.1	34040.10
10	2019	42378.97	8215.1	34163.86
11	2020	42502.73	8215.1	34287.62
12	2021	42590.21	8215.1	34375.10
13	2022	42677.70	8215.1	34462.59
14	2023	42767.32	8215.1	34552.21
15	2024	42859.07	8215.1	34643.96
16	2025	42952.96	8215.1	34737.85
17	2026	43048.98	8215.1	34833.87
18	2027	43145.00	8215.1	34929.89
19	2028	43245.29	8215.1	35030.18
20	2029	43345.58	8215.1	35130.47
21	2030	43448.00	8215.1	35232.89
22	2031	43554.69	8215.1	35339.58
23	2032	43659.24	8215.1	35444.13
24	2033	43770.20	8215.1	35555.09
25	2034	43883.29	8215.1	35668.18
26	2035	43994.25	8215.1	35779.14
27	2036	44111.61	8215.1	35896.50
28	2037	44231.10	8215.1	36015.99
29	2038	44350.59	8215.1	36135.48
30	2039	44474.35	8215.1	36259.24
31	2040	44600.25	8215.1	36385.14
32	2041	44664.26	8215.1	36449.15
33	2042	44730.41	8215.1	36515.30
34	2043	44794.42	8215.1	36579.31
35	2044	44860.57	8215.1	36645.46
36	2045	44926.72	8215.1	36711.61
37	2046	44995.00	8215.1	36779.89
38	2047	45061.15	8215.1	36846.04
39	2048	45129.43	8215.1	36914.32
40	2049	45199.84	8215.1	36984.73
41	2050	45270.26	8215.1	37055.15
42	2051	45340.67	8215.1	37125.56
43	2052	45413.22	8215.1	37198.11
44	2053	45483.64	8215.1	37268.53
45	2054	45558.32	8215.1	37343.21
46	2055	45630.87	8215.1	37415.76
47	2056	45705.55	8215.1	37490.44
48	2057	45780.24	8215.1	37565.13
49	2058	45857.05	8215.1	37641.94
50	2059	45933.87	8215.1	37718.76
51	2060	46010.69	8215.1	37795.58
52	2061	0.00	-458396.1	458396.10
TOTALS		2196855.4	1210859.4	985996.0