KILDARE COUNTY COUNCIL

Site-Specific Flood Risk Assessment

for

Proposed Development of a New Machinery Yard and Regional Salt Barn, Jigginstown, Newhall, Naas, Co Kildare

KILGALLEN & PARTNERS
CONSULTING ENGINEERS

Kildare County Council, **County Hall** **Devoy Park** **Naas, Co. Kildare** **W91 X77**	**17032-R-FRA** **Issue PL1**	**Kilgallen & Partners** **Consulting Engineers** **Well Road, Kylekiproe** **Portlaoise, Co. Laois**

REVISION HISTORY

Client	Kildare County Council
Project	Proposed Development of a New Machinery Yard and Regional Salt Barn, at Jigginstown, Newhall, Naas, Co Kildare
Title	Report on Site-Specific Flood Risk Assessment

Date	Details of Issue	Issue No.	Origin	Checked	Approved
15/02/19	Initial Issue	PL1	PB	MK	PB

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1. INTRODUCTION

1.1 INTRODUCTION

Kildare County Council proposes the construction of a machinery Yard and regional Salt Barn at Jigginstown, Newhall, Naas, Co. Kildare, hereafter referred to as the 'proposed development'.

Kildare County Council has appointed Kilgallen and Partners to carry out a site-specific flood risk assessment for the proposed development in accordance with the Flood Risk Management Guidelines. This report presents the findings of this assessment.

1.2 STRUCTURE OF THE REPORT

The structure of this report is outlined as follows:

- Section 2 provides a description of the site of the proposed development and its immediate environs;
- Section 3 describes the proposed development;
- Section 4 defines the scope of the assessment;
- Section 5 describes the findings and initial assessment of fluvial flood risk and states whether detailed site-specific FRA is required for this flood mechanism;
- Section 6 describes the findings and initial assessment of pluvial flood risk and states whether detailed site-specific FRA is required for this flood mechanism;
- Section 7 describes the findings and initial assessment of flood risk from groundwater and states whether detailed site-specific FRA is required for this flood mechanism;
- Section 8 provides a conclusion for the report.

2. DETAILS OF SITE

2.1 SITE LOCATION AND DESCRIPTION

Figure 2-1 shows the location of the proposed development.

The site measures 1.88 hectares and is located on the southern side of the M7 Slip Road, which connects the Bundle-of-Sticks Roundabout to the southbound on-ramp to the M7 Motorway. This road also serves a Local Road (the Rathasker Road) located southwest of the site. Eastbound traffic flows (i.e. from the Local Road to the Bundle-of-Sticks Roundabout) are very low in comparison to the westbound traffic flows towards the M7.

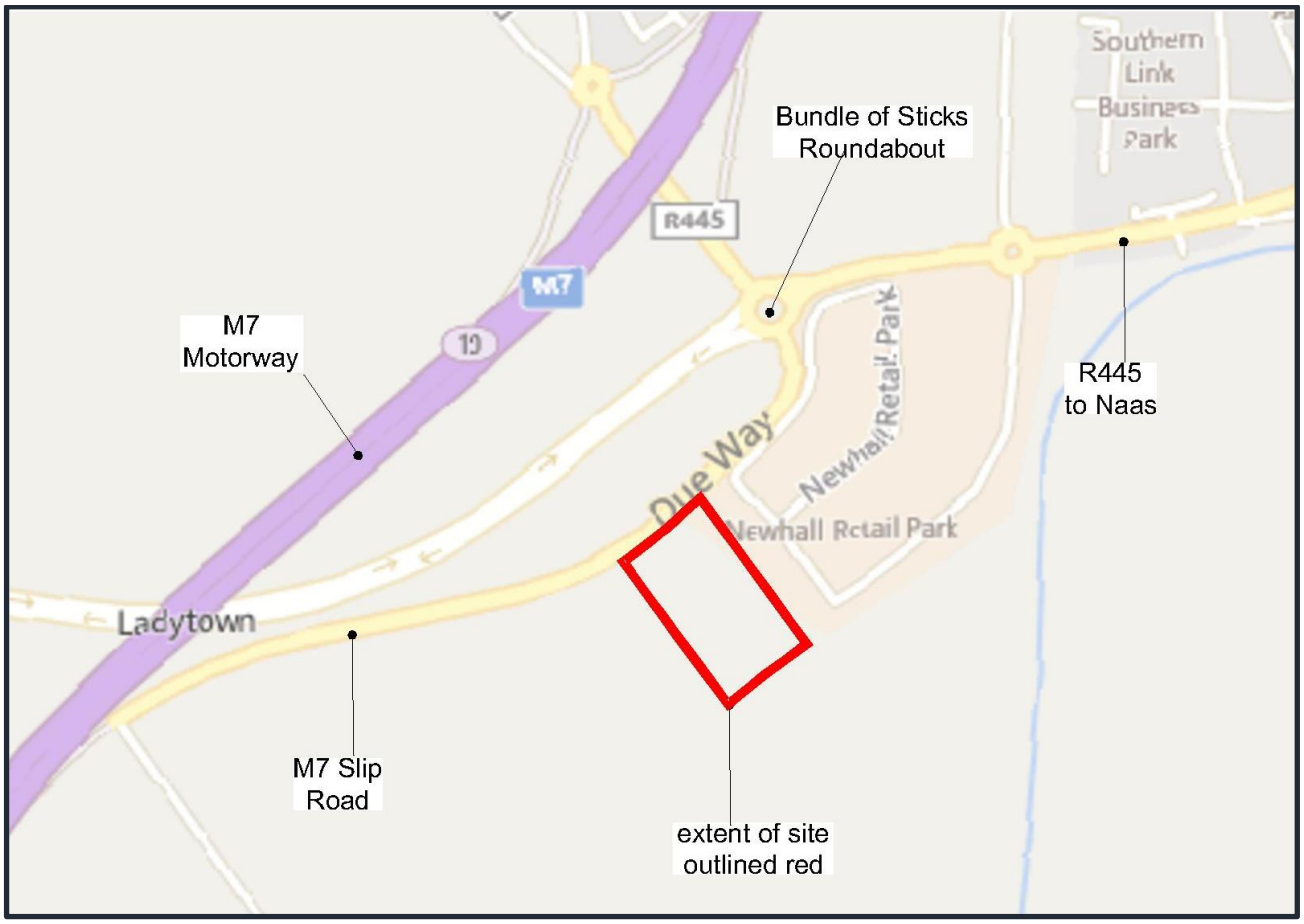

Figure 2.1 Site Location

The site, which was historically used for agricultural purposes, is undeveloped and currently unused, and so does not generate traffic flows. There are no facilities for vulnerable road users on the M7 Slip Road - this is not untypical for a road of this nature.

Access to the site is from the existing M7 Slip Road.

2.2 UPGRADE OF M7 INTERCHANGE

Figure 2-2 shows the layout of the upgrade to the adjacent M7 Interchange that is under construction as part of the M7 Naas to Newbridge Bypass Upgrade Scheme. The upgrade will relocate the existing westbound M7 on-ramp. The existing M7 Slip Road will no longer connect to the M7 and will only carry traffic between the Bundle-of-Sticks Roundabout and the Local Rathasker Road. Figure 2-3 shows the proposed development and upgraded interchange in context.

The upgrade is due to be completed in April 2019 and will therefore be fully open during the construction and operational stages of the proposed development.

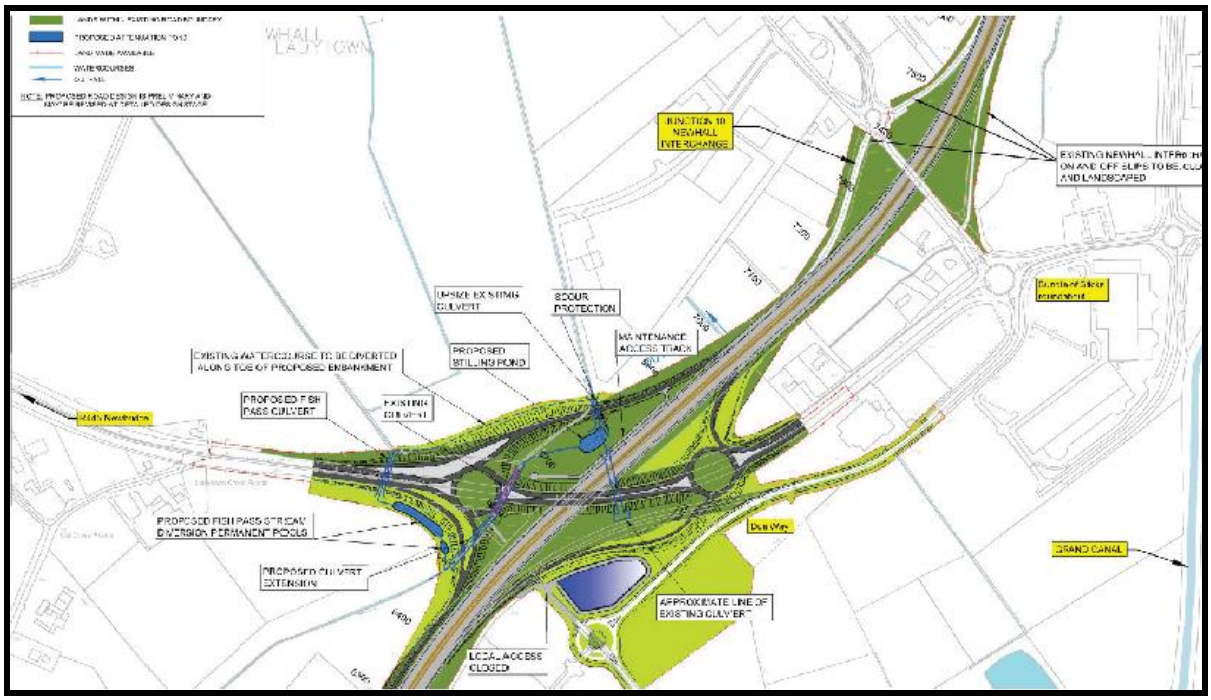

Figure 2.2 Upgraded M7 Interchange

Figure 2.3 Proposed Development and Upgraded M7 Interchange in Context

3. PROPOSED DEVELOPMENT

The proposed development is located on a 1.88 hectare site on the current M7 Slip Road southwest of the Bundle of Sticks Roundabout outside Naas.

The proposed development will provide a range of services to Kildare County Council including coordination of winter maintenance, coordination of surface dressing operations, vehicle hire and purchase, provision of vehicles for pothole repair and street sweeping, fuel storage, salt storage, bitumen storage, vehicle re-spray facility, plant storage, workshop facilities and offices for administration purposes. The two main structures to be constructed on the site are :

- An Administration building and workshop. The administration building comprises offices on the first floor (350sq.m) over storage and ancillary accommodation on the ground floor (320sq.m). The workshop will be 630sq.m and is attached to the Administration building.
- A 23,000 tonne (3,480sq.m) Regional Salt Barn for use by Kildare County Council and the Department of Transport. There is an open fronted lean-to (415sq.m) proposed to the side of the saltbarn for the storage of snow ploughs, gritters and other equipment associated with the salt barn. A small welfare building (52sq.m) is proposed for the use of night time gritter drivers.

Ancillary structures to be constructed on the site are:

- a 30,000 litre raised bitumen tank with access stairs and platform
- 2no. 10m x10m aggregate storage bays
- 1no. covered 10m x 10m covered ancillary storage bay
- covered truck wash area with raised platform
- brine storage tank

Other ancillary and associated works are

- site entrance
- weighbridges
- perimeter fences/walls
- internal fencing to secure storage areas
- parking areas
- fuel storage and pumps
- drainage and site services.

A direct access to the proposed development will be provided on the M7 Slip Road. The access will be a simple priority junction.

The Development is described in detail in the drawings and reports listed in Table 3-1.

Reference No	Type	Title
17032-000	Drg	Cover & Index of Drawings
17032-100	Drg	Site Location Map
17032-101	Drg	Site Layout Plan
17032-102	Drg	3d Site Layout Plan
17032-103	Drg	Contextual Sections & Elevations
17032-200	Drg	Admin & Workshop Ground Floor GA
17032-201	Drg	Admin & Workshop First Floor GA
17032-202	Drg	Admin & Workshop Elevations
17032-203	Drg	Admin & Workshop Sections
17032-205	Drg	Salt Barn GA & North East Elevation
17032-206	Drg	Salt Barn Elevations & Sections
17032-207	Drg	Truck Wash, Chip Store & Bitumen Tank
17032-210	Drg	Computer Generated Images
17032-211	Drg	Computer Generated Images
17032-DR-CEI-01	Drg	General Layout of Civil Engineering Infrastructure
17032-DR-CEI-02	Drg	Enabling Infrastructure in The Public Road
17032-R-CEI	Report	Report on Civil Engineering Infrastructure
17032-R-TIA	Report	Traffic Impact Assessment
17032-R-FRA	Report	Site Specific Flood Risk Assessment
	Report	Appropriate Assessment Screening Report
	Report	Ecological Impact Assessment (EcIA) Report
	Report	Archaeological Heritage Impact Assessment
	Report	Ground Investigation Report (March 2018)
17032-EIA	Report	EIA Screening Report

Table 3-1 Schedule of Drawings showing details of Proposed Development

4. SCOPE OF ASSESSMENT

The purpose of this FRA is to ensure that all relevant flood risks are assessed in relation to the planning decisions to be made by the Planning Authority and to ensure that all potential conflicts between flood risk and development are addressed to the appropriate level of detail. The assessment process comprises an initial FRA to assess the adequacy of existing information and to identify any further studies that may be required to fully address flooding issues.

Potential Sources of Flood Risk

The subject site of the proposed development is an inland site without any existing flood defence mechanisms. In such circumstances, the potential flood risk mechanisms at any similar site are as follows:

- Fluvial flooding caused by overtopping of streams and rivers;
- Pluvial flooding caused when the intensity of rainfall events is such that the ground cannot absorb rainwater effectively or urban drainage systems cannot carry the run-off generated;
- Groundwater flooding caused by an increase in the level of the water table.

Identification and Initial Assessment of Fluvial Flood Risk

The risk of flooding from fluvial mechanisms are typically assessed by means of a desktop study and a site walkover.

Identification and Initial Assessment of Flood Risk from Pluvial and Ground Water Sources

The risk of flooding from pluvial and from ground water mechanisms are typically assessed by means of a desktop study, site walkover and an assessment of any existing relevant drainage.

Information Sources

The desktop study is based on information provided by the following parties:

- Details of the proposed development;
- National Flood Hazard Mapping provided by the OPW,
- 6 inch mapping provided by Ordnance Survey Ireland,
- Flood Studies Update (FSU) Web Portal provided by the OPW,
- SFRA carried out on behalf of Kildare County Council as part the making of the current Kildare County Development Plan,
- Site walk-over by Kilgallen & Partners;
- Ground investigation information for the Site.

5. IDENTIFICATION AND INITIAL ASSESSMENT OF FLUVIAL FLOOD RISK

The risk of fluvial flooding arises when overtopping of streams and rivers occurs.

An open channel runs along the entire length of the Site's western boundary, sloping downwards from south to north. The channel does not carry significant flows of water and functions as an open drain for surrounding lands. Mapping confirms the drain stops approximately 150m south of the Site.

A number of datasets were interrogated for indicators of fluvial flood risk at the Site:

- A record of past flood events maintained by the OPW on its website, www.floodinfo.ie;
- Preliminary Flood Risk Assessment Maps (PFRA) for the area were prepared as part of the CFRAM study programme undertaken by the OPW. The PFRA maps do not show any fluvial flood risk at the Site;
- CFRAM Mapping;
- 6 inch mapping provided by Ordnance Survey Ireland,
- Flood Studies Update (FSU) Web Portal provided by the OPW,
- SFRA carried out for the current Kildare County Development Plan,
- Site Walkover.

No indicators of fluvial flood risk were identified by this study.

6. IDENTIFICATION AND INITIAL ASSESSMENT OF PLUVIAL FLOOD RISK

The risk of pluvial flooding arises when the intensity of rainfall events is such that the ground cannot absorb rainwater effectively or urban drainage systems cannot carry run-off generated.

The construction of an appropriate surface water drainage system within the site will ensure that surface water run-off from the proposed development will not give rise to a pluvial flood risk elsewhere.

A number of datasets were interrogated for indicators of pluvial flood risk at the Site:

(i). The Naas Branch of the Grand Canal runs in a north easterly direction approximately 250m south east of the Site. Waterways Ireland has undertaken a PFRA with respect to the infrastructure that they own, operate and maintain and that could give rise to flood risk, e.g., embanked sections of canal. The process and outcomes of this work is detailed in the PFRA Report by Waterways Ireland. The conclusion of the work by Waterways Ireland is that the relevant infrastructure does not give rise to significant flood risk. Reasoning and details of this conclusion can be found in the aforementioned report, an extract from which is provided in Appendix A.

(ii). Between the Grand Canal and the Site lies an artificial lake, which at its closest is approximately 180m from the Site boundary. The canal is not in significant embankment and does not constitute a flood risk to the Site.

(iii). A retail park adjoins the eastern boundary of the Site. Examination of the planning permission for this development indicates that the discharge of surface water run-off therefrom is restricted in accordance with sustainable drainage guidelines and thus would not be at a rate that would lead to flooding of the receiving ditch;

(iv). There are no records of past flood events at the Site or on the public road the OPW website, www.floodinfo.ie;

(v). Preliminary Flood Risk Assessment Maps (PFRA) for the area were prepared as part of the CFRAM study programme undertaken by the OPW. The PFRA maps do not show any pluvial flood risk at the Site;

(vi). The open channel described in Section 5 discharges to a 450mm dia. surface water pipe under the existing M7 Slip Road; this pipe flows in a westerly direction along the southern boundary of this road

before discharging to an open drain recently constructed as part of the M7 Interchange Upgrade. Site inspection revealed that as it discharges to the open drain, its invert level is below bed level of the open drain. Therefore, this pipe relies on an upstream head of water to discharge to the open drain. This gives rise to two potential issues:

- The outfall may silt up over time, obstructing the hydraulic capacity of the existing outfall pipe and potentially causing the existing outfall pipe to surcharge. If the surcharge was severe enough, the surcharged water could cause existing manholes to overflow, however these are downstream of the Site and flood risk associated with the potential obstruction would not impact on the Site itself.
- A reduction in the hydraulic capacity of the existing outfall pipe could leave it incapable of discharging surface water run-off from the proposed development. To eliminate this risk, a new outfall pipe, at a higher level than the existing outfall, will be constructed from the Site to the open drain.

(vii). The Site was inspected immediately after a period of heavy rainfall. There was no evidence of pluvial flooding.

Based on the indicators described above, the Site is not considered at risk from pluvial flooding.

7. IDENTIFICATION AND INITIAL ASSESSMENT OF GROUNDWATER FLOOD RISK

A number of datasets were interrogated for indicators of fluvial flood risk at the Site:

(i). There are no records of past flood events at the Site or on the public road the OPW website, www.floodinfo.ie.

(ii). A detailed ground investigation was carried out at the Site in December 2017 and January 2018. A number of standpipes were installed to allow monitoring of groundwater levels. These showed standing water levels in mid-January ranging from 83.05m to 83.24m OD (when re-measured in mid-February, the groundwater level had decreased slightly).

The minimum proposed floor level is 84.25m and the minimum yard level is typically 84.0m, approximately 750mm above the maximum recorded groundwater level.

The finished level of the existing public road at the location of the access to the proposed development is 83.3m, close to the maximum ground water level recorded within the Site. However, pluvial drainage at this location lowers the ground water level and flooding does not occur, as confirmed by the records available on the OPW website, www.floodinfo.ie.

Based on the indicators described above, the Site is not considered at risk from ground water.

8. CONCLUSION

The findings of this report conclude the following:

Fluvial Flooding

No indicators of fluvial flood risk were identified by this study.

Pluvial Flooding

Based on an assessment of indicators of pluvial flood risk, the Site is not considered at risk from pluvial flooding.

Groundwater

Based on an assessment of indicators of flood risk from groundwater, the Site is not considered at risk from groundwater flooding.

Based on the above and in accordance with the document *'Planning System and Flood Risk Management – Guidelines for Planning Authorities (2009)'*, a Detailed Site-Specific Flood Risk Assessment is not required.

Appendix A

Preliminary Flood Risk Analysis by Waterways Ireland

Preliminary Flood Risk Analysis Report

Waterways Ireland

18th July 2011

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Executive Summary

The statutory function of Waterways Ireland, the largest of the six North/South Implementation Bodies established under the British-Irish Agreement Act 1999, is to manage, maintain, develop and restore specified inland navigable waterways; the Barrow Navigation, the Lower Bann Navigation, the Royal Canal, the Erne System, the Shannon-Erne Waterway, the Grand Canal and the Shannon Navigation principally for recreational purposes.

The Statutory instrument transposing EU 'Floods' Directive into Irish law identifies roles for organisations such as local authorities, Waterways Ireland and ESB to undertake certain duties with respect to flood risk within their area of responsibility. Such risks must be identified through a preliminary flood risk assessment by December 2011. The PFRA is a high level screening exercise which involves collecting existing and readily available information on historic and potential floods, assembling it into a preliminary assessment report and using it to identify Flood Risk Areas which are areas where the risk of flooding is significant.

This report looks at the possible flooding mechanisms arising from the 'artificial water bearing infrastructure' and includes an analysis of historic flooding and potential future flooding of the Grand and Royal Canals and other smaller canals linked to the Shannon Navigation, the Lough Allen Canal, the Jamestown Canal and the River Blackwater / Erina-Plassey Canal.

Conclusion

The analysis of historic data shows that, while there have been incidences of flooding caused by failure of embankments and operational issues on the Grand and Royal Canals, they have generally occurred in rural areas with very limited damage to property. In only 2 cases a small number of houses and businesses were affected but for the remainder of cases the damage has been limited to temporary flooding of bog or farmland. In Tullamore and Edenderry the ground levels are lower than the canal in some areas and there is a potential for some flooding of property but the only area where the consequences of an embankment failure is relatively high is the embanked section of canal close to Mullingar, Co. Westmeath where up to 200 houses could be flooded. However this embankment has no history of failure, has been strengthened and partially lined in recent years, is inspected weekly for any sign of a potential breach and remedial action would be put in place immediately so while the consequences would be significant the likelihood of failure is extremely low and therefore this is not considered to be an area of significant flood risk.

Waterways Ireland is committed to continuing to work with the Office of Public Works and the ESB to deliver the Assessment and Management of Flood Risks on designated waterways as required by EC Dir 2007/60/EC.

1.0 Background and Introduction

Between 1998 and 2004 Europe suffered over 100 major damaging floods including the catastrophic floods along the Danube and Elbe rivers in Summer 2002. Further severe floods in 2005 further reinforced the need for a co-ordinated approach to the management of the problem. Since 1998 floods in Europe have caused up to 700 deaths, the displacement of 500,000 people and at least €25 billion in insured economic losses. Catastrophic floods endanger human lives and cause human tragedy as well as heavy economic losses and can have severe environmental consequences. Floods are natural phenomena but through the right measures it is possible to reduce their likelihood and lessen their impact.

Directive 2007/60/EC on the assessment and management of flood risks aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. Under S.I. 122 of 2010 European Communities (Assessment and Management of Flood Risks) Regulations 2010, the Statutory Instrument transposing the EU Directive into Irish Law, the Commissioners of Public Works in Ireland are appointed as the Competent Authority for flood risk management and other local authorities and organizations are named. Waterways Ireland, as the statutory body responsible for the majority of Ireland's inland navigable waterways, is obliged to undertake tasks the first of which is to prepare a Preliminary Flood Risk Assessment (PFRA) of the potential flood risk posed by the structural or operational failure of any of its infrastructure.

The PFRA is a high level screening exercise which involves collecting existing and readily available information on historic and potential floods, assembling it into a preliminary assessment report and using it to identify Flood Risk Areas which are areas where the risk of flooding is significant. This PFRA concentrates on flooding which has arisen or is likely to arise from the Royal and Grand Canals, classified in the legislation as 'artificial water bearing infrastructure'.

2.0 Waterways Ireland

Waterways Ireland is the largest of the six North/South Implementation Bodies which was established by means of an international treaty made on 8 March 1999 between the British and Irish Governments. This treaty was given domestic effect by means of the North/South Co-operation (Implementation Bodies) (Northern Ireland) Order 1999, and the British-Irish Agreement Act 1999 respectively.

As a Cross Border body, Waterways Ireland operates under the policy direction of the North / South Ministerial Council and the two Governments, and is accountable to the Northern Ireland Assembly and the Houses of the Oireachtas.

The statutory function of Waterways Ireland is to manage, maintain, develop and restore specified inland navigable waterways, principally for recreational purposes.

Waterways Ireland has responsibility for approximately 1,000 km of navigable waterways (Figure 1) comprising;

- the Barrow Navigation
- the Lower Bann Navigation
- the Royal Canal
- the Erne System
- the Shannon-Erne Waterway
- the Grand Canal
- the Shannon Navigation

Waterways Ireland's remit was extended by the North South Ministerial Council in July 2007 to include responsibility for the reconstruction of the Ulster Canal from Upper Lough Erne to Clones and following restoration for its management, maintenance and development principally for recreational purposes.

Of the water bodies listed above the artificial water bodies are the Grand Canal, the Royal Canal, part of the Shannon-Erne Waterway and a number of smaller canals linked to the Shannon Navigation namely the Lough Allen Canal, the Jamestown Canal and the Erina Plassey canal. The other navigation systems are a mix of River/Lake navigation with short lateral canals. Flooding on these systems is being dealt with under the fluvial PFRA being prepared by the Office of Public Works.


Ireland's Waterways
Coleraine
Lough Foyle
Londonderry
Foyle
Strabane Canal
Strabane
Lower Bann Navigation
Larne
Lough Beg
Antrim
Donegal
Omagh
Tyrone Navigation
Lough Neagh
BELFAST
Lisburn
Lagan Navigation
Ballyshannon
Belleek
Lower Lough Erne
Blackwater
Benburb
Upper Bann
Portadown
L. Melvin
Enniskillen
Erne
Upper Lough Erne
Armagh
Newry Canal
Poyntz Pass
Belmullet Canal
Sligo
Ulster Canal
Clones
Newry
Newry Ship Canal
Lough Allen
Lough Allen C.
L. Key
Ballinamore
Belturbet
Dundalk
Boyle
Shannon-Erne Waterway
Lough Oughter
Carrick-on-Shannon
Westport
Tarmonbarry
Longford
Drogheda
Boyne
Navan
Lough Mask
Roscommon
Ballymahon
Abbeyshrule
Mullingar
Royal Canal
Cong Canal
Lecarrow Canal
Lough Corrib
Lough Ree
Killinure Lough
Ballykeeran
Athlone
Kilbeggan
Maynooth
Clonmacnois
Edenderry
Ballinasloe
Grand Canal
Robertstown
DUBLIN
Galway
Eglinton Canal
Suck Navigation
Navigation
Tullamore
Naas Branch
Galway Bay
Shannon
Banagher
Milltown Feeder
Naas
Portumna
Mountmellick
Lough Derg
Mountmellick Branch
Athy
Scarriff
Barrow Navigation
Ennis
Fergus Navigation
Killaloe
Carlow
Shannon Estuary
Castleconnell
Bagenalstown
Kilrush
Limerick
Foynes
Tarbert
Graiguenamanagh
St Mullins
Slaney
New Ross
Tralee
Carrick-on-Suir
Suir
Wexford
Rosslare
Tralee Ship Canal
Bridgetown C
Waterford
Lismore Canal
Fermoy
Bride Navigation
Munster Blackwater
Cork
Lee Navigation
Bantry
Kinsale
0
50
100 km
N
LEGEND
Waterways Ireland network
Other navigations
Tidal navigations
Disused navigations
Restoration in progress
Border
Cartography © EUROMAPPING 2009

Figure 1

3.0 Potential Flooding Mechanisms

The possible flooding mechanisms arising from canal infrastructure are:

3.1 Failure or Breach of an Embankment

A large proportion of the Grand and Royal Canals are built in embanked sections running at a higher level than the surrounding countryside. These embankments were constructed of local readily available material, sometimes stone and clay but in some cases they are soft peat embankments which require considerable maintenance. Failure or breach of these embankments results in water from the level being released but the impact of the flood waters very much depends on the time of year and the level of saturation of the surrounding area. The tables in Appendix 1 & 2 shows the maximum volume of water which would be released by a failure of each of the levels of the Grand and Royal Canals.

3.2 Overtopping of the Banks

During periods of intense or prolonged heavy rainfall the volume of water running into the canal can exceed the volume of water which can be racked off using the overflows, the land tunnels and the gate sluices. This excess water overtops the banks and can cause flooding of surrounding areas if it cannot be discharged through the drainage network. The primary risk to the canal system of water entering at a rate which cannot be discharged or managed is that the canal water levels rise and will overtop. In embanked areas there is then a risk of failure particularly due to the erosion of the top bank level.

3.3 Operational Issues

Water has to be managed through the canal system to keep all levels at their optimum depth and sluices in the gates are used to carefully monitor the amount of water flowing from one level to the next. Overtopping from a long level to a shorter level can result in the shorter level being unable to discharge the volume of water and resultant flooding of the surrounding areas. Any failure of the lock-gates or interference with the sluices whether deliberate through acts of vandalism or accidental can result in overtopping of a short level as described above.

4.0 The Grand Canal

4.1 History of Construction

Work on the Grand Canal from Ringsend to the River Shannon, crossing the central plain and the Bog of Allen, commenced in 1756 and was complete to the Shannon in 1804. The canal is 182km long including the Branch Lines to Naas and Edenderry. The summit level at Lowtown is 40km west of Dublin and 85m above low tide at Dublin where there are 3 sea locks linking the Grand Canal Basin with the tidal River Liffey. The rise from Dublin to the summit is by way of 26 locks and the 50m fall to the River Shannon is by way of 18 locks over a distance of 93km. The average rise or fall of the locks is 3.0m while the largest is 5.7m at Inchicore Lock.

The Barrow Line of the Grand Canal is 45km from the summit at Lowtown to where it joins the Barrow River at Athy. The descent to the Barrow is by way of 9 locks, 2 of which are double-chambered.

There are 14 supply channels feeding the system at various lengths totally approximately 64km; the principal one being the Milltown supply from Pollardstown Fen which feeds the summit level. Most of the supply channels are artificially constructed and require constant maintenance particularly where they are embanked or through bog sections. From the summit level at Lowtown the canal begins its slow descent to Shannon Harbour where it joins the River Shannon. It passes through a varied landscape a particular feature of which is the high embankments with 24km through bogs.

4.2 Historic Flooding on the Grand Canal

4.2.1 Flooding due to embankment failure

Approximately 50% of the Grand Canal is built in embanked sections at a higher level than the surrounding countryside. These embankments were constructed in the late 1700s of readily available local material sometimes stone and clay but 24km are soft peat embankments which require considerable maintenance. There were numerous breaches of these embankments during the 1800s but none resulted in any significant flooding or damage to property, mainly due to the rural nature of the surrounding countryside much of which is bog.

The most significant breach of a peat embankment was the Edenderry breach in 1989 which occurred in a 31.5km level, the longest level of the Grand Canal. The Edenderry embankment, stretching from the Blundell Aqueduct to Downshire Bridge, is constructed entirely from turf, the only material available to the builders in the 18th century. When this section was first watered in 1797 it promptly collapsed and this was followed by further failures in 1800, 1855 and 1916. The most recent failure occurred in January 1989 when a large breach opened in the North bank about 950m west of the Blundell Aqueduct near the town of Edenderry. It is estimated that up to 135,000 m^3 of water was discharged through the breach and 100,000 m^3 of embankment material was displaced over a length of 300m; however, the damage to the surrounding land was comparatively minor. Approximately 12 acres of land were flooded with short term flooding of a further 36 acres including some football fields. This receded within a day and left little or no residual damage.

The failure was the result of a long length having become saturated over a period of many years. When the canals were commercially used 12 boats were continuously employed claying this section to avoid leaks. However, this ceased when the canals were closed to commercial traffic resulting in the peat becoming completely saturated and the continuing leaks causing piezometric pressure to build up near the base of the embankment. Long term wetting deteriorates the strength of the peat and eventually a point was reached, in this case, when the resistance due to the shear strength of the peat became less than the upward piezometric pressure resulting in a large wedge of the embankment simply floating away.

Similar breaches occurred in the Derries Embankment in 1955 and the Killeen embankment in 1975. In the former case the water was discharged to the Silver River in the immediate vicinity and the latter resulted in the flooding of some bogland. In August 1993 the partial collapse of a culvert at Hartley Bridge, Ticknevin, Co. Kildare resulted in the loss of approximately 30,000m^3 of water. This did not result in any damage to land but did cause some inconvenience to 3 dwellings during the repair of the culvert.

4.2.2 Flooding due to overtopping and operational issues

There have been a number of minor flooding incidents caused by overtopping and operational issues.

- In the Bluebell area of Dublin city in November 2005 some damage was caused to 5 business premises due to vandalism at locks which resulted in bank overtopping.
- Some flooding occurred in Ardclough village near Celbridge, Co. Kildare in winter 2009 partly as a result of overtopping of the canal bank but no houses or businesses were affected.
- In Ballycommon, Co. Offaly in August 2008 during a period of intense heavy localised rainfall the large diameter pipes under the towpath could not take the flow from the surrounding high ground and the water entered the canal flowing over the towpath. The volume of water entering the canal exceeded the volume of water which was being discharged via the sluices, overflows and racks. At the time there was a significant risk of overtopping and emergency services were put on alert but no damage occurred.

4.3 Inspection and Maintenance Regime

When a breach occurs dams are installed immediately to reduce the loss of water and the embankment is repaired. In the case of the 1989 Edenderry breach the section of embankment was completely rebuilt and lined and, as a result of the lessons learned, peat embankments are now inspected regularly for any signs of damage or leaks and there is an ongoing program to strengthen them and line them where necessary to reduce the risk. In addition a stop chamber was constructed at Rathmore which reduces the length of the level likely to be affected by another breach of this embankment to 8km and so the amount of water which would be discharged would be 25% less than was discharged in 1989.

Water is carefully managed throughout the system and all locks are inspected regularly to ensure that the water management regime is in order. Where there is a risk or history of vandalism, locks are placed on the sluices to prevent interference. Where banks have limited freeboard there is an ongoing program to raise them to increase the carrying capacity of the canal and there is also an ongoing maintenance program for overflows and back-drains.

4.4 Potential Future Floods

The majority of the Grand Canal runs through remote rural areas much of which is bog and so flooding will result in limited damage. The canal passes through a number of villages and 2 towns Edenderry and Tullamore.

Edenderry town ground levels are below canal water level and the toe of the embankment has been damaged in the past due to industrial activity particularly in the Edenderry Business Park. A catastrophic failure of this embankment could have serious consequences to property due to the volume of water contained in the 31.5km level and the topography of the area; however, some of the risk has been mitigated by the introduction of the stop chamber, the works done to the embankment and the regular inspections of the embankment.

The ground levels in some areas of Tullamore town are also below canal water level. The embankments here are intact but continuous development alongside the canal including underground services could impact on the structural stability of the canal embankments. A breach in the Tullamore area would have serious effects on property however, continuous monitoring and maintenance regimes are in place and a breach is thought to be unlikely in this area.

Appendix 1 lists all reaches of the Grand Canal system giving dimensions, embankment details, inflows and potential flooding volumes.

5.0 The Royal Canal

5.1 History of Construction

The Royal Canal was the second canal to be built across the country from Dublin to the River Shannon. Work started in 1790 and the canal reached the Shannon in 1817. Spencer Dock in Dublin was not complete until 1873. The navigation starts at Spencer Dock and the canal rises steeply out of the city through a succession of double locks. From the 10th lock, although still in Dublin, it begins to assume a rural aspect through an attractive tree lined stretch. It climbs up to a summit level through Mullingar at 94.3m higher than the entry level at Spencer Dock , then drops down to the River Shannon at approximately 40m above sea level. The canal is 146km in length with 46 locks 10 of which are double chambered and there is also a sea lock where the canal joins the River Liffey in Dublin. Approximately 55% of the Royal canal is embanked with 3 peat embankments at Cloonbreany, Begnagh and Ballymaclavy and a 3km embankment running around the town of Mullingar, Co. Westmeath. The Royal Canal was closed to navigation from 1960 and was only fully reopened in 2010 following a lengthy period of reconstruction.

5.2 Historic Flooding on the Royal Canal

5.2.1 Flooding due to embankment failure

The only significant breach of the Royal Canal embankments in recent years occurred in June 1993 on the 32.4km long level of the Royal Canal near the Longwood Aqueduct at Ballycooley, Longwood, Co. Meath. The breach was approximately 15m wide and occurred in a 6m high embankment. The water flowed through the breach into a low-lying strip of waste land and from there through a culvert under the railway and flooded a lane and some fields. A large area of land was flooded however the floods receded within 2 days and the breach did not result in any significant damage. A similar breach occurred in this area in the 1920s.

5.2.2 Flooding due to overtopping and operational issues

The most significant flooding due to overtopping was in the Spencer Dock area in Dublin city in 2002 when, due to the very high tide levels, the River Liffey was 0.4m higher than the level in the Royal Canal. The water flowed back up the Royal Canal and caused flooding of a maximum of 20 houses and 5 business premises.

Other flood events were extremely minor in nature Maynooth Harbour has occasional flooding of 1 garden if sluices in the lock gates are not left in the correct position and there is also occasional flooding of the road east of Darcy's Bridge and near Ferns Lock.

5.3 Remedial Action

Immediate repairs were made to the Longwood embankment which was rebuilt and sealed with a HDPE liner and puddle clay. The embankment is inspected regularly for any signs of a further breach.

In Spencer dock a new sea lock and flood protection system was constructed so that high tides can no longer cause this type of flooding.

5.4 Inspection and Maintenance Regime

All of the embankments in the Royal Canal are inspected regularly. Because of the level of risk the Mullingar embankments are inspected weekly while the Longwood, Downs and Ballymaclavy embankments are inspected monthly. Any necessary repairs are carried out immediately.

5.5 Potential Future Floods

The only area of potentially significant flood risk identified by this study is Mullingar where up to 200 houses could be flooded in the event of a failure of the embankment however

- this embankment has no history of failure
- has been strengthened and partially lined in recent years
- is inspected weekly for any sign of a potential breach
- remedial action would be put in place immediately

while the consequences of failure would be significant the likelihood of failure is extremely low and therefore this is not considered to be an area of significant flood risk.

Appendix 2 lists all reaches of the Royal Canal system giving dimensions, embankment details, inflows and potential flooding volumes.

6.0 Lough Allen Canal

6.1 History of Construction

The Lough Allen Canal is approximately 7.4Km long. It was constructed in the early 19th century to connect the Shannon Navigation at Battlebridge to Lough Allen at Drumshanbo Bridge through Acres Lake, near Drumshanbo. The canal fell into disuse after 1933 but was restored and reopened as far as Acres Lake in 1977 and fully reopened to Lough Allen in 1995.

Datum Levels (Poolbeg)

Ordinary summer Level for Lough Allen is 48.16m OD.

The canal is formed on two levels, (1) Drumshanbo to Acres lake to Drumleague Lock 3.18km at OSL of 49.85m. OD and (2) Drumleague to Battlebridge, a length of 2.67km at OSL (Ordinary Summer Level) of 46.45m OD

The Ordinary Summer level downstream of Battlebridge lock is 42.98m

6.1.1 Storage capacity

The volume of water stored at Level 1 is 221.7 x 10^3 cubic metres. The volume of water stored at Level 2 is 57.6 x 10^3 cubic metres. In times of low water, the level is maintained by an intake pumps. In times of heavy rainfall, levels are reduced by gravity flow through lock gate and land sluices.

6.2 Historic flooding on the Lough Allen Canal

While there is a historical reference to bank failure in 1876, the raised embankment section of the Lough Allen canal performed satisfactorily in recent flooding events.

6.3 Inspection and Maintenance Regime

Water Levels are managed daily by experienced personnel. Inspection regimes are in place to carry out regular inspections of the canals and amenities. Maintenance programmes are in place to address reported defects.

During a flood event water levels are monitored daily and sometimes hourly and water levels are managed to reduce pressure on the banks.

6.4 Potential Future Floods

Specifically, in consideration of potential floods arising from Waterways Ireland infrastructure and not from river flooding, the potential risks are associated with failure of raised canal banks, failure of lock gates, and potential vandalism, neglect or human error.

There is 3.18km of raised bank on Level (1) and 2.40km of raised bank on Level (02). This represents 35% and 45% of the canal banks respectively.

7.0 Jamestown Canal

7.1 History of Construction

The Jamestown Canal is located just south of the village of Jamestown on the Roscommon side of the Shannon. The canal is approximately 2.7km long. It was originally constructed in 1754 and upgraded in 1845. As a lateral canal the water level is determined by the upper region and is the same as the Carrick-on-Shannon to Jamestown stretch with an OSL of 42.98m OD. 24% of Jamestown canal is raised bank.

7.1.1 Storage capacity

As a lateral canal, the canal level is determined by the River Shannon, and therefore Jamestown Canal will be incorporated in the River Shannon Assessment.

7.2 Historic Flooding on the Jamestown Canal

The canal does not contribute to flood relief. During the 1999/00 and 2009 floods, temporary dams were required to reduce pressures on the canal banks.

7.3 Inspection and Maintenance Regime

Water Levels are managed daily by experienced personnel. Inspection regimes are in place to carry out regular inspections of the canal and amenities. Maintenance programmes are in place to address reported defects.

Appendix 3 contains summary details and dimensions.

8.0 Shannon Navigation – River Blackwater

8.1 River Blackwater

The River Blackwater is a small tributary of the River Shannon which joins the latter on its right bank about 2 miles upstream of Limerick City. The catchment area covers 15,500 acres and is entirely in Co. Clare with the village of Clonlara almost in the centre. From the southern slopes of the Slieve Barnagh range of hills the several streams which form the river flow from north to south where it then passes under the Headrace of the Ardnacrusha generating station west of Clonlara and thence in a south-westerly direction to join the Shannon. Most of the area is steeply sloped having Knockanuartha (1017ft) and Knockaphunta (845ft.) on its watershed. The lowlands (about 40ft) are just 10miles from the farthest point on the watershed. Due to the very steep slope of the catchment the river responds extremely quickly to rainstorms. Rainfall in the upper reaches discharges into the lowland area in about 2 ½ hrs after the commencement of a storm resulting in floods of high intensity and short duration causing damage to several hundred acres of land and at times flooding buildings.

8.2 Errina Plassy Canal

When the Commissioners of Inland Navigation and / or the Limerick Navigation Company in or about 1770 were making the River Shannon navigable from the head of the tideway at Limerick to Lough Derg they constructed a 6 ½ mile long lateral canal between Plassy and Errina just downstream of O'Briensbridge to overcome the falls at Doonass and Castleconnell. A supply of water from the Canal was taken from the River Shannon at the upstream end and near Errina. No other water was carried in the Canal. There were 6 navigation locks to overcome a total lift of about 56 feet. The Canal was not finally completed by the Directors General of Inland Navigation until about 1812. Ownership passed to the Limerick Navigation Company in 1829, to the Shannon Commissioners in 1839 to the Commissioners of Public Works in 1846 and to Waterways Ireland in 1999.

The Canal has not been used for navigation since 1930 when the Shannon Hydroelectric Scheme rendered the waterway unusable as a route to Lough Derg and a new navigation was incorporated in the Headrace Canal of the generating station.

The route of the Canal passes through the lower catchment area and flood plain of the River Blackwater. For topographical reasons it was not possible to carry the canal through the flood plain by aqueduct over the River Blackwater. The latter was diverted a short distance downstream of Mountcatherine Bridge, and both River and Canal were turned in a south-westerly direction to discharge into the Shannon at Plassy. Both run parallel and are separated by the canals right embankment for the entire length of the diversion. This embankment retained the Canal's operating water level which in summer was higher than the diverted river. During flood periods however the river level used to rise higher than the Canal's level and can overtop the Canal embankment in extreme conditions.

As part of the diversion works embankments and a sluice were also constructed along both banks of the River Blackwater diversions as far as the diversion point which is also the upstream limit of Waterway Ireland's jurisdiction for Navigation purposes. Upstream of the diversion point and on both banks of the River Blackwater these embankments are continued to higher ground just downstream of Mountcatherine bridge. It is not known by whom the latter were constructed or where responsibility for their maintenance rests. Waterways Ireland however carries out repairs from time to time on the embankments downstream of the diversion point. In 1984 a landowner removed part of the embankment on the left bank of the River Blackwater just downstream of Mountcatherine Bridge, leaving a large gap in the flood defence works and contributing to a large extent to the flooding of the 5th / 6th August 1986.

The purpose of the river embankments was to divert all the upland water upstream of Mountcatherine Bridge along the new channel and to protect the Canal from flooding. This conferred valuable immunity from flooding on the low lying lands of the Blackwater though which the Canal is carried as long as the embankments from Mountcatherine Bridge to Plassy are not breached or overtopped. Even if they are the extent of flooding cannot be as great as would be the case had the Canal not been constructed since the diversion carries the bulk of the Blackwater's discharge away from the old course. The new channel is ¾ mile shorter than the old course which was extremely tortuous and must have been inefficient to cater for any flood.

No records survive to indicate ancillary works carried out affecting the drainage of the low lying lands on either side of the Canal in the townlands of Mountcatherin, Newtown, Springfield and Cappavilla North. In times of flood the River Shannon backwaters along those drains and can cause flooding. The old course of the River Blackwater was abandoned but the outfall section from the River Shannon to a point about 1 mile south-east of Newtown Lock was retained to drain the balance of the Blackwater catchment not served by the diversion. The lands on either side of the canal are extremely low lying and of poor quality. Moderate rainfall causes waterlogging or flooding due to the small gradient and poor condition of the channels.

As the canal level is determined by the River Shannon it will be dealt with as part of the River Shannon study.

8.3 Past Floods on the River Blackwater

Flooding of 5th/6th August 1986

Exceptional rainfall occurred throughout the Southwest and eastern parts of the country on the night of 5th/6th August 1986 when there was record rainfall in Counties Kerry, Cork, parts of Limerick and Dublin. However the storm was less intense when it reached east Limerick and Clare. The following rainfall fell in a period of 12 hours, Ardnacrusha 40mm, Parteen 46.6mm and Shannon Airport 35.5mm. The Metrological Service stated that the rainfall could have been as high as 50mm in the Clonlara area and considerably higher in the upper reaches of the Blackwater.

The discharge in the River Blackwater as a result of the rainstorm appears to have been exceptionally high. The flood peaked in the early hours of the 6th August and an estimate of the peak discharge was recorded as 2,500 cusecs.

Part of the discharge flowed directly through a breach in the left bank where a local landowner had removed a large section of embankment. In doing so one dwelling house and office was flooded to a depth of 2 and a half foot while another house was flooded to a depth of 6 inches.

Further downstream there was more flooding on the left bank as a result of damage to the embankments by cattle but no houses were affected.

8.4 Remedial Action

The embankments were repaired.

8.5 Inspection Regime

The banks are inspected regularly, once weekly and necessary repairs, removal of trees and debris carried out. The banks are also checked after high winds and heavy rain.

8.6 Potential Future Floods

If the embankment was breached was breached at the same location again, then there is the potential for more flooding of dwelling houses. There are now 27 houses at that location and, depending on their floor levels, some or all of those could be at risk of flooding. This falls outside the significant flood risk as defined for the PRFA Report.

The Inspection Regime mentioned above is in place and there was no flooding at this location in the extreme flood event of 2009.

Appendix 1 **Grand Canal** **Lengths and Estimated Flood Volumes**

	Level Name	Water Level	Length	Est embanked length	Embankment Condition	Depth	Avge Width	Volume	Spread Radius	Overflows	Receiving Water	Intakes to Canal	Historic Flooding	
		mOD	km	(m)		m	m	m^3	m					
Grand Canal Dock	**GCD**	3.39	1.2	0		4.5	80	432000	742			DCC Stormwater outfall Ringsend		Ringsend Sea Lock & Grand Canal Docks
Circular Line	**C1**	4.12	0.2	0		2.02	12	4836	78					Maquay Br.
Circular Line	**C2**	6.98	0.2	0		2.20	12	5268	82					Lr. Mount Street
Circular Line	**C3**	9.85	0.4	0		2.21	12	10613	116					Upr. Mount Street
Circular Line	**C4**	12.45	0.6	0		2.06	12	14803	137					Baggot Street
Circular Line	**C5**	15.13	0.6	0		1.96	12	14119	134					Leeson Street
Circular Line	**C6**	18.05	0.4	0		2.10	12	10094	113					Charlemont St.
Circular Line	**C7**	20.68	2.4	0		1.97	12	56707	269					Portobello
Main Line	**1**	24.90	0.6	300 NB	Fair	1.99	12	14328	135					Suir Road Bridge
Main Line	**2**	28.90	1.0	90 NB	Fair	2.65	12	31848	201	Overflow below 3rd Lock	Camac River			Goldenbridge
Main Line	**3**	34.87	0.4	0		1.98	12	9494	110					Blackhorse Bridge
Main Line	**4**	38.80	0.4	400 NB Slightly embanked	Fair	1.96	12	9427	110					
Main Line	**5**	41.90	0.4	400 NB&SB Slightly embanked	Fair	2.61	12	12504	126	Take-off point Dublin City Council above 5th Lock. Take-off point for CIE	DCC / CIE			
Main Line	**6**	45.21	0.8	600 slightly embanked SB	Fair	2.04	12	19613	158				Flooding of 5 no. businesses occurred including some damage due to vandalism at locks and bank overtopping Nov 2005 - measures since taken to reduce risk of this re-occurring	
Main Line	**7**	48.89	0.8	130 NB&SB	Fair	1.97	12	18912	155					Ballyfermot Bridge
Main Line	**8**	51.59	1.8	0		2.19	12	47347	246	Take-off point Dublin City Council at Filter beds above 8th Lock	DCC			
Main Line	**9**	56.16	0.4	500	Fair	2.05	12	9835	112					Clondalkin Bridge
Main Line	**10**	59.32	0.4	180	Fair	2.28	12	10925	118					
Main Line	**11**	62.47	3.0	0		2.02	12	72648	304	Griffeen Overflow	Griffeen River			
Main Line	**12**	66.05	7.4	1400 NB 450 SB	Fair	1.99	12	176534	474	Behans overflow	Shinkeen River			Lucan Road Bridge
Main Line	**13**	71.16	6.0	1250 NB 900 SB	Fair	2.05	12	147600	434			Morrell below lock 14	Flooding occurred in Ardclough village in winter 2009, canal bank overtopping likely contributing to this - the bank has since been raised.	
Main Line	**14**	73.12	0.6	180 NB 0 SB	Fair	2.06	12	14810	137					Devonshire Bridge
Main Line	**15**	75.73	7.2	600 NB 320 SB	Fair	2.01	12	173837	470	Lein Aqueduct overflow / overflow to Morrell @ 15th Lock	Liffey & Morrell Rivers	Monread east of Sallins		
Main Line	**16**	78.32	1.0	0		1.94	12	23340	172					Digby Bridge
Main Line	**17**	81.07	1.4	90 NB	Fair	2.07	12	34810	211					Landenstown Bridge
Main Line	**18**	82.45	6.6	1100 NB 900 SB	Poor	1.93	12	152777	441			Milltown Feeder		Bog of Moods Roberstown
Naas Branch	**Naas**	varies	5.0	0		2.00	12	120000	391	Overflow Between Locks N2 & N3	From bypass drain / Rathasker	Rathasker in Naas Harbour		
Corbally Branch	**Corbally**	n/k	8.0	1200WB 200 EB		1.50	12	144000	428	2 Overflows	Via drains to Liffey	2 Intakes - Corbally Harbour & Hoares Bridge		
Main Line	**19**								0					Lowtown (Summit Level)
Main Line	**20**		14.5	12500	2500 Soft	2.00	12	348000	666		Gravity Overflow to Slate River		Aug 93 Approx 20000 - 30000 cumecs flooding 3 houses inconvenienced during replacement of culvert	Allenwood
Edenderry Branch									0					Edenderry Harbour
Main Line	**21**		31.5	25500	22500 Soft	2.00	12	756000	981		Overflows to Boyne, Barrow & Tullamore/Brosna	7 Uncontrolled drains between Daingean & Ballycommon		Edenderry / Daingean
Main Line	**22**		1.4	1400	Solid	2.00	12	33600	207		Overflow to Tullamore / Brosna Rivers			Ballycommon
Main Line	**23**		0.6	600	Solid	2.00	12	14400	135		Overflow to Tullamore / Brosna Rivers			Cappyroe Bridge
Main Line	**24**		3	300	Solid	2.00	12	72000	303		Overflow to Tullamore / Brosna Rivers			
Main Line	**25**		0.6	600	Solid	2.00	12	14400	135		Overflow to Tullamore / Brosna Rivers			
Main Line	**26**		0.8	800	Soft	2.00	12	19200	156		Overflow to Tullamore / Brosna Rivers			Cappincur Bridge
Tullamore Branch									0					Tullamore Harbour
Main Line	**27**		3	2500	1500 Soft	2.00	12	72000	303		Overflow to Tullamore / Brosna Rivers			Tullamore
Main Line	**28**		0.4	400	Solid	2.00	12	9600	111					
Main Line	**29**		3.4	3400	Solid	2.00	12	81600	322		Overflow to Tullamore / Brosna Rivers			Ballycowan Bridge
Main Line	**30**		7	7000	Solid	2.00	12	168000	462		Overflows to Tullamore, Clodiagh/Brosna Rivers	Newtown Supply		Ballincloughin Bridge
Main Line	**31**		0.8	800	Solid	2.00	12	19200	156		Overflow to Brosna			Cornalour Bridge
Main Line	**32**		15.6	14800	14000 Soft	2.00	12	374400	690		Overflow to Silver Brosna Rivers	Derrycooley Supply		Pollagh
Main Line	**33**		2	2000	Solid	2.00	12	48000	247		Gravity Overflow to Brosna			Belmont Bridge
Main Line	**34**		3.6	2800	Solid	2.00	12	86400	332		Brosna River			Clononey Bridge
Main Line	**35**		2	800	Solid	2.00	12	48000	247		Brosna / Shannon Rivers			Shannon Harbour
Main Line	**36**		0.4	200		2.00	12	9600	111					Junction with Shannon
Barrow Line	**19**		2.6	500	Fair	2.0	12	62400	282					Lowtown
Barrow Line	**20**		3.4	800	Fair	2.0	12	81600	322					
Barrow Line	**21**		0.2	200	Fair	2.0	12	4800	78					
Barrow Line	**22**		4.8	4800	Fair	2.0	12	115200	383			White Eye Supply		
Barrow Line	**23**		4.8	2600	Fair	2.0	12	115200	383					Rathangan
Barrow Line	**24**		7.6	3600	Fair	2.0	12	182400	482					
Barrow Line	**25**		2.4	1000	Fair	2.0	12	57600	271					Monasterevin
Barrow Line	**26**		21.0	8000	Fair	2.0	12	504000	801			Annaknock Supply		
Barrow Line	**27**		0.8	0		2.0	12	19200	156					
Barrow Line	**28**		0.4	0		2.0	12	9600	111					Athy

Notes: **NB - North Bank** SB - South Bank **Occasional ponding around at locks during boat movements - not considered as flooding**