Appendix M5

Hydrological Impact Assessment

RPS

Hydrological Impact Assessment

JANUARY 2009

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NON-TECHNICAL SUMMARY

This hydrological assessment outlines the existing environment along the proposed pipeline route based on the level of information currently available with regard to hydrology. To this end predicted impacts have been assessed in accordance with methodology set out in the *NRA Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (Draft)* (NRA 2007).

The proposed scheme has the potential to cause a medium scale localised flood risk in the vicinity of the proposed watercourses during the construction phase of the works. This could occur due to a reduction of stream/river flow conveyance area if the proposed stream/river diversion works were to be inadequately sized / designed. This may also be caused from collapsing of unstable river/stream/trench banks. Such potential impacts would only occur for the open cut crossings of the streams/rivers. Localised flooding in the vicinity of the proposed river/stream crossings, particularly, at the Leenamore River crossing can occur from a joint effect of high fluvial and tidal flood levels in Sruwaddacon Bay. It is recommended that the proposed river/stream crossings be completed during a dry weather period and with suitably sized fluming/diversionary methods in place. Methods for bank reinstatement will be agreed in advance with the relevant authorities such as NWRFB and NPWS.

There is potential for the water quality of Sruwaddacon Bay and its tributaries to be temporarily affected by the proposed pipeline during construction due to possible run-off. The main threats to water quality as a result of construction include: (i) surface water discharge from the temporary working areas during construction and (ii) surface water discharge from the existing watercourses during open-cut crossings (iii) and construction in the bay (if an intervention pit is required). It is recommended that proper sedimentation and filtration of surface water from open cut crossings and construction areas be provided before being discharged into the existing watercourses.

No surface water abstraction points are present in the immediate vicinity of the proposed pipeline route.

A separate assessment of the eco-hydrology of the blanket bog traversed by the proposed route is provided in Appendix M of the EIS. Overall, the predicted impact on the regional hydrology in this regard will be minimal.

1.0 INTRODUCTION

This report examines the existing hydrological environment of the proposed Corrib Onshore Pipeline route. The report also assesses all associated potential impacts that the proposed pipeline construction might have on the existing hydrological regime. The information provided in this report is additional to that provided in Chapters 13 and 15 of the EIS.

The principal objectives of this study are to:

- Complete a desk study and to obtain hydrological data associated with the proposed pipeline construction.
- Identify, describe and evaluate sites of known or potential hydrological interest.
- Assess the significance of the likely impacts of the proposed scheme on the existing hydrological environment along the proposed pipeline route including the residual impact.
- To propose mitigation measures required to minimise the likely impacts.

The location of the proposed pipeline route is illustrated in the Alignment Sheets contained in Appendix A1 of the EIS.

1.1 METHODOLOGY

This hydrological assessment was carried out by the members of the RPS Design Team for the Corrib Onshore Pipeline project. The assessment was based on a desk study of available information and a site visit carried out along the proposed route in August 2008.

This report is based on a desk study and a site visit and was prepared having regard to;

- *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes* (NRA 2008);
- *Environmental Impact Assessment Guidelines of National Road Schemes – A Practical Guide* (National Roads Authority (NRA) 2004;

- *Advice Notes on Current Practice in the preparation of Environmental Impact Statements* (EPA 2003);
- *Guidelines on the information to be contained in Environmental Impact Statements* (Environmental Protection Agency (EPA) 2002); and
- *Guidelines for the Crossing of Watercourses during the construction of national Road Schemes (NRA).*

The following sources of information were used in order to complete the assessment:

- Flood data was obtained from the website maintained by the Office of Public Works (www.opw.ie),
- Other relevant websites consulted were those of the EPA (www.epa.ie) and Met Eireann (www.meteireann.ie), and
- Ordnance Survey 1:50,000 Discovery Series.

A site visit to the project study area was undertaken by RPS in August 2008**.**

2.0 PROPOSED DEVELOPMENT

Details on the proposed development are provided in Chapters 4 and 5 of the EIS.

The proposed route will cross two small streams, one estuarine river and two crossings of Sruwaddacon Bay (**Drawing No. MI2188** in Appendix B). The proposed route will also run through blanket bog areas. These areas are highlighted in **Drawing No. MI2188** in Appendix B of this Report.

Specialist trenchless construction techniques have been proposed for the two crossings of Sruwaddacon Bay. It is proposed to use open-cut techniques for the other river/stream crossings. In the blanket bog areas a special construction method referred to as the “Stone Road” method is proposed. The details of these construction methods have been discussed in Chapter 5 of the EIS.

3.0 EXISTING ENVIRONMENT OF THE PROPOSED PIPELINE

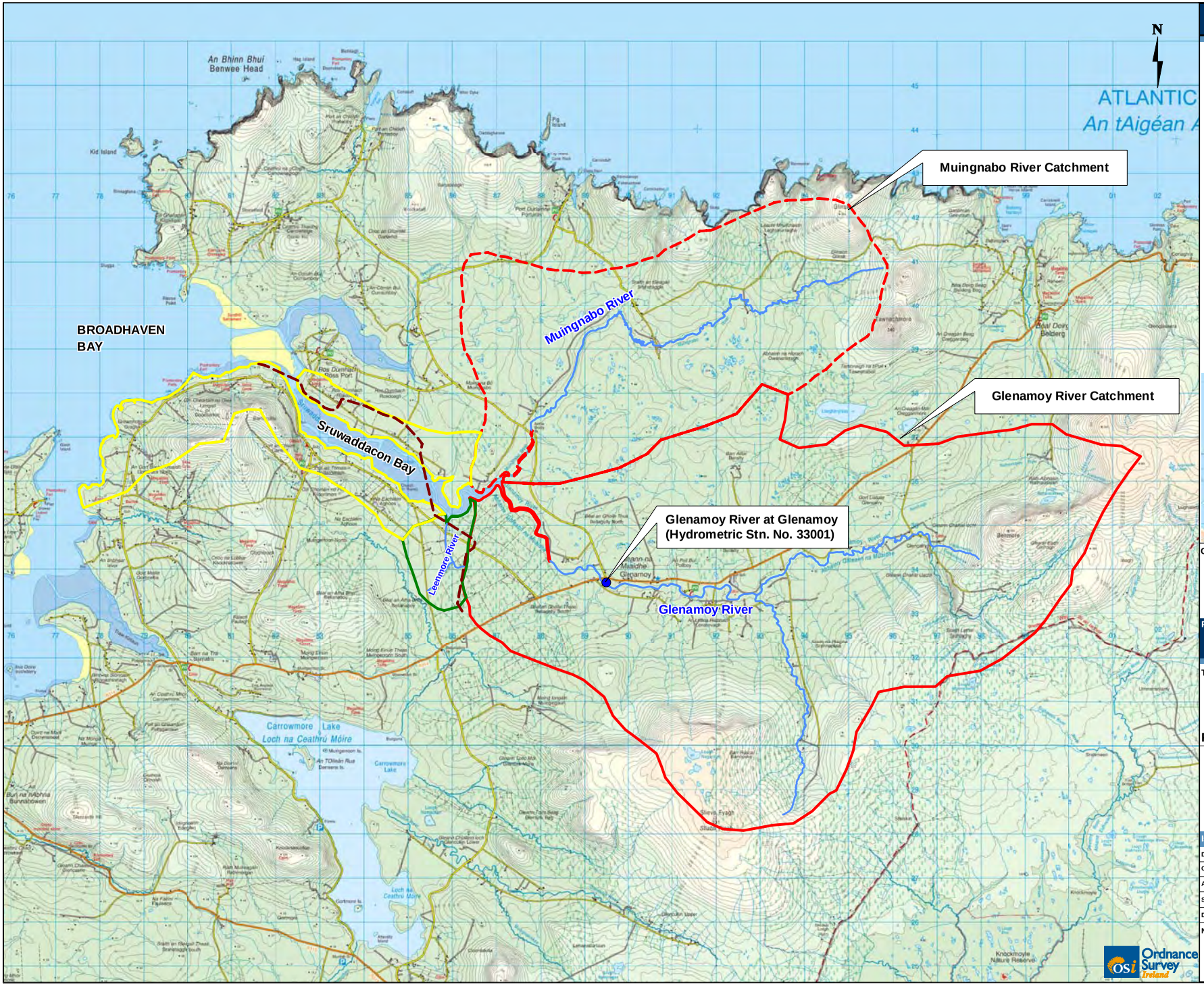
3.1 REGIONAL HYDROLOGY

The proposed pipeline route mainly lies within Sruwaddacon Bay catchment area. The two largest rivers draining into Sruwaddacon Bay are the Glenamoy and Muingnabo Rivers. Sruwaddacon Bay catchment forms part of the National Hydrometric Area – 33 – and falls under the Western River Basin District (WRBD). Refer to **Figure 1** for the extents of the associated river catchment areas draining into Sruwaddacon Bay together with a layout of the proposed pipeline route. A short section of the route within the Bellanaboy Bridge Gas Terminal is not shown within any catchment as it is facilitated by the surface water drainage in the Terminal site.

The Glenamoy River rises in a mountain located at Glenagh, Co. Mayo (land elevation 304mOD malin head) approximately 20km northeast of its confluence with Sruwaddacon Bay. The Glenamoy River has an approximate catchment area of 87km^2 upstream of this confluence. The Muingnabo River rises in a high ground at Glenagh (at land elevation of 265mOD malin head) approximately 15km upstream of its confluence with Sruwaddacon Bay. This river has an approximate catchment area of 40.14 km^2 upstream of the confluence. Both the river catchments are steeply sloped towards Sruwaddacon Bay with an approximate main channel slope of 1 in 85. The soil types within both of the catchments areas vary between the FSR (The UK Flood Studies Report, NERC 1975) soil types 3 and 5, suggesting moderate to very low winter rain acceptance potential. The long term average annual rainfall within Sruwaddacon Bay catchment areas varies between 1,142 mm and 1,500mm (Met Eireann, 2008).

In addition to the above mentioned two main river catchments, a number of local rivers/stream and some lands surrounding Sruwaddacon Bay also drain into this Bay (**Figure 1**).

The main rivers, their associated tributaries and other land drains located within the Sruwaddacon Bay catchment areas form part of the regional OPW arterial drainage network (**Figures 1 & 2**).



Legend

- Proposed Pipeline Route
- Muingnabo River Catchment
- Glenamoy River Catchment
- Leenmore River Catchment
- Additional Catchment Areas
- River Station
- River

Client: Corrib natural gas

Project: *Corrib Onshore Pipeline*

Title

River Catchments

Figure 1

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Flow records for the Glenamoy River at Glenamoy (Hydrometric Station No.33001, **Figure 1**) have been obtained from the EPA Hydro-data website. Mean daily flow records for a period from 1977 to 2007 are available for this station, a summary of which is presented in **Table 1.** The recorded mean annual maximum and 95%tile flows at this location are 27.87m^3/s and 0.24m^3/s respectively. This relatively high rate of mean annual maximum flow rate (0.366m^3/s/km^2) can be attributed to its steep catchment slope.

Table 1 Summary of Flow Records for the Glenamoy River at Glenamoy (Hydrometric Station No. 33001).

Upstream Catchment Area (km^2)	Mean Annual Flow (m^3/s)	Rainfall (mm)	95 Percentile Flow (m^3/s)	Annual Maximum Flow	
				Mean (m^3/s)	Median (m^3/s)
76.1	2.91	1467	0.24	27.87	27.50

No flow records for the Muingnabo Rivers in the vicinity of the study area were available.

The Glenamoy and Muingnabo rivers generally flood every winter after a heavy prolonged rainfall. These catchments have experienced a number of high floods in the past. The worst flooding in this catchment occurred in 1984 (21st September), 1989 (27th October) and in September 2003 (date not known). Much of the low lying flood plains of the River catchments flooded during these flood events. However, the OPW flood hazard map does not show any flood prone points in the vicinity of the proposed pipeline route (**Figure 2**).

A major landslide event occurred in the Pollatomish area in September 2003, during a period of very heavy rainfall. There were about 40 individual slides of peat and weathered rock, varying between 15m^3 to 20,000m^3 which resulted in considerable damage to roads, bridges and property and the evacuation of over 40 families from their homes (Geological Survey of Ireland, 2006). The primary cause of the landslides in the Pollatomish area was exceptional rainfall following a dry summer period, of such intensity as to overwhelm natural drainage systems in the relatively thin overburden layers of peat and weathered rock (see Chapter 15 of the EIS for further information).

Flooding of low lying lands in the vicinity of the proposed Sruwaddacon Bay crossings can be caused by joint occurrences of high fluvial flows from the upstream river catchments and high tide levels in the Broadhaven/Sruwaddacon Bay. Unfortunately no tidal recorders are available in Sruwaddacon Bay but a tidal survey carried out in July 2007 (see Chapter 14 of the EIS) showed that the highest observed tide level in Broadhaven Bay was in the order of 3.8m above chart datum. The predicted highest tide level in Broadhaven Bay showed in the 2008 Tide Table for Broadhaven Bay (Proudman Oceanographic Laboratory) was in the order of 3.9m above chart datum (March, April and October).

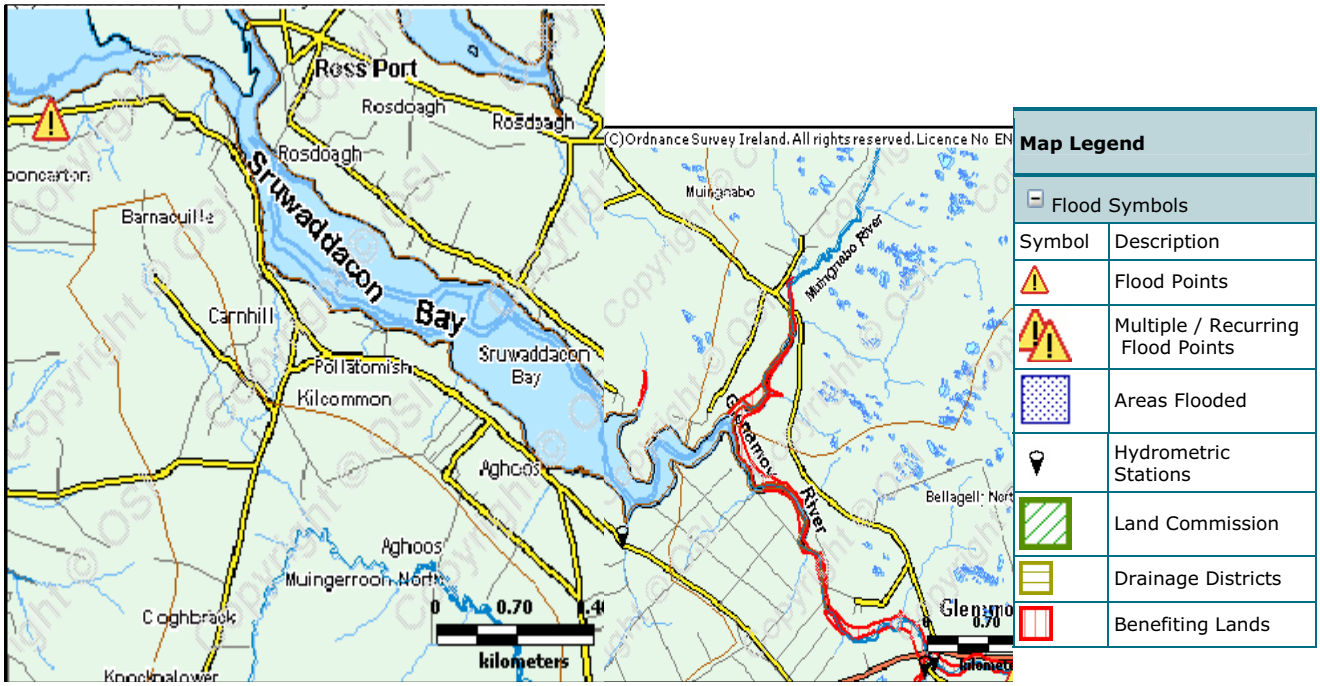


Figure 2 An extract of the OPW Flood Hazard Maps showing the subject Study Area (Source - www.opw.ie).

Water Quality Records for the watercourses in the vicinity of the proposed pipeline route were sourced from the Environmental Protection Agency (EPA). An assessment carried out by EPA on these water quality records showed that the Glenamoy River has a Biotic Index (Q-value) of Q4 at Glenamoy (located approximately 5km upstream of the confluence with Sruwaddacon Bay), suggesting the river has "good status" water quality [*Water Quality in Ireland 2001-2003, EPA 2005*] (**Figure 3**). Bathing water quality in the vicinity of the proposed landfall valve has been assessed as '*good*' and complies with EU Guide Values. Further information on the water quality in the rivers and streams traversed by the proposed route is provided in Chapter 13 of the

EIS, while issues regarding the water quality of Sruwaddacon Bay are discussed in Chapter 14 of the EIS.

A recent assessment of the water quality status for the watercourses within the Sruwaddacon Bay catchment areas has also been carried out under the WRBD project (**Figure 3**). **Table 2** gives an overview of the risks assessed for these watercourses. Both the Glenamoy and Muingnabo Rivers in the immediate upstream vicinity of the confluences with Sruwaddacon Bay were assessed as "***1b- Probably at Significant Risk***'. The study also showed that Sruwaddacon Bay water (Transitional water) is at a status of "*probably at risk not achieving good status by 2015*". The source of the water pollution at the upper section of these watercourses was mainly identified as siltation resulting from land clearing practices and agricultural practices within the catchment areas.

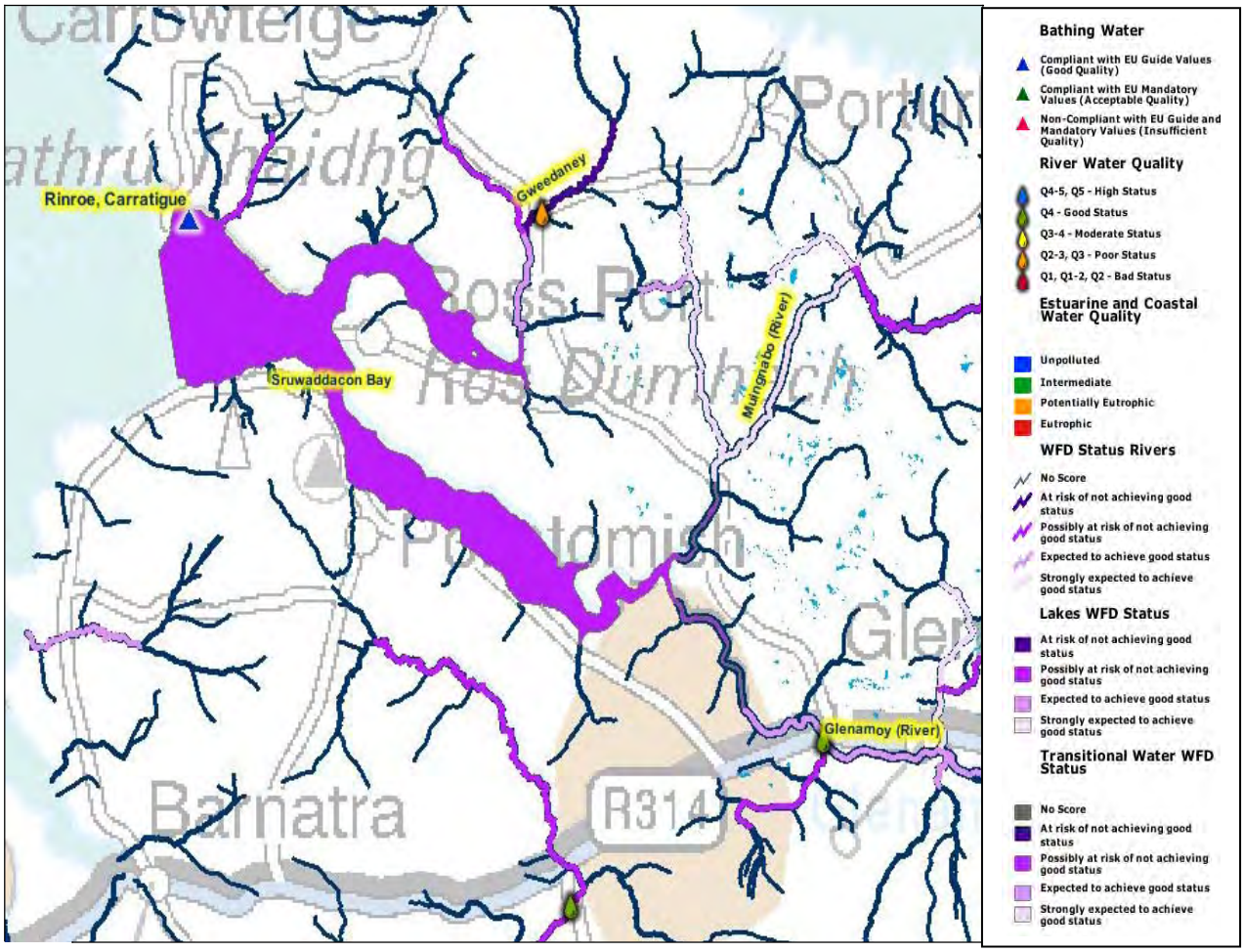


Figure 3 Water Quality Map and Risk Assessment for the surface water bodies located within the study area (Source - www.epa.ie).

Table 2 WRBD – Water Quality Risk Assessment Results

Risk Factors	Risk			
	Glenamoy River	**Muingnabo River**	**Transitional Water (Sruwaddacon Bay)**	**Coastal Water (Broad Haven), EPA**
River Risk Assessment Summary	1b- Probably at significant risk	1b–Probably at significant risk	1b– Probably at significant risk	Unpolluted

3.2 EXISTING ENVIRONMENT OF PROPOSED PIPELINE

The route description is provided in Chapter 4 of the EIS. Table 3 below outlines the locations and description of streams and river crossings along the proposed route. (Refer to **Drawing No. MI2188** in Appendix B for the locations of these crossings). At the proposed crossing, the Leenamore River is approximately 40m wide and 2.5m deep below its banks (**Photo 3** in Appendix A). Although, a small first order stream exists in the townland of Barnacuille in the vicinity of the temporary working area, it is not anticipated that it will be interfered with during the works.

It was reported locally that the above mentioned rivers/streams generally flood their banks every winter after a heavy prolonged rainfall. However OPW flood hazard maps do not shown any flood prone areas along the proposed pipeline or in the vicinity of the proposed crossings.

Table 3 List of Watercourses to be crossed by the proposed pipeline.

Approximate Chainage (km)	Location/Townland	Brief Description
84.05-84.5	Lower Sruwaddacon Bay crossing	This is the outer section of Sruwaddacon Bay containing the main low-tide channel in and out of the bay; it is fully marine.
88.6-89.5	Upper Sruwaddacon Bay crossing	This is the upper-mid section of Sruwaddacon Bay containing – the migratory route for salmon and seatrout in and out of the Glenamoy and Muingnabo Rivers.
90.1	Leenamore River	A small second order[1] stream draining to the southeast corner of Sruwaddacon Bay, known locally as the Leenamore.
90.5	Na hEachú (Aghoos)	A first order stream close to the roadside about 0.5km east of the most downstream crossing of the Leenamore River.
91.5	Na hEachú (Aghoos)	A small first order stream/drain ~0.7km north of the Bellanaboy Bridge Gas Terminal site.

Surface runoff from the existing lands along the proposed pipeline route drains into Sruwaddacon Bay as overland flow and also via a number of local streams and drainage ditches (**Figure 2 & Drawing MI2188**).

The existing water quality status for all watercourses in the vicinity of the proposed pipeline route has been discussed in the Section 3.1 and further in Chapter 13 of the EIS.

No surface water abstraction points have been identified within the subject study area. Both the Glenamoy and Muingnabo rivers are perennial flow rivers. Sruwaddacon Bay also has a significant amenity value (see Chapter 6 of the EIS).

[3] A second order stream is formed by the joining of two first-order streams

4.0 IMPACT ASSESSMENT

4.1 GENERAL

There is the potential for Sruwaddacon Bay and its associated tributaries located in the vicinity of the proposed pipeline route to be impacted by the proposed development during the construction phase of the pipeline works. The hydrology of the associated blanket bog areas may also be affected by the proposed development, but this is addressed in a separate assessment on ecohydrology (see Appendix M(5) of the EIS..

The potential impact on various hydrological aspects such as flooding, drainage, water quality and amenity value likely to be caused by the proposed pipeline construction have been examined and appropriate mitigation measures have been proposed in accordance with the "*Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (Draft)* (NRA 2007)".

All relevant authorities including OPW, the North Western Regional Fisheries Board and the Western River Basin District Office (WRDB) were contacted in order to get feedback on any likely adverse impact that the proposed route option might have on the environment. This information along with the EPA & WRBD water quality status data for the associated watercourses were taken into account in carrying out this hydrological impact assessment for the proposed pipeline route.

4.2 IMPACT ASSESSMENT

As the pipeline will be laid beneath the beds of the associated watercourses (minimum depth of cover is 1.6m), the crossings will not cause any constriction to the existing flood flow path. Any adverse impact on the current flood levels in the associated rivers/streams or in their flood plains is not therefore expected during the operational phase of the works.

However, during the construction phase of the works, temporary localised flooding of lands in the vicinity of the proposed river/stream crossings might occur. This may occur due to a reduction of stream/river flow conveyance area if the proposed

diversion works were to be inadequately sized / designed. This may also be caused by the collapsing of unstable river/stream/trench banks. This second scenario would only occur in the cases of the river/stream crossings, where it is proposed to use 'open-cut' techniques for laying pipe in the river beds. Therefore, it is recommended that these proposed river/stream crossings be carried out during a period where flooding risks are low. An examination of historical flood records for the Glenamoy River at Glenamoy hydrometric station shows that most of the worst fluvial flooding in Sruwaddacon Bay catchments occurred during the months of September and October. Flooding in the vicinity of the proposed river crossings, particularly, at the Leenamore River crossing can occur from a joint effect of high fluvial and tidal flood levels in Sruwaddacon Bay. Therefore it is recommended that the works be undertaken again when flooding risks are low and that the stream diversion works for the river/stream crossings be adequately designed to take the above into consideration. Furthermore, all banks will be reinstated as agreed in advance with the relevant authorities.

If works are to be carried out adjacent to the foreshore when carrying out the Sruwaddacon Bay crossings and the Landfall Valve Installation works, then the high tide levels in its vicinity as discussed earlier in Section 3.1 should also be taken into consideration when planning the works.

The proposed pipeline will be crossing a number of streams along its route which form part of the regional OPW arterial drainage scheme. This scheme has improved a number of land areas located in the vicinity of the proposed pipeline route which may have been liable to periodic flooding or water logging prior to scheme (south of Sruwaddacon Bay, Figure 2). Any potential increase in water logging in these lands during the construction stage of the scheme should be minimised."

Changes/alterations in the existing surface water drainage regime along the proposed pipeline route will be insignificant. Surface water runoff from the working areas, particularly along the northern bank of Sruwaddacon Bay will be drained as overland flow directly into the Bay, while from the southern bank working areas surface water will discharge via a number of local streams/land drains. The increase in the storm runoff volume caused by the increased impermeable areas both during and after construction will be insignificant. However it is recommended that proper

sedimentation and filtration of surface water from construction areas be provided before being discharged into the existing watercourses.

The impact of construction on hydrology in the blanket bog areas has been addressed in a separate report (see Eco-Hydrological and Eco-Hydrogeological Impact Assessment Report in Appendix M) however the predicted impact on the regional hydrology in this regard will be minimal.

There is the potential that the water quality of Sruwaddacon Bay and its tributaries may be affected by the proposed pipeline construction. The main threats to water quality as a result of construction include: (i) surface water discharge from the temporary working areas during construction, (ii) surface water discharge from the existing watercourses during open-cut crossings and (iii) construction in the bay (if an intervention pit is required).

Any deterioration of the river/coastal/transitional water quality caused by the pipeline construction will be minimised and where possible avoided both during construction and reinstatement of the works. It is recommended that proper sedimentation and filtration of surface water from open cut crossings and construction areas be provided before being discharged into the existing watercourses. It is also recommended that the proposed river/stream crossings be completed during a dry weather period and with suitably sized fluming/diversionary methods in place. Methods for bank reinstatement will be agreed in advance with the relevant authorities such as NWRFB and NPWS.

No surface water abstraction points have been identified in the vicinity of the proposed pipeline route.

Table 4 overleaf below summarises the hydrological impact assessment results.

Table 4 Assessment of Hydrology Impacts for the proposed pipeline.

Attribute	Attribute Importance	Potential Impact	Level of Impact	Mitigation Measures	Residual Impact
Flooding Risk	Medium	Medium flooding risk in the vicinity of the proposed river/stream crossings caused by the high fluvial and tidal flood levels during the construction phase of the works.	Moderate Negative	Stream/river diversion works should be designed in order to deal with the likely worst fluvial and tidal flooding in the vicinity of the proposed river/bay crossings. It is proposed to undertake the stream/river crossing works during a dry weather period. As it is proposed to tunnel underneath the Bay, flooding will not be an issue.	None
Drainage	Medium	See Eco-Hydrological and Eco-Hydrogeological Impact Assessment Report in Appendix M regarding the potential impact on drainage in the blanket bog areas. The impact of the surface water drainage from the remaining sections of the pipeline route will be insignificant.	Moderate Negative	It is recommended during the construction phase of the works, that proper sedimentation and filtration of surface water runoff and/or pumped water be undertaken before being discharged into the adjacent water courses. See Eco-Hydrological and Eco-Hydrogeological Impact Assessment Report in Appendix M for mitigation measures in the bog.	Insignificant residual impact on the existing hydrological/drainage regime.
Water Quality	High	Potential Temporary Deterioration of the Sruwaddacon Bay and the associated rivers/streams water quality caused by the surface runoff/pumped water during the construction phase of the works.	Major Negative	It is recommended during the construction phase of the works, that proper sedimentation and filtration of surface water runoff and/or pumped water be undertaken before being discharged into the adjacent water courses.	Insignificant residual impact
Water Quantity (abstraction)	Low	No impacts identified	Neutral	None	None

5.0 CONCLUSIONS AND RECOMENDATIONS

This hydrological assessment has outlined the existing environment along the proposed pipeline route based on the level of information currently available with regard to hydrology. To this end predicted impacts have been estimated.

The proposed scheme has the potential to cause a medium flood risk in the vicinity of the proposed water course crossings during the construction phase of the works. This may occur due to a reduction of stream/river flow conveyance area if the proposed diversion works are inadequately sized / designed. This may also be caused by the collapse of unstable river/stream/trench banks. Flooding in the vicinity of the proposed river crossings, particularly, at the Leenamore River crossing may occur from a joint effect of high fluvial and tidal flood levels in Sruwaddacon Bay. It is recommended that the proposed river/stream crossings be completed during a dry weather period and with suitably sized fluming/diversionary methods in place. Methods for bank reinstatement will be agreed in advance with the relevant authorities such as NWRFB and NPWS.

The main threats to water quality as a result of construction include: (i) surface water discharge from the temporary working areas during construction and (ii) surface water discharge from the existing watercourses during open-cut crossings (iii) and construction in the bay (if an intervention pit is required). It is recommended that proper sedimentation and filtration of surface water from open cut crossings and construction areas be provided before being discharged into the existing watercourses.

No surface water abstraction points are present in the vicinity of the proposed pipeline route. It is recommended that attention to be paid to existing activities to preserve the existing fishing, bathing, boating and navigation activities in the vicinity of Sruwaddacon Bays both during and after construction of the pipeline works.

Overall, the predicted impact on the regional hydrology will be minimal.

REFERENCES:

Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA 2008),

Environmental Impact Assessment Guidelines of National Road Schemes – A Practical Guide (National Roads Authority (NRA) 2004,

Advice Notes on Current Practice in the preparation of Environmental Impact Statements (EPA 2003),

Guidelines on the information to be contained in Environmental Impact Statements (Environmental Protection Agency (EPA) 2002),

Guidelines for the Crossing of Watercourses during the construction of national Road Schemes (NRA)

Natural Environmental Research Council (NERC), 1975: Flood Studies Report" Vols 1 to 5, London.

Geological Survey of Ireland, 2006. A report of the Irish Landslides Working Group, Editor Ronnie Creighton.

Appendix A

Photographs

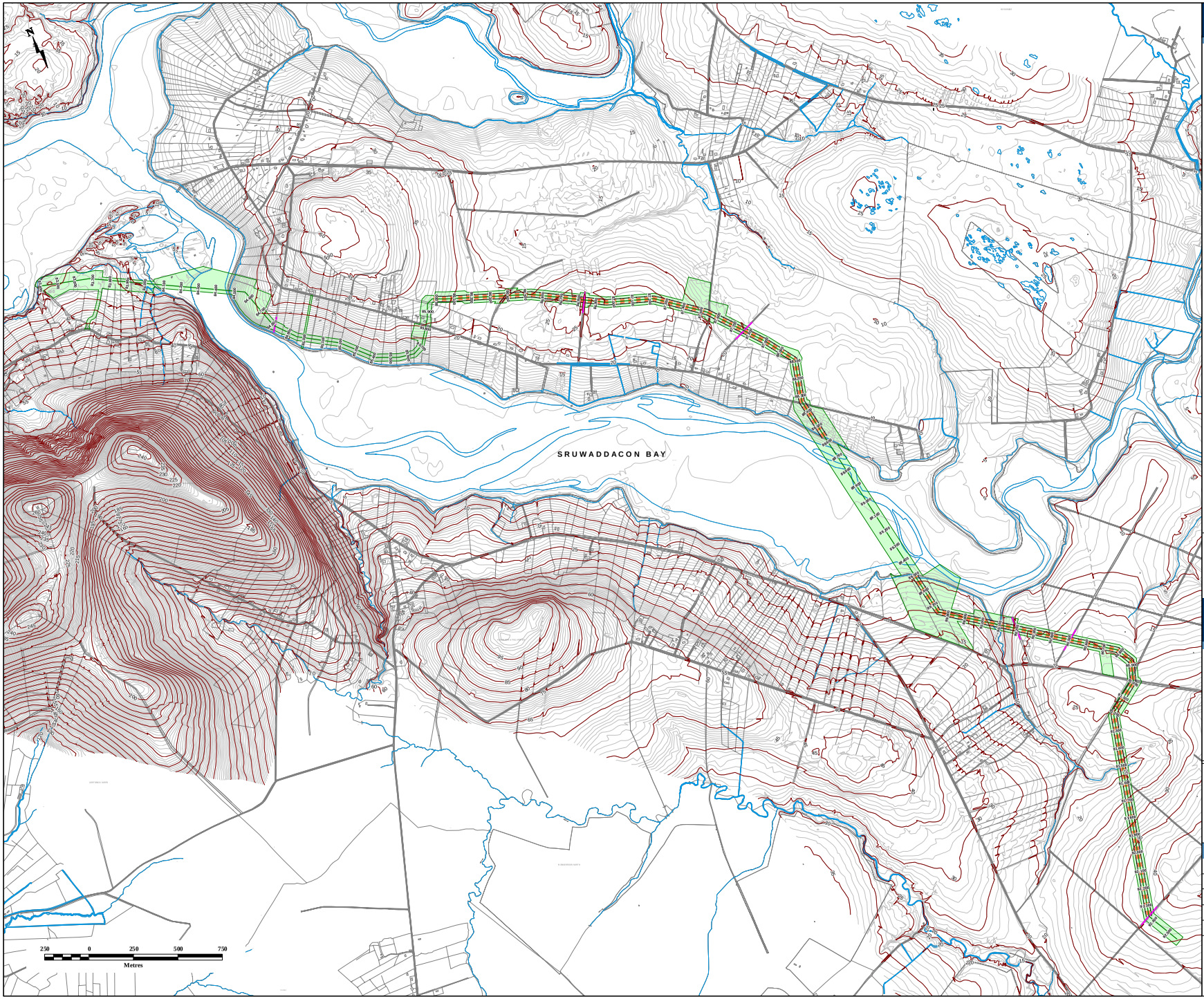
Photo 1: Lower Sruwaddacon Bay Crossing

Photo 2: Upper Sruwaddacon Bay Crossing

Photo 3 : Leenamore River Crossing

Appendix B

Drawing No. MI2188



Legend

- Streams
- Proposed Route
- Temporary Working Area
- Drainage Ditch
- Blanket Bog Area/Stone Road

Corrib natural gas

Project
CORRIB ONSHORE PIPELINE

Title

Proposed Pipeline Route and River Crossings

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Appendix C

Annual Maximum Flow Records

Annual Maximum Flow Records

Glenamoy River at Glenamoy (Hydrometric Station No.33001)

Year	AM Flow m3/s	Date
1977	32.7	28/09/1978
1978	30.7	15/11/1978
1979	35.9	25/11/1979
1980	28.2	15/09/1981
1981	22.3	01/11/1981
1982	26.1	19/12/1982
1983	31.6	12/10/1983
1984	40.8	21/09/1985
1985	26.4	06/08/1986
1986	21.1	05/12/1986
1987	27.5	06/09/1988
1988	19.4	20/09/1989
1989	38.9	27/10/1989
1990	30.6	06/10/1990
1991	30.3	07/01/1992
1992	28.3	15/12/1992
1993	26.1	03/12/1993
1994	26.0	11/12/1994
1995	23.4	26/10/1995
1996	29.1	16/09/1997
1997	24.5	06/12/1997
1998	19.3	08/09/1999
1999	31.8	28/11/1999
2000	27.3	03/10/2000
2001	24.7	03/12/2001
2002	26.9	27/10/2002
2003	N/A	Sept.
2004	25.6	15/01/2005
2005	27.7	10/10/2005
2006	29.5	03/12/2006
2007	31.1	03/02/2008