ROADEX
Implementing Accessibility

Northern Periphery Programme 2007–2013

Innovatively investing in Europe's Northern Periphery for a sustainable and prosperous future

European Union
European Regional Development Fund

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ROADEX IN IRELAND

ROADEX demonstrations project report

PREFACE

This is a final report from Task D5 of the ROADEX “Implementing Accessibility” project, a technical trans-national cooperation project between The Highland Council, Forestry Commission Scotland and the Western Isles Council from Scotland; The Northern Region of The Norwegian Public Roads Administration; The Northern Region of The Swedish Transport Administration and the Swedish Forest Agency; The Centre of Economic Development, Transport and the Environment of Finland; The Government of Greenland; The Icelandic Road Administration; and The National Roads Authority and The Department of Transport of Ireland.

The lead partner of the ROADEX “Implementing Accessibility” project was The Northern Region of The Swedish Transport Administration and the project consultant was Roadscanners Oy from Finland.

This report provides a summary of the works and undertakings by ROADEX in western Ireland from 2010 to 2012. Topics covered include demonstrations of ROADEX road assessment methods for the identification of weak sections of road, demonstrations of ROADEX methods of drainage analysis, and discussions of Irish practices in road construction and maintenance on peat.

The demonstrations were commissioned by the Department of Transport and the National Roads Authority and organised by ROADEX. Site measurements were led by Bruce Wiljanen and Seppo Tuisku of Roadscanners Oy in cooperation with PMS Pavement Management Services Ltd.

All work was carried out in close cooperation with personnel from the Department of Transport, the National Roads Authority, Donegal, Mayo, Galway and Offaly County Councils, and Coillte Teoranta. In this, the authors would specially like to thank and acknowledge the assistance given by the following persons:

- Dominic Mullaney and John McCarthy of the Department of Transport
- Tom Casey of The National Roads Authority
- Dr Eric Farrell, School of Engineering, Trinity College Dublin
- John Dempsey and Tom Ryan (retired) of Coillte Teoranta
- Charles McCarthy and Damian Grennan of Offaly County Council
- James Boyle and Brian Burke of Donegal County Council
- Michael Mongan and Michael Lyons of the Roads Services of Mayo County Council
- Uinsinn Finn of Galway County Council

Without their help and support it would not have been possible to complete the work.

Finally the authors would like to thank the ROADEX IV Project Steering Committee for their guidance and encouragement in the work.

ROADEX “Implementing Accessibility” Lead Partner: The Swedish Transport Administration, Northern Region, Box 809, S-971 25 Luleå. Project co-ordinator: Mr. Krister Palo.

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1. INTRODUCTION

1.1. THE ROADEX PROJECT

The ROADEX Project is a technical co-operation between road organisations across northern Europe that aims to share road related information and research between the partners. The project was started in 1998 as a 3 year pilot co-operation between the districts of Finland Lapland, Troms County of Norway, the Northern Region of Sweden and The Highland Council of Scotland and was subsequently followed and extended with a second project, ROADEX II, from 2002 to 2005, a third, ROADEX III from 2006 to 2007 and a fourth, ROADEX IV from 2009 to 2012.

Figure 1.1 The Northern Periphery Area and ROADEX IV Partners

The Partners in ROADEX IV “Implementing Accessibility” comprised public road administrations and forestry organisations from across the European Northern Periphery. These were The Highland Council, Forestry Commission Scotland and Comhairle Nan Eilean Siar from Scotland, The Northern Region of The Norwegian Public Roads Administration, The Northern Region of The Swedish Transport Administration and the Swedish Forest Agency, The Centre of Economic Development, Transport and the Environment of Finland, The Government of Greenland, The Icelandic Road Administration, and The National Roads Authority and The Department of Transport of Ireland.

The aim of the Project was to implement the road technologies developed by ROADEX on to the Partner road networks to improve operational efficiency and save money. The lead partner for the project was The Swedish Transport Administration and the main project consultant was Roadscanners Oy of Finland.

A main part of the Project was a programme of 23 demonstration projects showcasing the ROADEX methods in the Local Partner areas supported by a new pan-regional “ROADEX Consultancy Service” and “Knowledge Centre”. Three research tasks were pursued as part of the project: “Climate change and its consequences on the maintenance of low volume roads”, “Road Widening” and “Vibration in vehicles and humans due to road condition”.

All ROADEX reports are available on the ROADEX website at www.ROADEX.org.

1.2. THE DEMONSTRATION PROJECTS

Twenty three demonstration projects were planned within the ROADEX IV project. Their goal was to take selected technologies developed by ROADEX out on to the local road networks to have them physically used in practice to show what they could achieve. The projects were funded locally by the local Partners, designed and supervised by local staff, and supported by experts from the ROADEX consultancy.

The demonstrations were managed in 6 groups by a nominated lead manager from ROADEX:

D1 - "Drainage Maintenance Guidelines", lead manager Timo Saarenketo

D2 - "Road friendly vehicles and Tyre Pressure Control", lead manager Pauli Kolisoja

D3 - "Forest Road policies", lead manager Svante Johansson

D4 - "Rutting, from theory to practice", lead manager Pauli Kolisoja

D5 - "Roads on Peat", lead manager Ron Munro

D6 - "Health and Vibration", lead manager Johan Granlund

1.3. THE IRISH DEMONSTRATION PROJECTS

The Department of Transport (DoT) and National Road Authority (NRA) of Ireland were new partners to the ROADEX network. As part of their request for demonstration projects they asked for demonstrations of ROADEX technologies that could possibly aid road construction over peat as this was a major issue in Ireland.

The Irish Forest Agency, Coillte, had also planned to be a Partner in the ROADEX IV project but had had to withdraw just before the ROADEX application was made due to financial cutbacks as a result of the world financial crisis. The company did however continue to actively co-operate with the ROADEX project, and attend Steering Committee meetings where it could. A background to Coillte is given in Appendix 2.

Two formal demonstrations of ROADEX technologies were subsequently identified:

a) A demonstration of the ROADEX drainage analysis method on typical roads the Irish road network. Two road sections were selected:
   - 156km of the N56 from Donegal town to Letterkenny
   - 297km of the N59 from Sligo town to Galway city

b) A demonstration of the ROADEX road risk assessment method on two planned road rehabilitation works for roads over peat. Two road sections were agreed:
   - 10km of the N56 from Drumnaraw to Cashelmore in County Donegal
   - 15km of the N59 from Newport to Mulranny in County Mayo.

In addition to these scheduled demonstration projects, good weather during the visit to Ireland for the risk assessment demonstrations permitted an additional informal demonstration of the ROADEX method of GPR and laser scanning to be carried out for Coillte on local forest roads in Galway.

All demonstrations, formal and informal, are summarised in the following report together with any resulting discussions and actions.

1.4. TIMELINE OF ROADEX ACTIVITIES IN IRELAND

The following table gives a history of the ROADEX IV project in Ireland over the period 2010-12:

Date(s)	Event
6-7 May 2010	Planned date of 2nd ROADEX Steering Committee meeting. This meeting cancelled on 5 May 2012 due to European airspace being closed by the ash cloud from the Eyjafjallajökul eruption in Iceland.
2- 5 May 2010	Haraldur Sigursteinsson of The Icelandic Road Administration meets the ROADEX Irish partners to discuss the "Roads on Peat" task. Additional meetings held with Offaly County Council, Trinity College Dublin, and Coillte.
13-22 September 2010	ROADEX drainage demonstration surveys on N56 & N59
1-2 November	3rd ROADEX Steering Committee meeting, Westport, County Mayo
27 November 2010	DoT & NRA agree risk assessment road sections on N56 & N59
7-10 March 2011	ROADEX road condition demonstration surveys on the N56 & N59
11 March 2011	GPR & laser scanner demonstration surveys on Coillte forest road
4 July 2011	Drainage reports delivered and published
25 July 2011	Risk analysis reports delivered and published
27 October 2011	ROADEX workshop in Ireland to discuss results and obtain feedback
28 October 2011	Meetings held with Galway and Offaly County Councils
31 May 2012	ROADEX presentation to Engineers Ireland, Dublin

2. INITIAL VISIT

An initial visit to meet the Irish Partners in Ireland was arranged for the same week as the second ROADEX Steering Committee meeting scheduled for 5/6 May 2010. Haraldur Sigursteinsson of The Icelandic Public Roads Administration flew to Ireland on Monday 3 May 2010 to meet the Partners to gain an insight into the problems of building and maintaining roads on peat in Ireland.

Unfortunately the planned steering committee meeting could not take place due to Irish airspace being closed as a result of the ash cloud drifting in from the eruption of Eykjafjallajökull in Iceland. It was a strange irony that the Icelandic partner could be in Ireland when the rest of the steering committee were prevented from flying by an Icelandic ash cloud.

Haraldur was however able to gain the insight that was needed and his diary notes form the basis for this section of the report.

2.1. MEETING WITH THE ROADEX PARTNERS

This day commenced with a meeting with Dominic Mullaney and John McCarthy of the Department of Transport and Tom Casey of the National Roads Authority.

The Department of Transport (DoT) has a wide range of functions in relation to roads. These include:

- the legal framework relating to the provision and maintenance of national roads and the legal framework within which the National Roads Authority (NRA) operates;
- funding for the national roads programme;
- monitoring NRA expenditure;
- providing policy guidance to the NRA;
- overseeing the effective implementation of the national roads element of Transport 21 investment programme;
- the promotion of the safer use of roads through a combination of policy, education and legislative measures.
- the provision of funding of roads under Transport21
- the promotion of road safety;

The National Roads Authority was formally established as an independent statutory body under the Roads Act, 1993 with effect from 1 January, 1994. The Authority's primary function, under the Roads Act 1993, is to secure the provision of a safe and efficient network of National roads. For this purpose, it has overall responsibility for planning and supervision of construction and maintenance works on these roads.

Funding for the national primary roads is administered centrally by the National Roads Authority. Local councils are responsible for the maintenance regional and local roads are less well funded (although funding has increased in the 2000s). these roads, as opposed to the NRA.

A summary of the roads network in Ireland is given in Appendix 1.

County Councils
There are 34 County and City Councils in the Republic of Ireland, of which 8 lie within the boundaries of the Northern Periphery area. These are the Counties of Clare, Cork, Donegal, Galway, Kerry, Leitrim, Limerick, Mayo and Sligo.

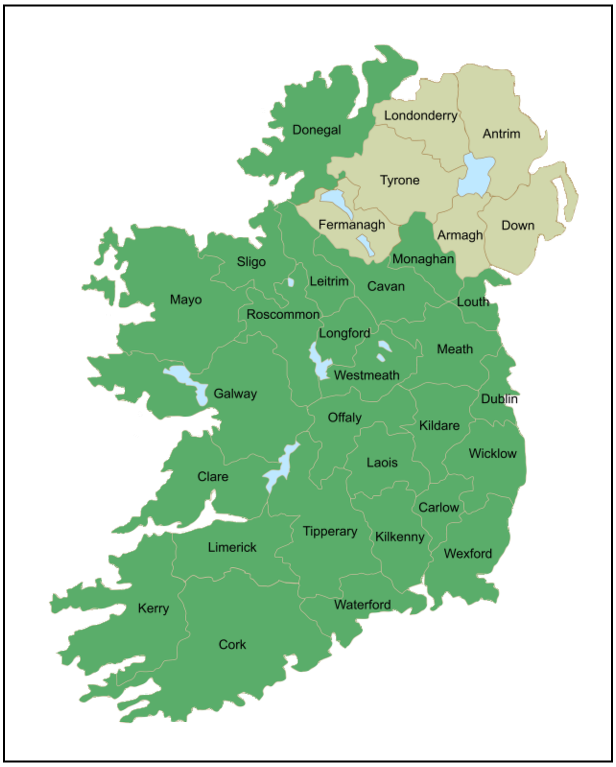

Figure 2.1 Map showing the County Councils in Ireland

<u>Matters discussed</u>

The meeting took the shape of an informal discussion on roadbuilding on soft ground in Ireland exploring the challenges and successes of constructing and maintaining roads on peat.

Western Ireland has extensive deposits of blanket bog. Those on the western fringes still retain their natural character, whereas those in the centre tend to have been worked for peat fuel and agriculture with the result that the old roads now sit above the landscape as “bog ramparts”

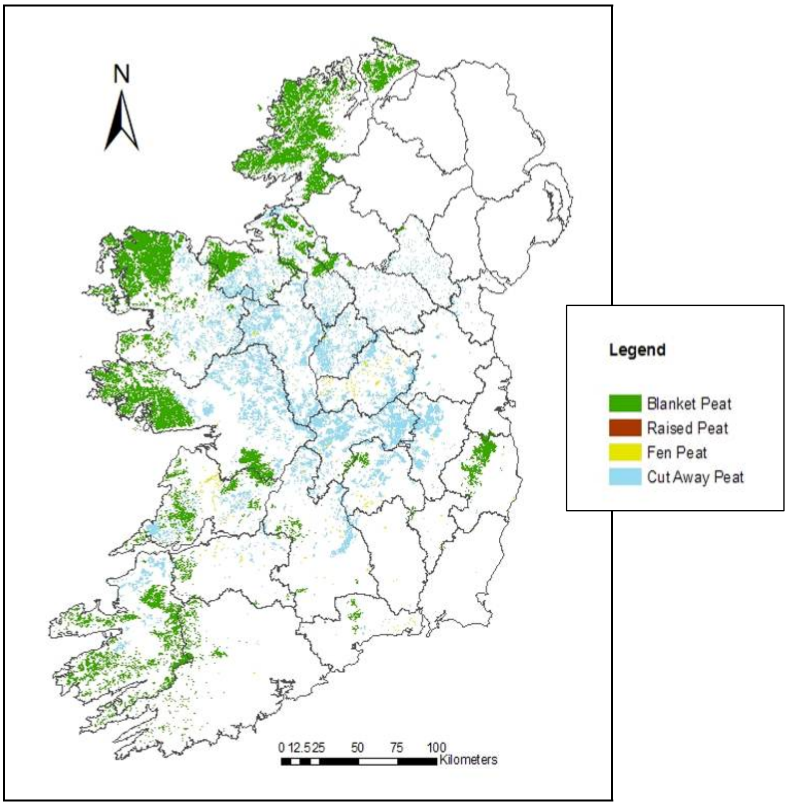

Figure 2.2. Soils and soils data generated by Teagasc using GSI data as input under the EPA Soils and Subsoils Mapping Project, May 2006

A "bog rampart" is the name given to a road over peat that is above the level of the surrounding ground. The original road in this system would have originally been constructed on top of the bog surface in the normal fashion, but over the years the peat in the fields adjacent to the road would have been removed for burning and agriculture. At the same time, over the years, the old road would have been repaired and strengthened with new materials so increasing the height and weight of the road. The result of this lowering of the fields and raising of the road is a road of variable thickness, variable construction and restricted width that sits above the adjacent landscape. These roads have narrow verges with steep side slopes that that are prone to slipping. This makes any improvement work very challenging.

Examples of typical roads on peat in western Ireland can be seen below:

Figure 2.3 Transverse cracking on peat

Figure 2.4 Potholing and cracking on peat

Figure 2.5 Typical roadworks site

Figure 2.6 Road improvement on peat by preloading

On the conclusion of the meeting the group moved on to Trinity College Dublin to meet Dr. Eric Farrell of the School of Engineering.

Meeting with Dr Eric Farrell, School of Engineering, Trinity College Dublin

Dr Farrell has a long background in research into building on peat and at the time was working on an interesting test project involving the vacuum consolidation of peat. The main advantages of vacuum consolidation are stated as:

- A surcharge equivalent to approximately 4m of fill without the associated risk of shear failure.
- Isotropic consolidation.
- Greater improvement of soft ground at depth.
- Generally faster consolidation.
- Can be combined with embankment loading.

Figure 2.7 Photograph of the TCD Vacuum Consolidated Field Trial.

2.2. MEETING WITH OFFALY COUNTY COUNCIL, TULLAMORE

The meeting with Offaly County Council took place in the Offaly County Councils office in Tullamore. Present at the meeting were: Haraldur Sigursteinsson, Charles McCarthy and Damian Grennan of Offaly County Council, John McCarthy from the Department of Transport, and John Dempsey special projects engineer from Coillte.

Figure 2.8 Offaly County Council's office in Tullamore. From left, Haraldur Sigursteinsson, Charlie McCarthy from Offaly County Council, John Dempsey special projects engineer from Coillte, John McCarthy from the Department of Transport, and Damian Grennan of Offaly County Council.

<u>Offaly County Council roadwork sites</u>

After lunch in the Offaly County local office the group inspected a number of roads built on peat bogs, some with minor cracks and slightly deformed. The circumstances seen were different from Scandinavian roads. The peat to the side of the roads had been lowered compared with the original pavement (the "bog rampart" described in Section 2.1) . These types of roads can be quite difficult to strengthen as there is usually very limited space available in the existing road width.

Figure 2.9 Bog road, east of Tullamore

Figure 2.10 Damaged bog road, north of Daingean

An interesting road strengthening using polyester grid below an asphalt overlay was seen at the entrance to An Foras Áiseanna Saothair (FAS), the Training and Employment Authority. Figures 2.11 and 2.12.

Fig. 2.11 Overlay at entrance to FAS

Fig 2.12 Excavated grid material in the strengthening

Figure 2.13 Recycled road section on the R400 between Rhode and Rochfirtbridge.

2.3. MEETING WITH COILLTE AND VISIT TO FOREST SITES

Wednesday 5th May allowed an introduction to the state owned Irish Forest Service "Coillte" and its operations involving peat with the help of John Dempsey and Tom Ryan, an experienced engineer in roadbuilding in the forest area. Coillte is a private limited company whose shares are held by the Minister for Agriculture, Food & Forestry and the Minister for Finance on behalf of the Irish State. Coillte currently manages:

- 7,400 km of forest road on the Coillte estate
- 800 km of constructed right of way serving the Coillte estate
- 1,250 km of engineered track on the Coillte estate

And in addition Coillte has a future plan for 800 km of proposed roads to service the Coillte estate.

Figure 2.14 Tom Ryan (former Chief Engineer, Coillte – now retired) and John Dempsey (Special Projects Engineer, Coillte)

<u>Site visits to Coillte opertations</u>

A tour was then taken around the western part of Ireland to see some typical forest areas and roadbuilding operations.

Figure 2.15 New bridge

Figure 2.16 Sunken forest road

Figures 2.17 Rock breaking

Figures 2.18 Use of trees as grillages. Trees are felled and randomly laid down as a supporting layer before the crushed rock is filled over.

Futher examples of Coillte innvovation in forest road operations are given in Appendix 2.

2.4. THE EYKJAFJALLAJÖKULL ERUPTION ENDS THE ROADEX VISIT

Towards the end of the site visit the group was advised that the planned second ROADEX Steering Committee meeting in Westport had been cancelled by the Chairman due to airbourne ash from the Eykjafjallajökull eruption closing European airspace. Fortunately at that time, Irish and Icelandic airspace were west of the prohibited area, and so stiill open for flights, and it was possible for Haraldur Sigursteinsson to fly back to Keflavik. The following day Irish airspace was also closed.

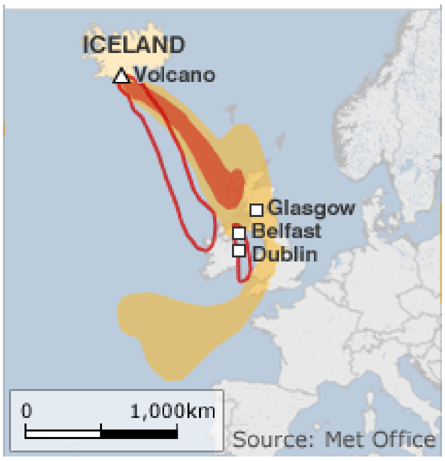

Figure 2.19 Ash cloud 5 May 2011

3. DRAINAGE DEMONSTRATION PROJECTS

This chapter deals with the demonstrations of the ROADEX drainage analysis method in Ireland in September 2010. The goal of the work was to demonstrate the ROADEX drainage analysis technique and guidelines on the Irish road network. The field surveys were carried out by Seppo Tuisku of Roadscanners with the help of PMS Pavement Management Services Ltd. In September 2010 Roadscanners Oy carried out drainage analysis field surveys on roads N56 and N59 in western Ireland.

3.1. BACKGROUND

The methodology for the ROADEX drainage analysis was mainly developed during the ROADEX III project as a way to locate road sections needing special drainage improvement and regular maintenance. For this, data is collected from all of the important factors that affect the road drainage condition, i.e. local surroundings, road topography, presence and quality of existing drainage, verges, walls, etc and subsequently analysed to identify sections that need work done.

The existing drainage condition is first classified into three categories: Class 1 for good and properly working drainage, Class 2 for fair drainage conditions and Class 3 for poor drainage conditions, and at the same time the crossprofile of the road (Figure 3.1) is noted for use in the analysis.

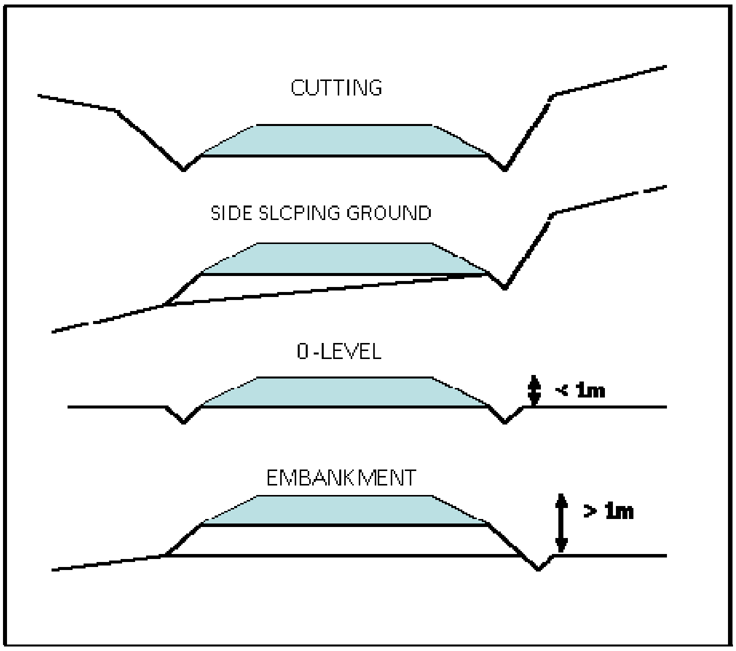

Figure 3.1 Road crossprofile types

The collected information is then analysed, classified and reported in accordance with the ROADEX Drainage Survey Method Description, available on the ROADEX website, www.roadex.org. This analysis identifies those critical sections of the road that require special drainage maintenance measures in drainage maintenance operations. The ROADEX drainage analysis can be carried out on both paved and gravel road networks. The survey results are reliable and repeatable and allow the drainage condition of the road network to be monitored.

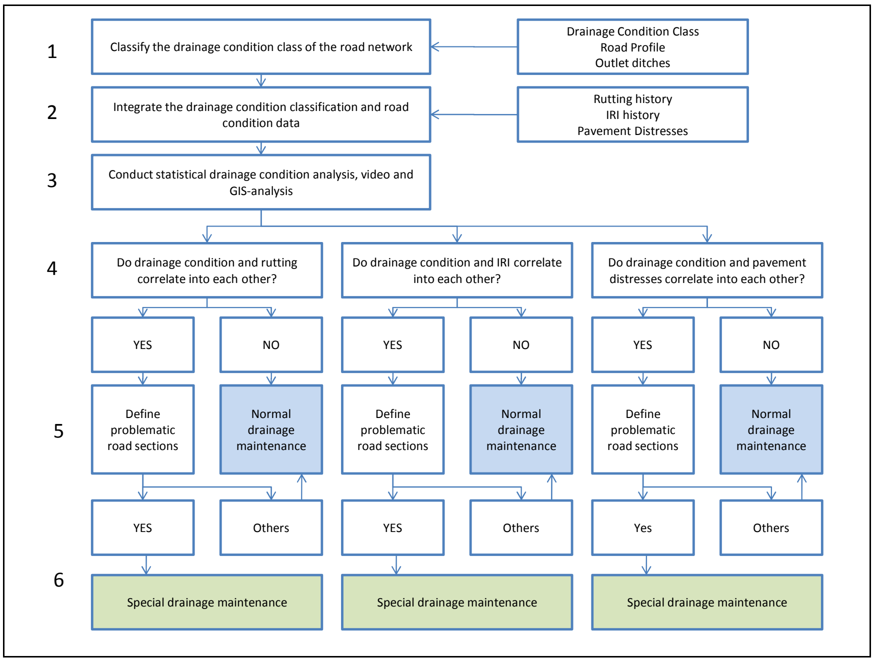

Figure 3.2 The ROADEX drainage analysis process

3.2. ROAD SECTIONS SURVEYED

Two road sections of the N56 and N59 roads were selected as demonstration projects as shown in the maps in Figures 2 and 3.

Figure 3.3: Map showing the length on N56 surveyed

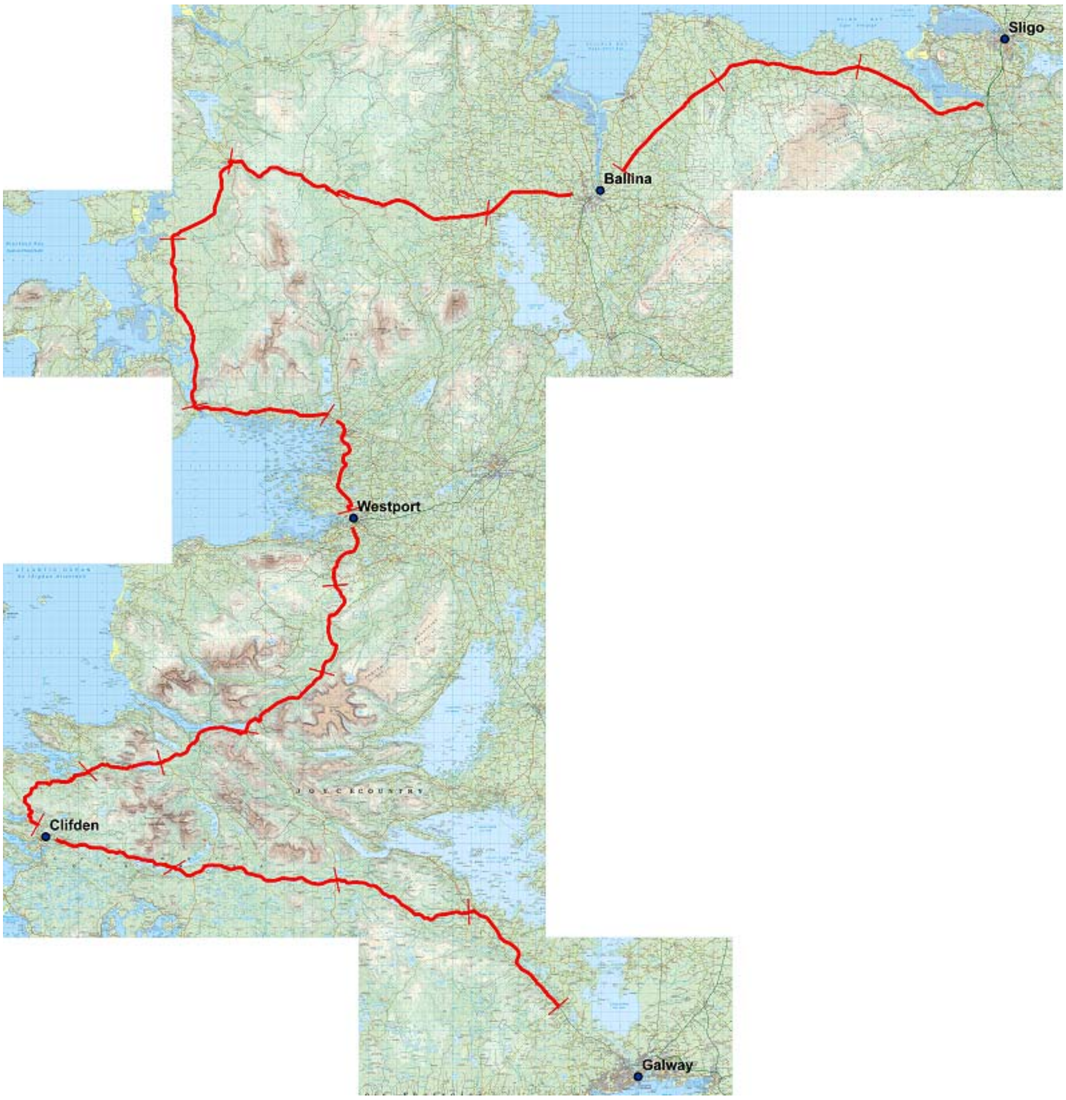

Figure 3.4 Map showing the length on N59 surveyed

The landscape and terrain along the roads was variable. Generally they were coastal on side sloping ground with variable subgrade types, including significant sections on peat.

3.3. DATA COLLECTION, FIELD SURVEYS

The data collection for the two demonstration projects was carried out in September 2010. The surveys started from Galway on the N59 road to County Sligo and then continued on road N56 from Donegal to Letterkenny. PMS Pavement Management Services Ltd office at Athenry provided the vehicle for the survey and a CamLink video-logging system by Roadscanners Oy was installed on the van roof.

Figure 3.5 The PMS survey vehicle used in the project. Video cameras were placed in the orange CamLink box for shelter from the rain and dust. .

Two digital video cameras were used in the survey, one camera for the road view and the second camera to record the ditch. Preliminary classifications were directly recorded using the pc keyboard. Audio comments in the vehicle were also recorded to assist data interpretation in the office. Typically these included: the classification of the drainage condition, the classification of the road profile; any corrections to mistyping the inventory which need to be corrected later; any observations on grass verges or pavement distresses restricting the water flow to the ditch; any notes on soil slippage into the ditches, blocking the water flow.

Figure 3.6 The laptop used in the drainage analysis project. The coloured pieces of paper helped to choose the right keys during the survey.

3.4. ANALYSIS

General

The analysis revealed that road drainage systems in Ireland differed fairly significantly from the ROADEX Nordic countries. Open roadside ditches were noticeably absent in the older sections of roads. The upgraded sections of road were much better. These usually had open ditches.

Typical drainage problems

The majority of drainage problems in Ireland appeared to occur in the same kind of circumstances as in Nordic countries, a good example being road sections in side sloping ground. A few particular Irish problems were also noted that were not so common in Nordic countries (but they had been seen in Scotland). These included:

Verges

Verges with verge offlet channels were very common on the N56 and N59.

Figures 3.7 Examples of road sections suffering from problems due to verges.

Stone walls

Stone boundary walls were a typical part of the landscape on the N56 and N59. Usually these walls were located along old sections of roads that had not been upgraded.

Figures 3.8 Examples of road sections suffering problems due to stone walls.

Road cuttings
A very special feature on the roads surveyed was the narrow road cutting. A high proportion of these steep slopes appear to consist of stone walls obscured by vegetation and soil.

Figure 3.9 An example of a road cut on road N59.

In many cases ditches or any other drainage structure were absent in these road cuts. This meant that water generally flowed along the road, in turn causing erosion, bearing capacity and deformation problems to the road.

Figures 3.10 Examples of road sections located in road cuts.

3.5. REPORT, MAPS & DVD

The outputs of the drainage demonstration projects comprised three elements:

- A formal written report "*Summary of Drainage Analysis in Ireland, Roads N56 and N59*" available on the ROADEX website www.roadex.org.

- Recommended tables and maps of road sections requiring work to be done (Table 3.1 and Figure 3.11) delivered to the local offices.
- The full Road Doctor project file on DVD delivered to the Department of Transport for Ireland

An example of the operational maintenance measures recommended to the Partners is shown in Table 3 and Figure 3.11.

Table 3.1 N56, Section 8, 86840-94210, showing recommended verge and drainage works

Road	Section	From (m)	To (m)	m	Operation
N56	Section 8	89065	89279	214	Verge left
N56	Section 8	89340	89911	571	Verge left
N56	Section 8	89997	90543	546	Verge left
N56	Section 8	91300	91484	184	Verge left
N56	Section 8	94108	94210	102	Verge left
N56	Section 8	88855	88938	83	Special maintenance section left
N56	Section 8	88890	88994	104	Special maintenance section right
N56	Section 8	89265	89392	127	Special maintenance section right
N56	Section 8	89678	90183	505	Special maintenance section right
N56	Section 8	88287	88478	191	Verge right
N56	Section 8	89074	89201	127	Verge right
N56	Section 8	91086	91274	188	Verge right
N56	Section 8	93754	93943	189	Verge right
N56	Section 8	94020	94210	190	Verge right

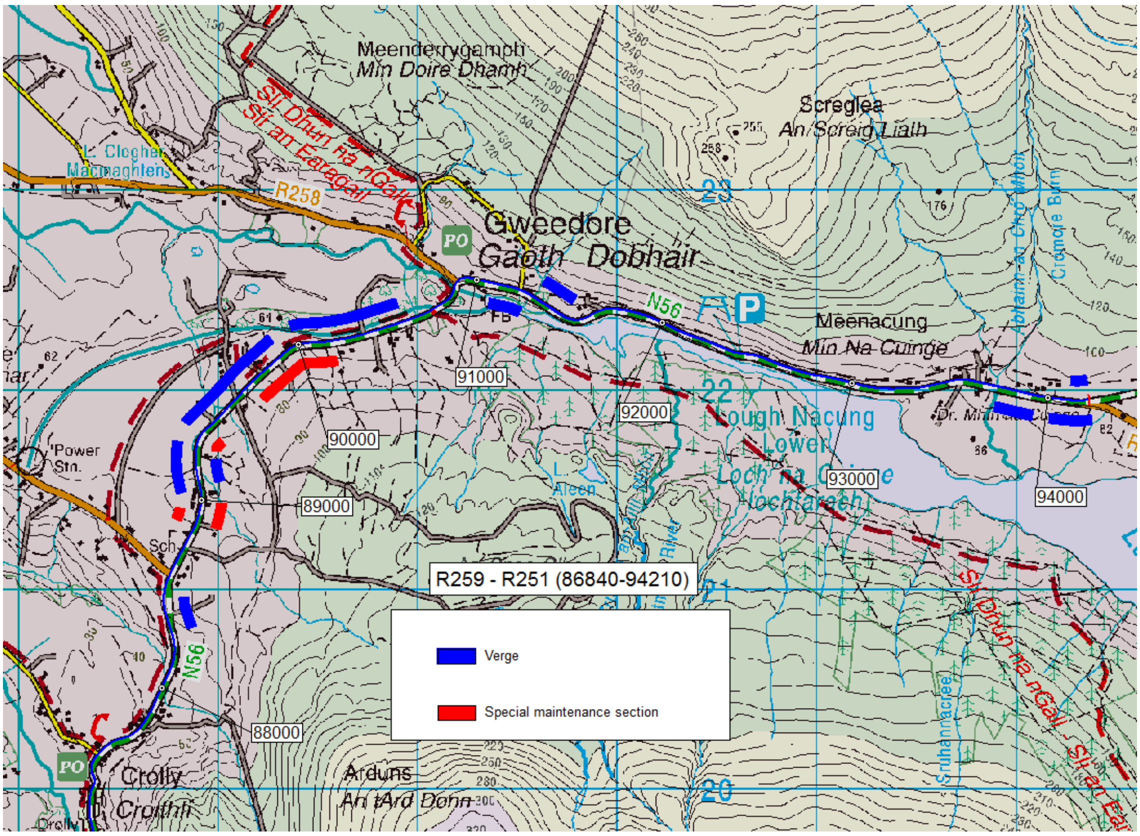

Figure 3.11 GIS map of the N56, Section 8, chainage 86840-94210, at Gweedore showing recommended verge and drainage works. The blue lines signify that verges should be removed. The red lines are sections of drainage requiring special measures.

4. RISK ANALYSIS DEMONSTRATION PROJECTS

4.1. BACKGROUND

The ROADEX risk analysis method was originally developed for the B871 Kinbrace - Syre Road in Scotland in 2001 and is explained in greater detail in the ROADEX II project report "*Monitoring, communication and information systems & tools for focusing actions*" by Saarenketo (2005).

The risk analysis method utilises the full range of modern survey techniques, ground penetrating radar (GPR), falling weight deflectometer (FWD), digital video, laser scanning, as well as sampling and coring when available,. Once collected the data is processed through an integrated analysis system using a proprietary software package, "Road Doctor"™ Pro® software in the present case, to give an evaluation of the condition of the surveyed road on a metre by metre basis.

4.2. ROADS SURVEYED

The demonstration road sections surveyed were:

- N56 Donegal - commencing in Drumnaraw at its junction with the road L1212 to Glen. The survey section length was 10250 m and ended in Cashelmore.
- N59 Mayo - commencing in Newport at the southern access to the "Topaz" filling station. The survey section length was 15470 m and ended in Mulranny.
- Coillte forest road – 832m of forest road, Derrydonnell property

4.3. DATA COLLECTION, FIELD SURVEYS

Ground Penetrating Radar (GPR) surveys of the demonstration road sections
The GPR surveys were carried out using a GSSI SIR-20 unit with two antennas, an air-coupled 1.0 GHz horn and a 400 MHz ground-coupled antenna (Figure 2.1). A digital video with GPS coordinates was also taken.

Figure 4.1 PMS measurement vehicle equipped with GPR, GPS, digital video and laser scanner

Falling Weight Deflectometer (FWD) surveys of the demonstration road sections
The FWD surveys were carried out using a Dynatest FWD trailer towed by a Mitsubishi L200 pick-up van (Figure 3.2). Testing was carried out every 50 metres in one direction.

Figure 4.2 PMS Falling Weight Deflectometer vehicle and trailer

4.4. ANALYSIS

Processing and interpretation
The collected GPR data was processed and interpreted using RoadDoctor™ Pro® software. The FWD data and digital video were then imported into the same software for integrated interpretation and risk analysis. GIS maps of the surveyed depths of the pavement and road structure on the N56 and N59 are shown in Figures 4.1 & 4.2 respectively.

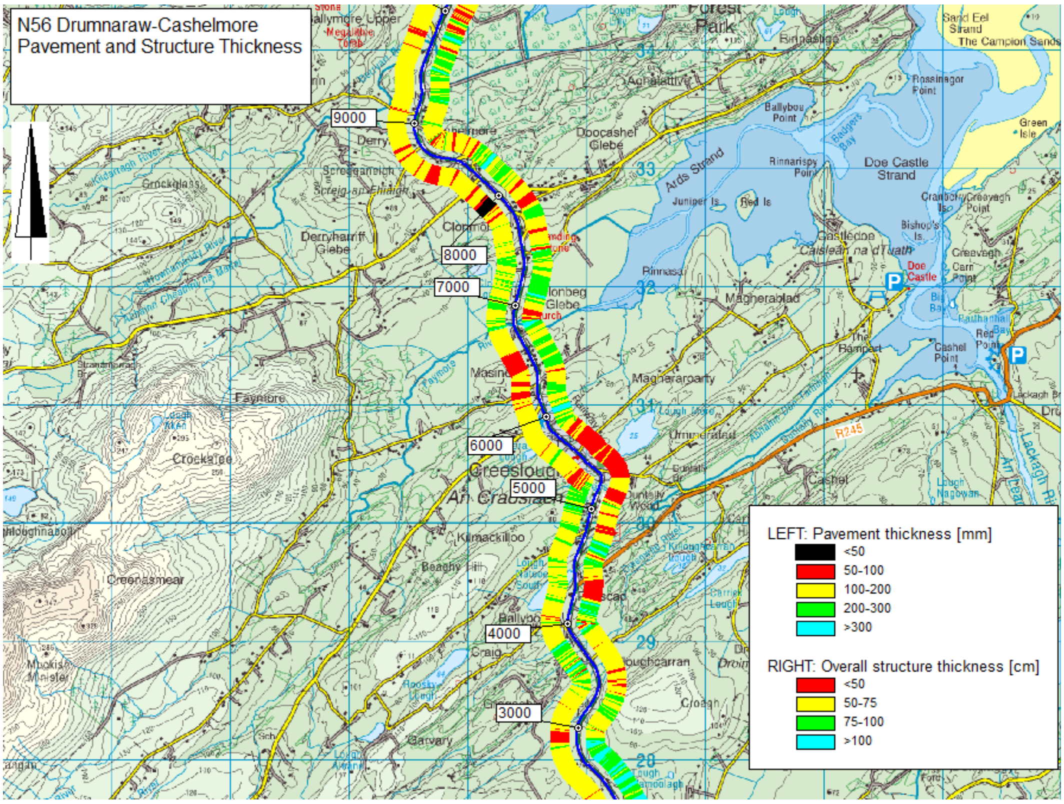

Figure 4.1 GIS map of pavement and structure depths on Road N56

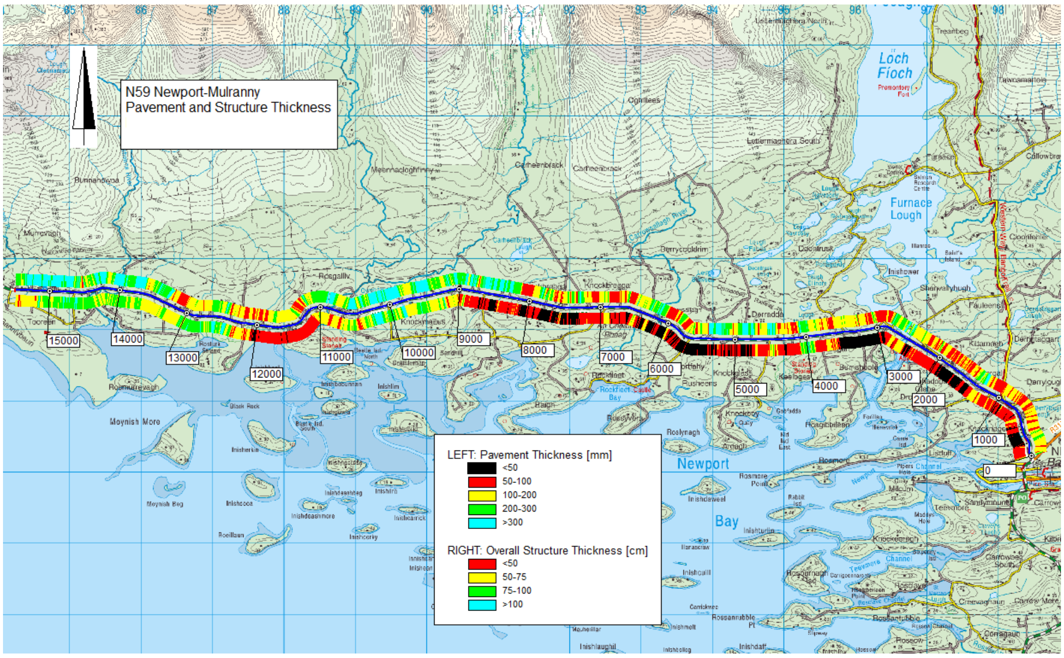

Figure 4.23GIS map of pavement and structure depths on Road N59

<u>Soft Subgrade and Peat</u>

An early aim of the project was to try to demonstrate the use of ROADEX methods for the construction and maintenance of roads on peat. This estimate was based on the skilled interpretation of GPR radargrams, FWD values and the digital video recording taken at the time of the surveys. Ideally these interpretations should be followed up by proving cores and/or probing in the areas concerned to confirm the presence of soft soil and its type(s).

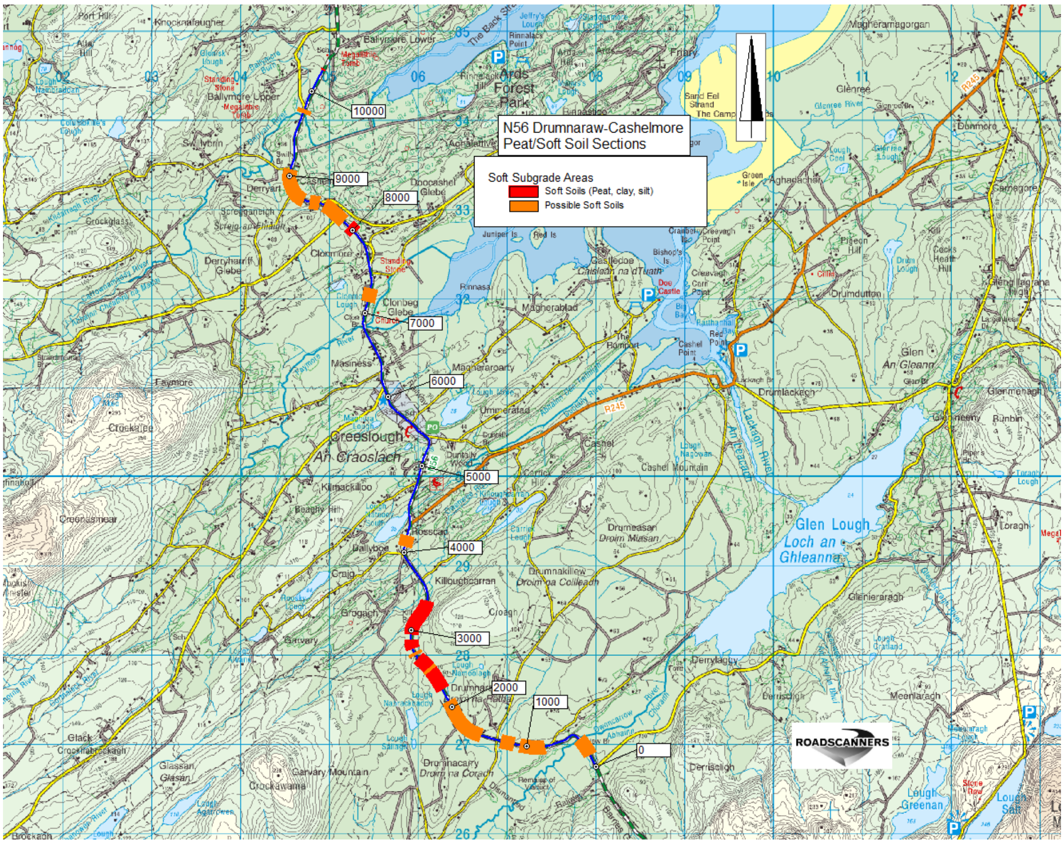

Figure 4.5 GIS map of soft subgrade sections on Road N56

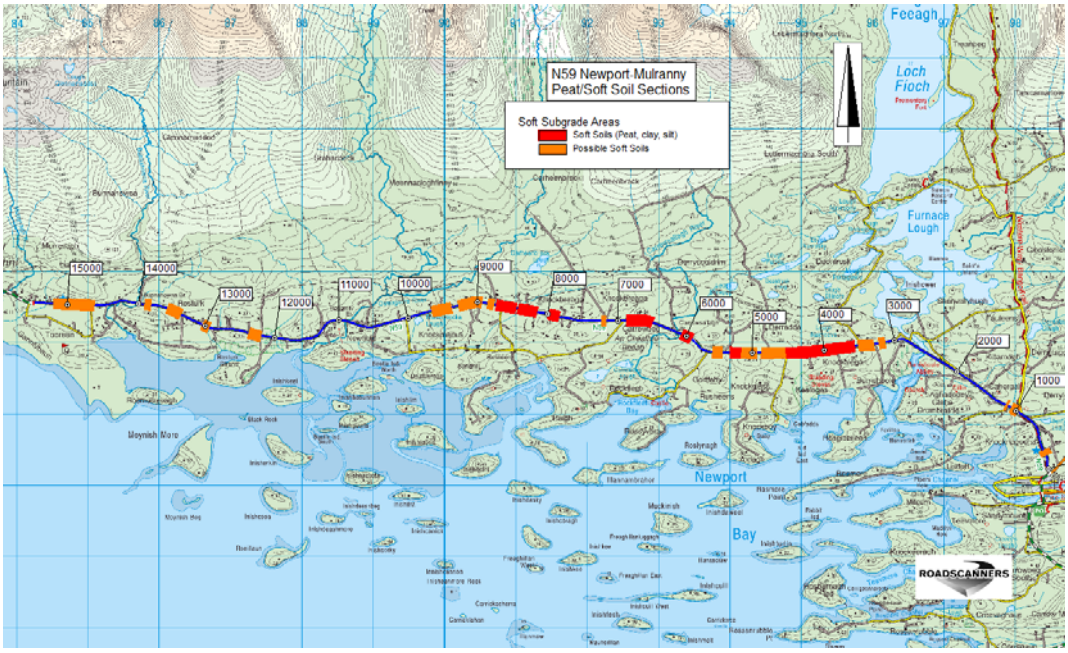

Figure 4.6 GIS map of soft subgrade sections on Road N59

<u>Risk Analysis</u>

ROADEX risk analyses were carried out on the two demonstration sections using deflection indexes derived from the FWD surveys, supplemented by reference to the digital video recordings for pavement layer risk. The risk evaluation separately analysed the condition of:

1) the surface layers, including the performance of the pavement and the top part of the base (0-200 mm),
2) the unbound layers, and
3) the subgrade

The overall risk evaluation was based on the analysis of these individual layers and the risk classification below:

Class	Evaluation
0.	No immediate risk for major pavement failure. Local pavement cracking and an increase in rut depth may occur.
1.	Pavement failure and rutting may occur but only after continued heavy transportation. Initially these failures will focus on sites where the bound layers are deteriorating or are debonded.
2.	Pavement distress (rutting and cracking) will be seen in the road a short time after heavy transport starts, but they should not cause immediate problems for road users.
3.	Severe pavement distress will appear immediately after heavy transport is started (less than 5000 axle loads). These major damages may cause problems for road users.

GIS maps summarising risk evaluation along the N56 & N59 are set out in Figures 2.7 and 2.8 respectively.

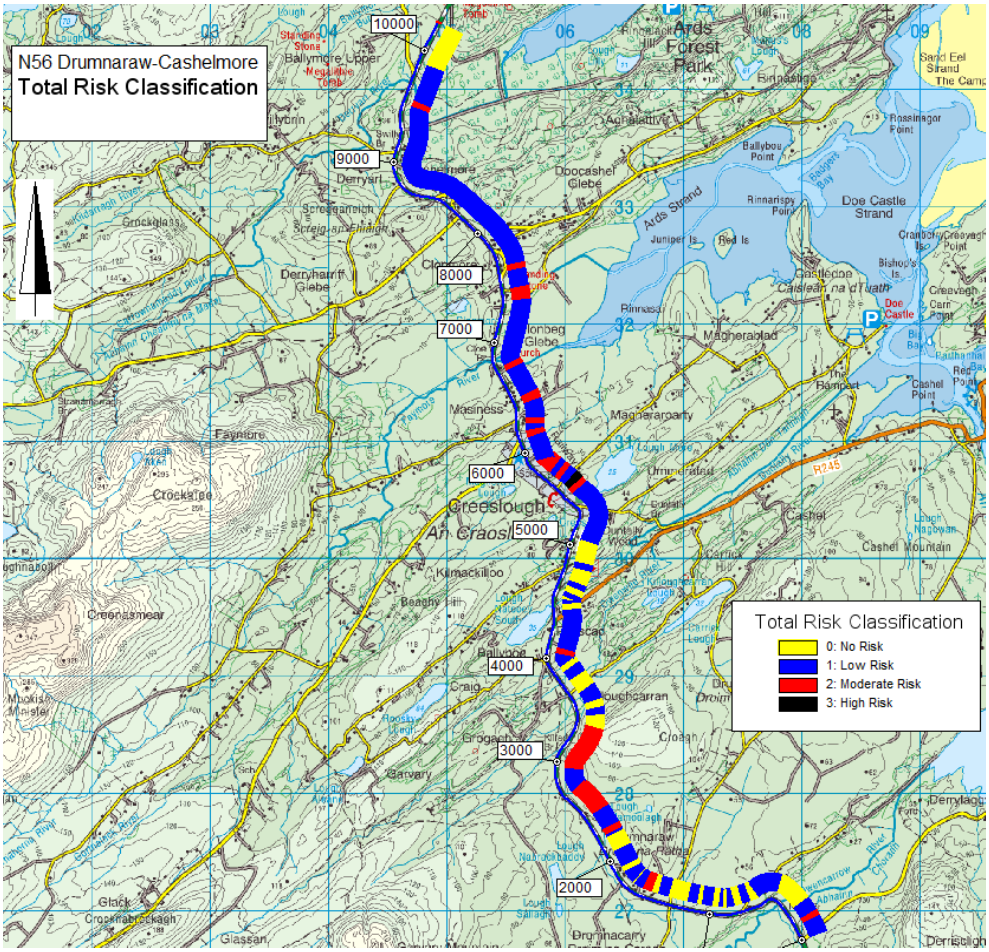

Figure 4.7 GIS map of total risk classification for road N56

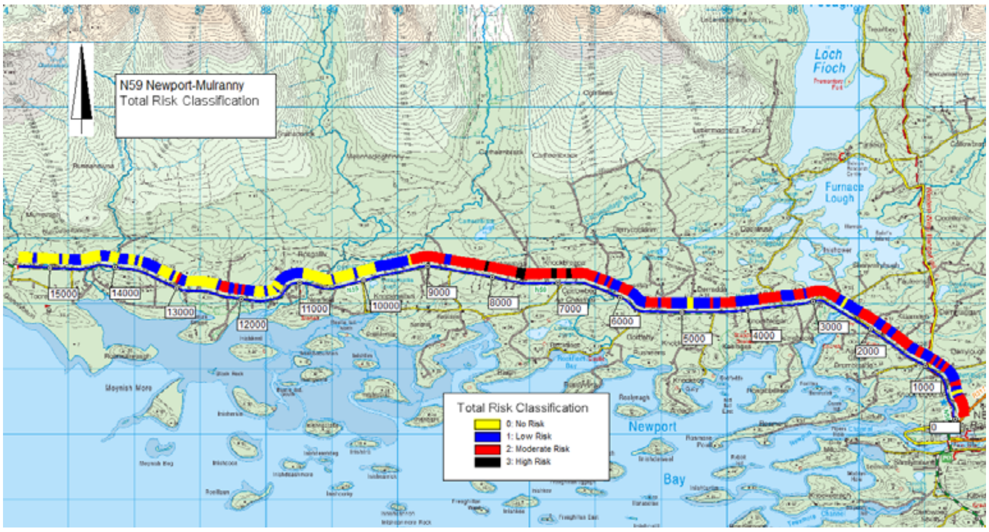

Figure 4.8 GIS map of total risk classification for road N59

Surface Bearing Capacity

In addition to the risk analysis, the surface bearing capacity [MPa] of the road was calculated using the Odemark feature of the RoadDoctor™ Pro® software. These calculations use the road structure thickness data imported from the GPR survey results.

In general it can be stated that road stiffness is extremely poor if bearing capacity is <100 MPa and if the value is >200 MPa there should not be an immediate risk of failures.

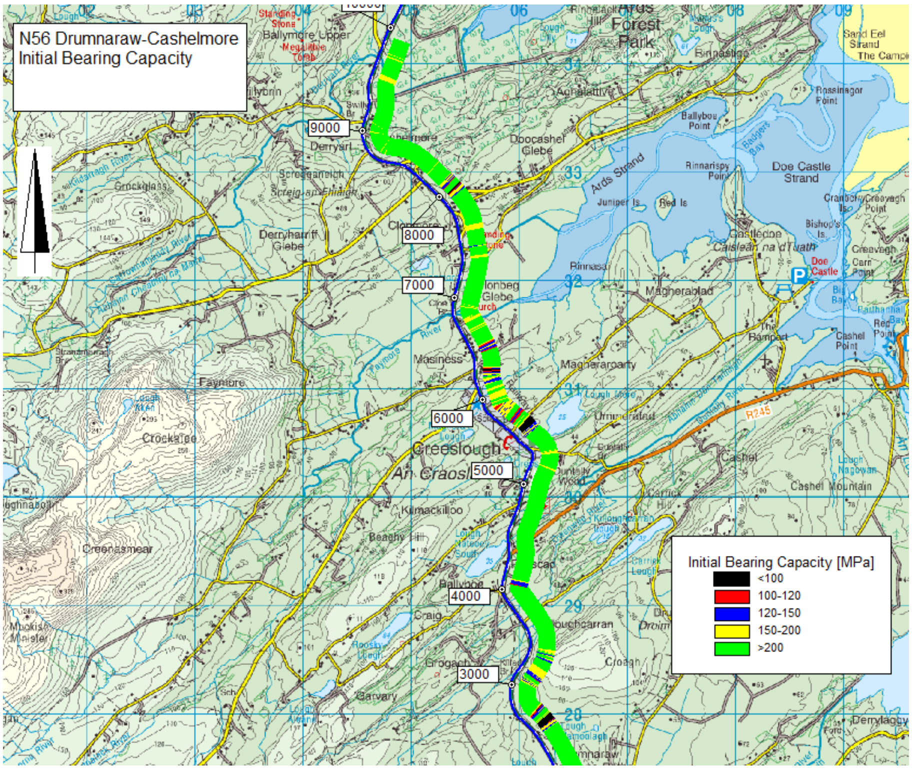

Figure 4.9 GIS map showing the initial bearing capacity for road N56

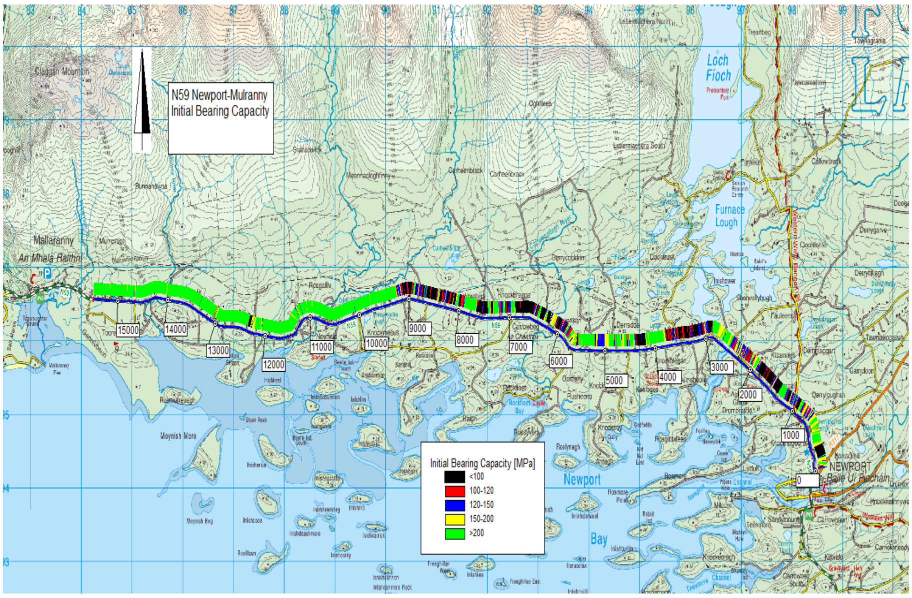

Figure 4.10 GIS map showing the initial bearing capacity for road N59

4.5. REPORTS AND DVDS

The outputs of the risk analysis demonstration projects comprised:

- Two formal written reports available on the ROADEX website www.roadex.org.
  - *"Risk Analysis of Road N56, Newport-Mulranny, Co Mayo (2011)"*
  - *"Risk Analysis of Road N59, Drumnaraw-Cashelmore, Co Donegal (2011)"*
- Full Road Doctor project files on DVDs delivered to the Department of Transport for Ireland

4.6. COILLTE FOREST ROADS

The GPR demonstration surveys for the N56 and N59 had been allocated the full week commencing 7 March 2012. In the event good weather permitted the work to be completed by Thursday 10 March allowing Friday 11 March to be available for an additional informal demonstration of the ROADEX method of GPR and laser scanning to be carried out for Coillte on a local forest road.

The road section selected was a 832 metres length of gravel road in the Derrydonnell property of Kilcornan Forest area, Figure 4.11, close to Athenry, County Galway.

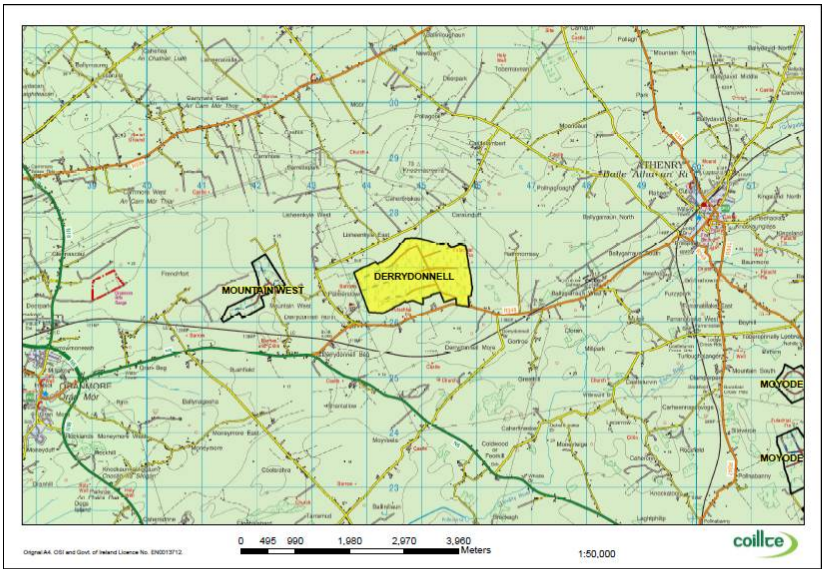

Figure 4.11 Location map showing Coillte Teoranta Derrydonnel property, Kilcornan Forest Area, Co. Galway, (map excerpt from Coillte)

This forest road section was different to others previously surveyed in ROADEX, e.g. in Scotland. The trees were growing up to the boundary of the road and were overhanging the road as a canopy (Figure 4.12). This effect disrupted the GPS signal at times but the distance measurement encoder fitted to the rear wheel of the vehicle kept a continuous record of the distance travelled, with the result that a complete distance record could be made of the survey from start to end.

Figure 4.12 Demonstration of GPR and laser scanning on a Coillte forest road

The laser scanner functioned throughout and recorded an “extremely steep and high vertical line” wherever it passed a tree. The forward facing video camera gave a metre by metre record of the passage of the survey vehicle and proved a useful aid in interpreting the data collected in the office.

The survey data was interpreted in the Roadscanners Office and issued to Coillte as a pdf of the GPR and laser scanner results (Figure 4.13), and a Road Doctor project file (Figure 4.14).

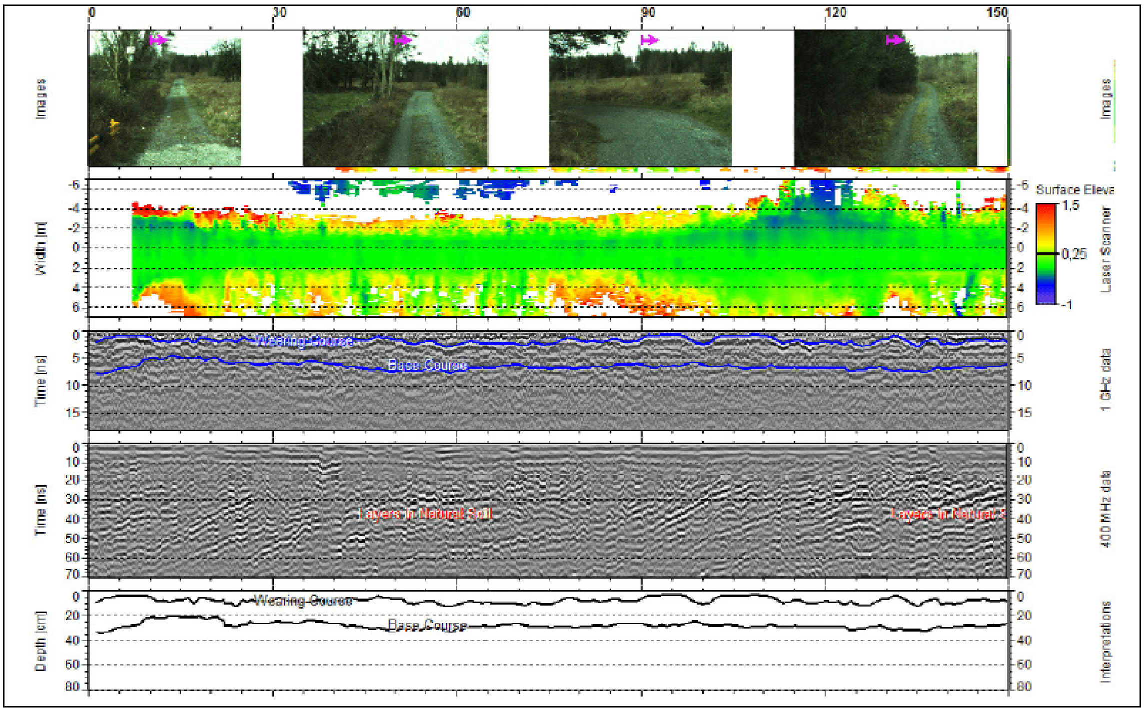

Figure 4.13 Summary screen showing chainage 0-150m of the Derrydonnel forest road. The top panel shows video still photographs forward along the road. The next panel records the output of the rotating laser scanner. The next two panels give the GPR radargrams for the road construction layers, and deeper into the structure. The bottom panel presents the interpreted GPR interfaces as black lines.

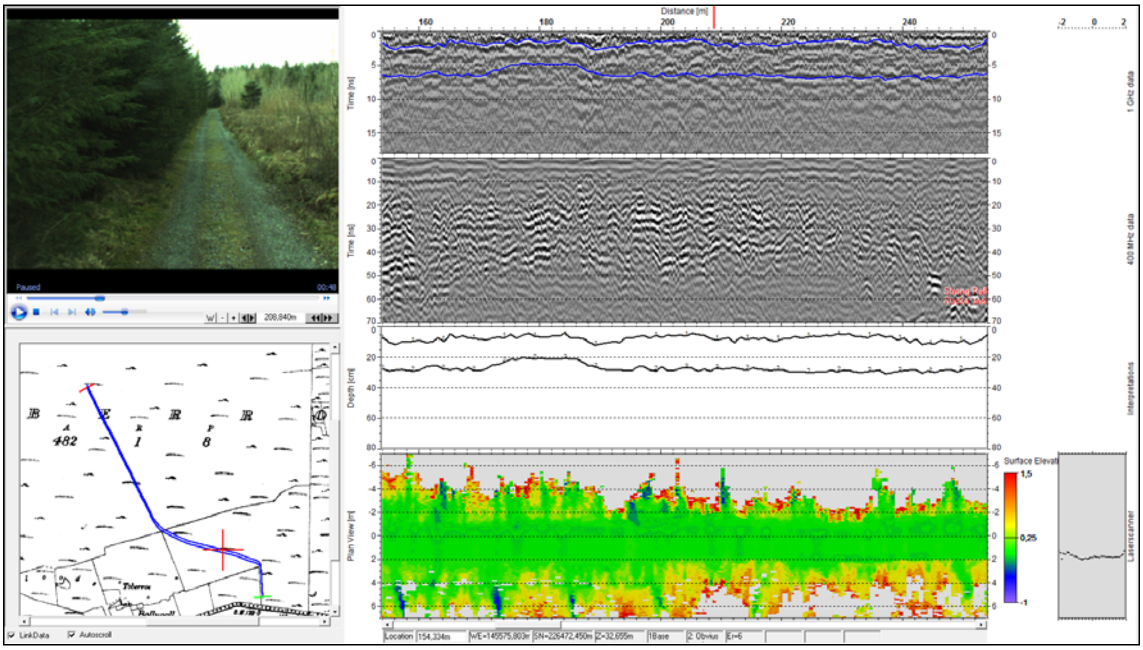

Figure 4.14 Road Doctor screenshot of the Coillte forest road. The photograph on the top left shows the forward view. The map on the bottom left gives the position of the survey vehicle. The top panel on the right shows the GPR radargram for the top road layers. The radargram below that shows the deeper structures. The third panel presents the interpreted GPR interfaces as black lines. The bottom panel records the output of the rotating laser scanner. The figure in the bottom right shows the laser scanner cross-section at the current point.

These productions were subsequently presented and discussed with Coillte colleagues at a Coillte Forest Engineering technical update meeting in Kehir, Tipperary on 22/23 September 2011.

5. ROADEX WORKSHOP, 27 OCTOBER 2011

A ROADEX workshop was held in Ireland on 27 October 2011 in the Landmark Hotel, Carrick-on-Shannon to deliver the results of the ROADEX tasks and obtain feedback from the ROADEX Partners in Ireland. The Agenda for the day is summarised below, and a full version appended at Appendix.

1. The ROADEX drainage maintenance guidelines
2. The 2011 ROADEX drainage analysis demonstrations
   a) 156km N59 Galway – Sligo
   b) 297km N56 Donegal to Letterkenny
3. Discussion & feedback
4. Roads on peat in Iceland & Ireland
5. ROADEX route risk assessment methods
6. The 2011 ROADEX route assessment demonstrations
   a) N59 Newport - Mulranny, Co Mayo
   b) N56 Drumnaraw To Cashelmore, Co Donegal
7. Discussion & feedback

Pdf versions of the presentations given are available on the ROADEX website in the Ireland folder at http://www.roadex.org/index.php/services/partner-knowledge-bank/ireland/carrick-on-shannon.

5.1. DISCUSSION & FEEDBACK

<u>Risk analysis costs</u>
The cost of risk analysis surveys and reports were queried and it was accepted that these were greater than those of existing visual assessment methods. The benefits gained however in focused maintenance on the weak sections of road that needed improvement more than outweighed the initial data collection costs. Comparative studies in ROADEX in Scandinavia have shown that focused ROADEX methods are less expensive that traditional methods even when the front data collection costs are included, e.g. the Timmerleden Forest Road.

<u>Preloading</u>
James Boyle of Donegal County Council said that Donegal had been carrying out on-line widening of roads on peat since the 1980's. Sections with shallow peat were excavated and the road widening constructed from firm ground with suitable fill. Deeper peat sections (3-4m) were widened using a preloading technique. A preload of approximately 1.5 m ("a load deep") was placed on the widened area for around 6 months and then removed. A temporary running surface of Clause 804 wet-mix macadam was then laid on the widened area and finished with 2 layers of surface dressing. This is trafficked for as long as necessary to further consolidate the underlying peat before the overall carriageway is reshaped, regulated and paved.

<u>Use of steel grids</u>
Steel grids have not been used and not considered necessary. The normal practice in Ireland was to lay "Terram" or equivalent on the virgin bog with the top heather surface intact to act as a separation layer and avoid contamination (lubrication) of the stone. Stone then was placed up to road level and then additionally preloaded to up to approximately 1.5 m. Where the bog was very soft and consolidation took place quickly this preloaded stone was levelled to road level again and preloaded a second time. After an "adequate" consolidation period the preloaded material is levelled to road level and any balance removed and a temporary surface put over the entire road. No mesh or steel used up to this stage. At final the surfacing stage (2 - 5 years, depending how the temporary surface performs) a mesh or some type of reinforcement may be used.

6. MEETINGS, 28 OCTOBER 2011

Meeting with Uinsinn Finn, Galway County Council, Loughrea

Galway County Council is responsible Roads Authority for road construction and improvement within County Galway. Major projects on national primary routes are fully funded by the N.R.A. and normally carried out by contracts awarded following public tender. In such cases, the County Council appoints supervisory engineering and technical staff to ensure the completion of the project to the required standard.

Smaller road schemes and alignment and improvement works may be carried out by the Council's Road Section, or by contract following public tender, or by a combination of contract and direct labour. All road construction and improvement works are carried out in accordance with the guidelines for roads standards laid down by Central Government.

<u>Bog ramparts</u>
A "bog rampart" is the name given to a road over peat that is above the level of the surrounding ground. The original road in this system would have originally been constructed on top of the bog surface in the normal fashion, but over the years the peat in the fields adjacent to the road would have been removed for burning and agriculture. At the same time, over the years, the old road would have been repaired and strengthened with new materials so increasing the height and weight of the road. The result of this lowering of the fields and raising of the road is a road of variable thickness, variable construction and restricted width that sits above the adjacent landscape. These roads have narrow verges with steep side slopes that that are prone to slipping. This makes any improvement work very challenging.

One method to overcome the restricted width is to wrap the new construction layers in a strong geotextile (e.g. Stabilienka or similar). This keeps the new materials in place and prevents the new construction from widening. Maccaferri steel reinforcement has also been used in a bog rampart rehabilitation in Roscommon in 2011.

<u>Offloading bog ramparts using waste tyre bales</u>
Offaly uses an offloading technique that employs lightweight tyre bales to rehabilitate bog rampart roads. A recent example of the work was seen in the 2006 Carnakelly South Tyre Bale trial project, near Kiltullagh in the Ballinasloe West engineering area. The sequence of events in the replacement project was (Whyte, 2007):

- the rampart was replaced excavated out to the required level
- a geotextile (Terram 1000) was laid across the excavated trench
- a 100mm layer of recycled fill was placed on the geotextile
- wire ropes were placed transversely across the trench for tying the bales together
- bales were placed tightly in a staggered pattern to break tranverse joints and create a more structurally cohesive base for the road layers (one and two bale solutions have been used) in the past. Bales were laid with the wire ties parallel to the direction of travel.
- a 250mm layer of crushed stone aggregate was placed over the bales to interlock with the joints between the bales and prevent fine material filling the voids
- a 25-50mm layer of fine material was laid on top of the fill as a preparation for the geogrid
- a geogrid
- a 500mm layer of recycled fill and imported aggregate was laid on the geogrid in two 250mm lifts.
- The completed installation was finished with a 150mm basecourse layer of Clause 804 crushed rock followed by a double surface dressing of 14mm and 10mm chippings.

Figure 6.1 Excavation

Figure 6.2 Placing bales in a staggered pattern

Figure 6.3 Sequence of layers

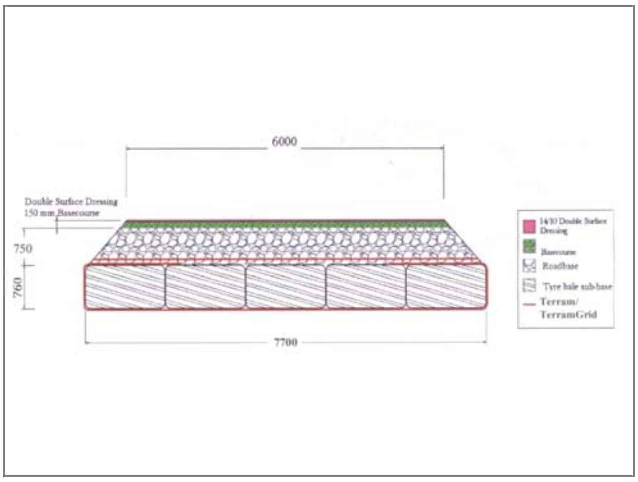

Figure 6.4 Final cross-section

The full cost of the works was approximately €350,000 for a finished road surface area of 3720m², or an installed cost of €90/m². The tyre bales were given free of charge by the manufacturer at his depot for this project. If the tyre bales have to be purchased this will have to be added to this cost.

Increasing regulation by the Environmental Protection Agency is making the technique less attractive however. Construction sites in Ireland intending to use waste tyre bales are now required to be licensed. Earlier it was thought that waste tyre bales could produce hazardous leachates into the groundwater table and sites were monitored for this without any effects being noticed. Offaly County Council plans to revisit former tyre bale sites to check that leachate levels are still the case.

Meeting with Charles McCarthy and Damien Grennan, Offaly County Council,

Offaly County Council has good experience of "recycling" roads, i.e. the "mixmilling" technique as outlined in the ROADEX elearning lesson on "Pavement Deformation". The main aim of recycling is to use the existing materials in a road, and not to add any new weight to the road. Offaly County Council had carried out five recycling schemes in 2011 and these are listed in Figure 4.5 below.

Recycling Sites for Offaly Co. Co. (June 2011)					
Road	Cloncrane Rd at Clonbullogue	Rathangan Rd	Cloncrane Rd at Edenderry	Tyrrellpass Rd at Daingean	Tunnel Rd / Soccer Field
Structure	25 mm of surface dressing on macadam	25 mm of surface dressing on 60 mm of macadam on unbound aggregate	20 mm of surface dressing on unbound aggregate	20 mm of surface dressing on unbound aggregate	20 mm of surface dressing on unbound aggregate
Existing Binder Content (%)	3.8	3.7	2.1	2.6	2.8
Recycling depth (mm)	100	100	100	100	100
% emulsion to add =	**3.0%**	**3.0%**	**4.0%**	**4.0%**	**4.0%**
Emulsion rate (litres/m^2) =	6.9	6.9	9.2	9.2	9.2
% water to add =	**1.5%**	**1.5%**	**1.5%**	**1.5%**	**1.5%**
Water rate * (litres/m^2) =	3.5	3.5	3.5	3.5	3.5

Figure 6.5 Offaly County Council recycling programme for 2011

Bitumen is added when recycling of Regional roads. The existing material in the road layers are tested for moisture content and bitumen content. Supplementary bitumen & water is then added to bring the material up to the specified design content. A typical recycling operation on a low volume road is shown in Figures 6.6 to 6.9 below.

Figure 6.6 Recycling operation

Figure 6.7 Grading the recycled layer

Figure 6.8 Surface dressing the finished work

Figure 6.9 Rolling with a pneumatic tyred roller

Recycling is considered to be a cost effective solution for strengthening an existing failing road. The cost of a 100mm deep recycling exercise, including finishing the recycled layer with 2 layers of surface dressing, was stated to be approximately 16 €/m² (2011 prices). The cost of a comparable standard rehabilitation overlay of 60mm dense bitumen macadam (DBM) basecourse and 40mm DBM wearing course was 25 €/m².

It was mentioned that it was not common to use grids or geotextiles on low volume local “L” class roads. A Macaferri twisted steel mesh was sometimes installed below the wearing course on “R” class regional roads.

7. ENGINEERS IRELAND SEMINAR, 31 MAY 2012

"Road Maintenance – Best Practice in Ireland and Abroad"

The Roads & Transportation Society of "Engineers Ireland" holds an annual seminar on a chosen topic of interest to the engineering professions in Ireland. In 2012 "Road Maintenance" was the theme and a number of speakers were invited to present on the subject of "Road Maintenance – Best Practice in Ireland and Abroad".

ROADEX was invited to give a summary background of the Project and what had been done in Ireland. Ron Munro, project manager for the ROADEX IV project gave the presentation. This covered the background to ROADEX and summarised the two demonstration projects of risk assessment and drainage analysis on the N56 and N59. The feedback to the presentation was very positive.

Four speakers from ROADEX partner organisations also presented:

1. Dominic Mullaney, Principal Advisor, Roads Inspectorate, Department of Transport, Tourism and Sport
2. Stephen Smyth, Engineering Inspector, Network Management, National Roads Authority
3. Tom Casey, Senior Project Manager, National Roads Authority
4. Michael Mongan, Senior Engineer, Mayo County Council

and summaries of their presentations follow. The full presentations in pdf format can be downloaded from http://www.engineersireland.ie/public/Road_Maintenance_seminar_PDFs.zip.

1. Dominic Mullaney, Principal Advisor, Roads Inspectorate, Department of Transport, Tourism and Sport

This speaker's presentation was titled "*Overview of Road Maintenance in Ireland*" and comprised a concise summary of the maintenance policies and practices across Ireland. It was explained that road maintenance & rehabilitation in Ireland can be divided into three categories:

- Routine maintenance
  Routine maintenance normally typically includes activities such as roadside verge clearing, grass cutting, cleaning of silted ditches and culverts, patching, pothole repair and repair of edge defects
- Periodic maintenance
  Periodic maintenance aims to protect the structural integrity of the road (e.g. by surface dressing).
- Urgent maintenance
  Urgent maintenance is undertaken for repairs that cannot be foreseen but require immediate attention such as collapsed culverts or landslides.

It was stated that there was not a clear divide between where road maintenance ends and road improvement/rehabilitation begins. However a criterion that was used by the World Bank was that if the sections of road to be completely rebuilt constitute more than 25% of the road's length, the work is rehabilitation, not maintenance. This was not an exact science however and discretion was still used in Ireland

Road rehabilitation and improvement was sub-dived into two categories:

- surface restoration
  This essentially comprised surface dressing to seal the road & improve skid resistance. * This was felt to be most effective when it was preventative rather than reactive. It was considered especially important to maintain a sealing layer over unbound materials, suh as cl.804 & wet mix). The surface dressing operation was also expected to include where necessary improvement of transverse and longitudinal drainage, pothole patching and restoration of road widths to those originally provided and local strengthening of weak road edges.

- road reconstruction
  This involved the regulation or reconstruction of the existing road pavement and overlaying with bound or unbound materials with or without surface dressing and the provision of drainage, where necessary.

The decision regarding the level of treatment was generally based on anumber of considerations that mirrored ROADEX practice:

- Would a surface dressing suffice?
- If strengthening was required, was the problem in the pavement or at subgrade level?
- Was there a drainage problem? Was the drain at least 200 mm (preferably it would be more) below road formation?


Figure 7.1 Road strengthening


Figure 7.2 Recycling of material

The speaker particularly commented on the outputs of ROADEX, notably the classification of rutting mechanisms (Mode 1 & Mode 2) on low volume roads and the benefits of drainage in keeping the road network functioning.

The presentation closed with a summary of the main issues in Ireland:

- Budgets were decreasing
- Spending in future would mainly be on maintenance & rehabilitation rather than major improvement – over 85% of the planned roads budget was for maintenance/rehabilitation
- A 2004 sample survey of all regional & local roads indicated a backlog of €2.7 billion
- A Pavement Management System was essential for the road network
- A new visual rating system (on a 1 to 10 basis) had been introduced to allow councils to rate the condition of their local roads
- More use needed to be made of recycling and low energy paving materials & processes
- The return on monies invested in roads had to be maximized.

2. Stephen Smyth, Engineering Inspector, Network Management, National Roads Authority

This speaker's presentation was titled "*National Road Management & Maintenance*" and gave a background to the workings of the NRA in Ireland

The National Roads Authority was formally established as an independent statutory body under the 1993 Roads Act. The Authority's primary function was to secure the provision of a safe and efficient network of National roads. For this purpose, it had overall responsibility for planning and supervision of construction and maintenance works on National roads.

National roads comprise almost 6% (approximately 5,300 km) of the entire 93,000km public road network in Ireland. They carry 46% of total traffic in Ireland and are the dominant mode of transport accounting for 96% of passenger traffic and 98% of freight traffic. They were stated to "fulfil a key role in catering for social and economic activity and in providing access to the regions as well as to ports and airports".

Figure 7.3 National Road Network 2010

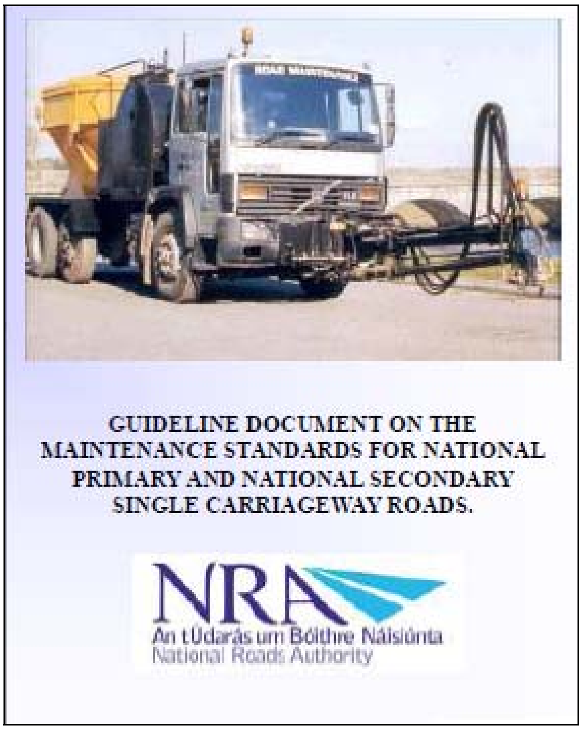

Figure 7.4 NRA Maintenance Guideline Document

The road statistics for the NRA were:

Motorway	900km
Dual Carriageway	330km
Single Carriageway	4,070km

3. Tom Casey, Senior Project Manager, National Roads Authority

This speaker delivered a very topical presentation on "*Road Pavements*" and why responsible maintenance was important. This struck many chords with ROADEX practices and reinforced many in the Irish context. In particular it was mentioned that:

- Minor problems can become more serious over time, and more expensive to repair.
- Repair costs can rise to up to six times maintenance costs after three years of neglect and to 18 times after five years of neglect.
- Delayed maintenance leads to neglected roads that are then more difficult to use, have increased vehicle operating costs, passenger and freight services are curtailed, loss of economic and social development opportunities.

The NRA recommendation was:

> "*If money is short – and it usually is – there's only one rational course of action:*
> *– Maintain existing roads before funding new ones.*
> *– Make sure it is done today, and even every day.*
> *– Because tomorrow, it will be much more expensive*" (PIARC 1999)

The NRA considered it essential to determine the cause of the deterioration or failure before deciding on any remedial measures. It was stated that the solution could however be constrained by the available budget, prevailing weather conditions, time available, development plans for the route or adjacent infrastructure. Typical solutions often included:

Table 7.1 Examples of typical remedial measures

Defect	**Remedial measures**
Surface deterioration	addition, or removal and replacement of the surface layer.
Non structural profile	Restoration, usually by surface overlay
Cracks	Seal individual cracks or apply over-band - wider cracks and "alligator" crazing signify structural damage
Structural & foundation weakness	Immediate repair e.g. Patching or haunching
Bleeding and fatting up	Water jetting and mechanical retexturing (shot blasting, or bush hammering); fog sealing and re - chipping.
Water related damage	Effective drainage. If not tackled, this can cause weakening of structural layers and freeze-thaw damage. Adequate drainage is particularly essential with water sensitive materials
Structural failure	May be extensive deterioration requiring reconstruction. Options may not require the full removal and replacement e.g. recycling using cement and/or bituminous based binders, crack and seat in composite pavements, asphalt reinforcement. Lightweight fills and sub-base substitution can enable effective reconstruction with limited service restrictions to motorists

The largest proportion of Irish road network was stated to be "legacy roads" carrying relatively low flows. Reconstruction was likely to involve elements of realignment. Existing pavement materials largely consisted of surface dressings, or thin bound layers, over unbound stone. These were very variable. Roadworks could involve long diversion routes that often dictated that the works were trafficked early. The climate in Ireland required materials and processes that were moisture tolerant

4. Michael Mongan, Senior Engineer, Mayo County Council

This speaker spoke on the importance of "*Drainage Maintenance of Roads*". Mayo County Council had been an active participant in the ROADEX drainage demonstration project on the N59 and the presentation gave a number of positive comments on what had been done.

It was stated that the main functions of a road drainage system were:

- To prevent flooding of the road and ponding on the road surface
- To protect the bearing capacity of the pavement + subgrade material
- To protect the road embankments from erosion

It was confirmed that Road Authorities should periodically review the adequacy of their road drainage systems under two headings: a) maintenance of existing road drainage systems, and b) improvement works to bring deficient road drainage up to an acceptable standard.

Table 7.2 gives a summary of some of the typical drainage maintenance operations carried out in Ireland.

Table 7.2 Typical elements in drainage maintenance operations

Type of drain	Maintenance
Piped drains	• Clean out road gullies • Check pipeline is clear • Check filter material in French drains is operating satisfactorily. Replace top 300mm every 10 years in drains adjacent to roads
Open drains adjacent to road	• Open drains are the preferred option, but adequate space needed between boundary fences/walls and open drains • Use pipe drains where there is insufficient width between the fence/wall & road edge • Use load bearing pipes where drains can be trafficked
Verge offlets	• Maintain existing offlets with concrete • Provide additional offlets if required • Use mechanical plant for wider offlets and to take material away
Channels	• Clear grass/vegetation growth in channels regularly • Do not obstruct channels during the course of temporary works • Do not block channels at entrances, i.e. no channel pipes or obstructions to be permitted

Figure 7.5 French drain adjacent to road

Figure 7.6 Piped obstruction in channel

8. SUMMARY

Work done

Five demonstrations of ROADEX technologies were given to Irish ROADEX Partners during the course of 2011. These were:

1) Two demonstrations of the ROADEX drainage analysis method on typical roads the Irish road network:
   a. N56 from Donegal town to Letterkenny
   b. N59 from Sligo town to Galway city
2) Two demonstrations of the ROADEX road risk assessment method on two planned road rehabilitation works for roads over peat:
   a. 10km of the N56 from Drumnaraw to Cashelmore in County Donegal
   b. 15km of the N59 from Newport to Mulranny in County Mayo.
3) A demonstration of the ROADEX GPR, FWD and laser scanning methods on an Irish forest road in Derrydonnel property, Kilcornan Forest Area, Co. Galway

In addition to the above demonstrations a number of meetings were held with engineering representatives of the Galway, Mayo and Donegal County Councils to gain an insight into public road operations in Ireland.

A ROADEX workshop was held in Carrick-on-Shannon, County Leitrim on 27 October 2011 to deliver the results of the ROADEX tasks and obtain feedback from the ROADEX Partners in Ireland.

Finally ROADEX, and ROADEX Partners, presented at the annual seminar of The Roads & Transportation Society of "Engineers Ireland" on 31 May 2012. The theme of the seminar was "Road Maintenance – Best Practice in Ireland and Abroad" where the ROADEX Project was mentioned as being an example of best practice in sharing information on roads.

Outcome

The main outcomes of the ROADEX IV project in Ireland has been a general raising of awareness of the benefits of the ROADEX network in Ireland and an acceptance of the technologies available.

As a tangible example of this is that the Department of Transport has allocated a sum of €900,000 in their financial plan for 2012-13 for pilot road repair projects identified by ROADEX in Donegal County Council and Mayo County Council. Both sections referred to are those relating to the ROADEX risk analysis reports but the work will also look at the Drainage as part of any overall repairs or solution.

Table 8.1 below was issued by the Department of Transport to ROADEX on 12 June 2012 as confirmation of this intent.

Table 8.1 Work confirmation issued by the Department of Transport dated 12 June 2012

Mayo County Council	N59	ROADEX Drainage Repairs	2km	€450,000	Pilot project for pavement improvement identified by research project - ROADEX (Westport - Carrowmore was identified in 2011 drainage report as exhibiting poor verges).
Donegal County Council	N56	ROADEX Drainage Repairs	2km	€450,000	Pilot project for pavement improvement identified by research project

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APPENDIX

1. Roads in the Republic of Ireland
2. Coillte background
3. ROADEX Workshop Agenda, 27 October 2011

Appendix 1

Roads in the Republic of Ireland (Wikipedia)

The Republic of Ireland has an extensive network of public roads connecting all parts of the country.

As of 31 December 2007, there was a total of 5,427.58 km of national roads: 2,743.606 km of national primary routes (including motorways) and 2,683.974 km of national secondary routes. In addition to national roads, the Republic also has an extensive network of other public roads: there are 11,630 kilometres of regional roads and 78,972 kilometres of local roads.

The different classes of roads in Ireland are allocated blocks of numbers so that no number is used more than once. (not all road numbers are currently in use):

- National Primary Roads are numbered from N1 to N50 (motorway sections are signed with M prefix instead of N).
- National Secondary Roads are numbered from N51 to N99.
- Regional Roads are numbered from R100 to R999.
- Local Primary Roads are numbered from L1000 to L4999.
- Local Secondary Roads are numbered from L5000 to L8999.
- Local Tertiary Roads are numbered from L10001 to L89999 with the first 4 digits representing the Local Primary or Secondary road it is off. Local Tertiary roads which are unrelated to a Local Primary or Secondary road are given numbers from L90000 up.

<u>National secondary roads</u>
There are 2683.974 km of national secondary roads in Ireland, making up slightly less than 50% of the entire national route (national primary and national secondary) network.

National secondary routes are generally more poorly maintained than primary routes (although their quality can vary widely), but often carry more traffic than regional roads. Almost the entire network of national secondary roads is single carriageway, although there are some short sections of dual carriageway.

Typically, national secondary roads are of a similar standard or higher than regional roads although some are of lower quality than the better sections of regional roads. Many of them have been resurfaced with higher quality pavements in recent years with relatively smooth surfaces and good road markings and signposting. However, road widths and alignments are often inadequate, with many narrow and winding sections.

<u>Regional roads</u>
There are over 11,600 kilometres of regional roads. Some of the more important regional roads such as the R136 Outer Orbital, Dublin and the R710 Waterford Outer Ring Road are dual-carriageway in whole or part. Most regional roads are however single carriageway roads, and many are rather narrow country roads.

Regional roads are subject to a general speed limit of 80 km/h (imperial equivalent: 50 mph) or 50 km/h (imperial equivalent: 31.25 mph) in built-up areas.

<u>Local roads</u>
“Local roads” is the generic name given to all public roads other than motorways, national roads or regional roads. They vary greatly in quality, from wide urban streets to very narrow, rural lanes, known as “boreens” in Ireland.

As mentioned in the listing above, local road can be classified into 3 types:

- Local Primary Roads (local roads wider than 4 metres),
- Local Secondary Roads (local roads narrower than 4 metres), and
- Local Tertiary Roads (cul-de-sacs and other minor roads).
- Local roads are subject to a general speed limit of 80 km/h (imperial equivalent: 50 mph) or 50 km/h (imperial equivalent: 31.25 mph) in built-up areas.

Appendix 2

Coillte

Coillte ("Forestry" in the Irish language) is the state-owned forestry company of Ireland. All of the shares of the company are held by the Minister for Agriculture, Fisheries and Food and the Minister for Finance on behalf of the Irish State. The Board of Directors is appointed by the Minister for Agriculture and Food.

Coillte started in 1989 when it acquired ownership of the State's forests. The core purpose of the company is to commercially manage these forest assets. The company has undergone a major transformation since that date by becoming a European scale forestry and forest products business:

- The forest estate has increased in area from 376,000ha to 445,421 ha. (445,315 ha are forested);
- Profits have increased from a loss of €438K to profits of €4.2 million (2009);
- Turnover has grown from €38 million to €206.9 million (2009);
- Roundwood sales have grown from 1.5 million cubic metres to 2.4 million cubic metres.

Coillte is organised into three divisions: Coillte Panel Products, Coillte Forest and Coillte Enterprise.

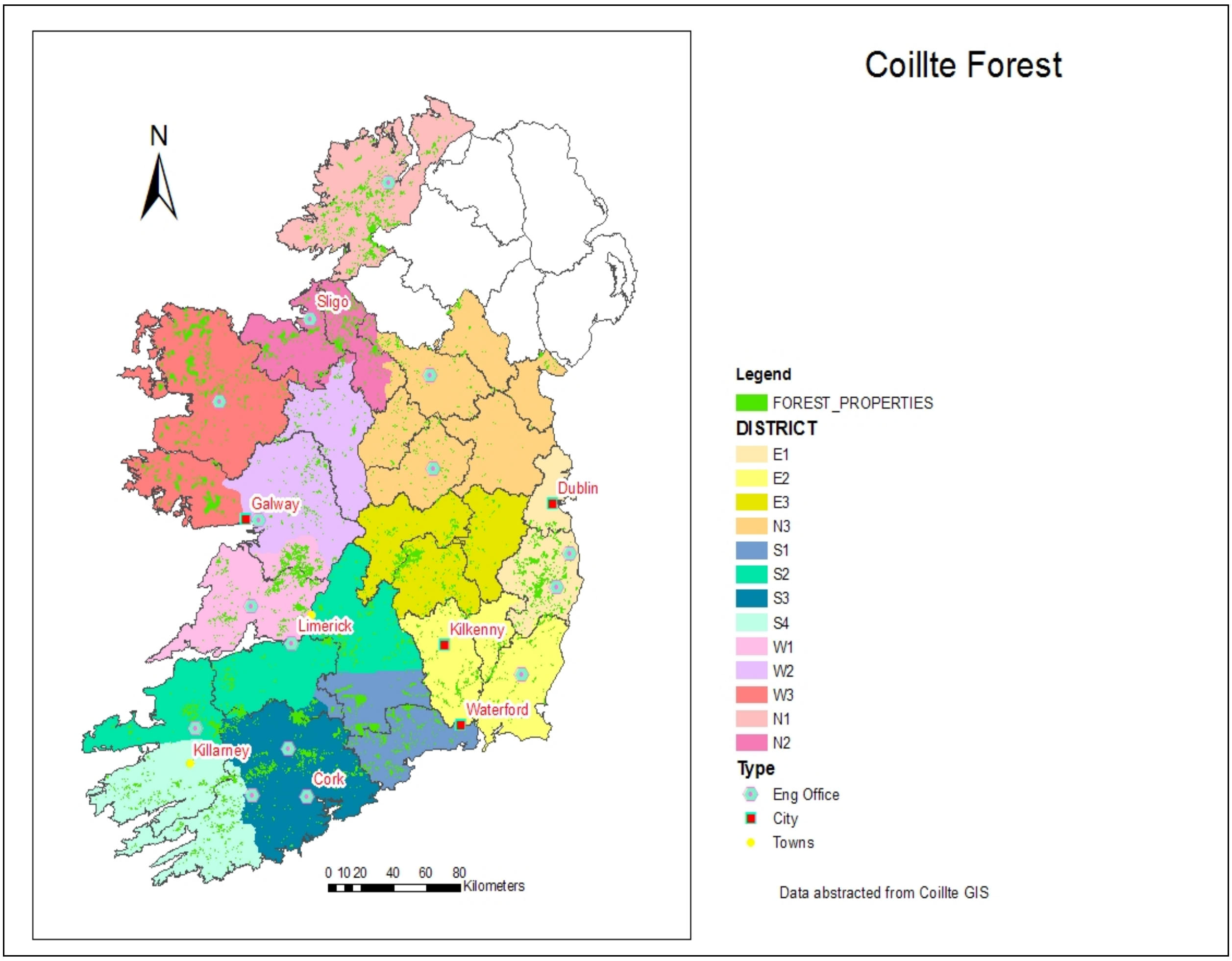
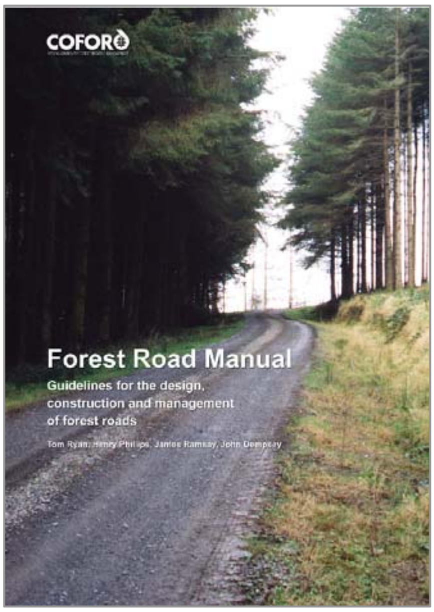


Figure 1. Coillte forest districts in Ireland

The following comments and photographs are taken from John Dempsey's ppts "*Coillte Forest Civil Engineering*" and "*Guidance Course for the Management, Maintenance and Repair of Forest Roads*".

Forest roads in Ireland, like other ROADEX areas, are subjected to low intensity, slow moving heavy vehicles in response to forest development and as a consqequence are designed to different standards than public roads. Coillte road standards are based on the Council for Forest Research and Development (COFORD) manual, COFORD is an agency of the Forest Service. Coillte operates a system that allows vehicles up to 44 tonne gross vehicle weights. Lifetime capacity is related to the accumulation of "factored" axle weights.



Road production figures 2004-8:

Year	New Roads (km)	Upgraded Roads (km)
2008	114.9	165.9
2007	157.9	213.4
2006	156.5	166.4
2005	166.2	306.8
2004	159.3	240.9

Coillte road repair and maintenance operations are based on:

- Forest operations function rather than engineering function
- Roads are classified for maintenance scheduling according to intensity of use
- Road repairs are associated with timber harvesting operation

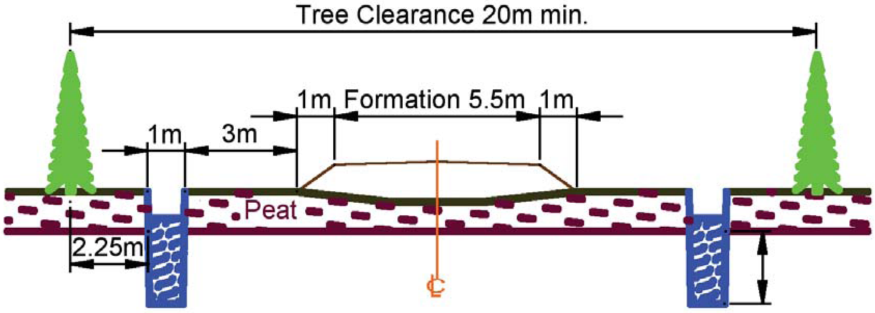
The main factors considered in planning maintenance and repair operations are: the preservation of the capital asset, the continued safety of the users, access for emergency services, and the reduction of vehicle operating costs. A satisfactory level of maintenance/repair is usually achieved by retaining the standards of the road as built.

Good maintenance and repair practice is considered essential to –

- protect the road foundation
- disperse water
- minimise environmental impact
- optimise return from the expenditure invested in the road network

Most road repairs on the Coillte forest estate are carried out in response to harveting demands, i.e. during and immediately after harvesting. Carriageways are usually constructed as a single layer of material. Sometimes they are a low quality fill capped with good quality material. The most suitable finish is a durable, well graded, crushed rock. An number of interesting engineering methods were seen and discussed during the visit and these are briefly mentioned below.

<u>Reversal roads</u> (from the COFORD manual)
This 'reversal' method of construction was introduced onto Irish forestry roads in the mid-seventies. The term 'reversal' describes the basic method of construction, which entails taking the mineral soil from beneath the peat layer and placing it as an embankment on top of the peat, thus reversing the natural order of the soil strata. This method has been adopted throughout most of the country since then with many variations, adaptations and developments.



A “Type A reversal road” section with a double drain (from COFORD manual)

The advantages of the reversal method are that it:

- provides a low cost method of construction by using fill material available on the site
- reduces spoil heaps at the side of roads that make timber extraction much easier; and
- raises the level of the road, enabling it in wet areas to be kept above the water table

A reversal road normally needs at least 2 years to construct to allow time for the completed road structure to settle and dry before trafficking.

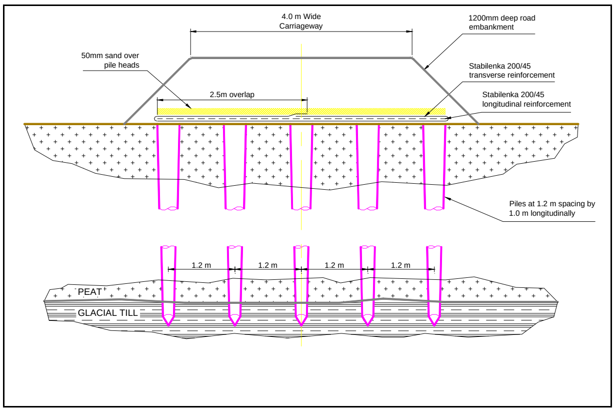
Coillte engineering trials

Coillte had been trialling a number of innovative engineering techniques over the previous years. These included the use of geocells, on-site stone crushing, waste tyre bales and timber piles as shown below:


Use of geocells in forest roads

Insitue stone crushing to produce road aggrelates

Waste tyre bales



Timber piled forwarder track

Appendix 3

ROADEX workshop, 27 October 2011, Landmark Hotel, Carrick-on-Shannon

Draft agenda

Time	Subject	Speaker
9.00	*Registration & coffee*	
9.15	Welcome & opening remarks	John McCarthy, DoT
9.30	The ROADEX Project - update on current work	Ron Munro
10.00	The ROADEX drainage maintenance guidelines	Timo Saarenketo
10.45	*Morning Break*	
11.00	The 2011 ROADEX drainage analysis demonstrations • 156km N59 Galway – Sligo • 297km N56 Donegal to Letterkenny	Timo Saarenketo
11.45	Discussion of the drainage analyses & feedback	All
12.15	Roads on peat, Iceland & Ireland	Haraldur Sigursteinsson
13.00	*Lunch*	
14.00	ROADEX route risk assessment methods	Timo Saarenketo
14.4-5	The 2011 ROADEX route assessment demonstrations • N59 Newport - Mulranny, Co Mayo • N56 Drumnaraw To Cashelmore, Co Donegal	Timo Saarenketo
15.30	*Afternoon break*	
15.45	Discussion of the route risk assessments & feedback	All
16.15	Closing remarks	Tom Casey, NRA
16.30	*End of Workshop*	

Pdf copies of the presentations are available on the ROADEX website in the Ireland folder at:

http://www.roadex.org/index.php/services/partner-knowledge-bank/ireland/carrick-on-shannon

ROADEX
Implementing Accessibility

ROADEX PROJECT REPORTS (1998–2012)

This report is one of a suite of reports and case studies on the management of low volume roads produced by the ROADEX project over the period 1998-2012. These reports cover a wide range of topics as below.

- Climate change adaptation
- Cost savings and benefits accruing to ROADEX technologies
- Dealing with bearing capacity problems on low volume roads constructed on peat
- Design and repair of roads suffering from spring thaw weakening
- Drainage guidelines
- Environmental guidelines & checklist
- Forest road policies
- Generation of 'snow smoke' behind heavy vehicles
- Health issues raised by poorly maintained road networks
- Managing drainage on low volume roads
- Managing peat related problems on low volume roads
- Managing permanent deformation in low volume roads
- Managing spring thaw weakening on low volume roads
- Monitoring low volume roads
- New survey techniques in drainage evaluation
- Permanent deformation, from theory to practice
- Risk analyses on low volume roads
- Road condition management of low volume roads
- Road friendly vehicles & tyre pressure control
- Road widening guidelines
- Socio-economic impacts of road conditions on low volume roads
- Structural innovations for low volume roads
- Treatment of moisture susceptible materials
- Tyre pressure control on timber haulage vehicles
- Understanding low volume pavement response to heavy traffic loading
- User perspectives on the road service level in ROADEX areas
- Vehicle and human vibration due to road condition
- Winter maintenance practice in the Northern Periphery

All of these reports, and others, are available for download free of charge from the ROADEX website at www.ROADEX.org.

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