ROADEX
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ROADEX DRAINAGE DEMONSTRATIONS IN NUUK, GREENLAND

A report on drainage demonstrations in Greenland, carried out by the Center for Arktisk Teknologi, DTU Byg, August 2011

ABSTRACT

Drainage is one of the most important factors to be kept in mind in road design and maintenance projects. It is accepted generally that road structures work well and last longer in dry conditions. Researches have shown that that poor drainage is often the main cause of road damages and problems with long term road serviceability. This knowledge however has not always been applied in practice with the result that the general drainage condition of the road networks is not good. Previous ROADEX projects have reported that poor drainage is the one of the biggest problems for Northern European rural roads, and parts of the main road network.

Drainage analysis was developed to locate those critical sections, needing improvement and after that regular attention and maintenance. Usually a drainage analysis is done visually from a moving car and later from digital videos with input from road historical performance data (roughness and rutting). In Greenland case roughness and rutting data was not available which caused limitations for the statistical analysis.

This report “ROADEX Drainage Demonstrations in Nuuk, Greenland” describes the results of the ROADEX drainage demonstration project in the Nuuk are of Greenland. The project was a supplementary project to the initial ROADEX demonstration project in Sisimiut and was carried out by staff and students of the The Danmarks Tekniske Universitetet (DTU) Arctic Technology Centre (ARTEK) led by Rasmus Lind Jensen, under the direction of Professor Arne Villumsen.

Overall the surveyed drainage sections proved to be in relatively good condition. Mainly the problems were related to a side sloping street profile and/or clogged access road culverts. Other specific reasons for poor drainage were also detected. The data collected by the laser scanner was useful for detecting the depth and form of the ditches, and changes in road cross sections.

KEYWORDS

Drainage, analysis, urban area, pavement, life time, laser scanner

PREFACE

This task “ROADEX Drainage Demonstrations in Nuuk, Greenland” was carried out in ROADEX IV work package 3, Local demonstrations. The purpose was to demonstrate how the principles of drainage analysis were suited for urban areas.

The field measurements were carried out by members of The Danmarks Tekniske Universitetet (DTU) Arctic Technology Centre (ARTEK) led by Rasmus Lind Jensen, under the direction of Professor Arne Villumsen.

Processing and analysis of measured data was done by Rasmus Lind Jensen who also wrote the report. Timo Saarenketo steered the demonstrations as lead manager of the ROADEX D1 “Drainage Maintenance Guidelines” group. Ron Munro checked the language. Mika Pyhähuhta from Laboratorio Uleåborg designed the report layout.

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

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CONTENTS

1. INTRODUCTION

1.1. THE ROADEX PROJECT

The ROADEX Project was a technical co-operation between road organisations across northern Europe that aimed 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 Finnish 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 "Implementing Accessibility" from 2009 to 2012.

Figure 1.1 The Northern Periphery Area and ROADEX Partners

The Partners in the ROADEX "Implementing Accessibility" project comprised public road administrations and forestry organisations from across the European Northern Periphery. These were 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 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 also pursued as part of the project: D1 "Climate change and its consequences on the maintenance of low volume roads", D2 "Road Widening" and D3 "Vibration in vehicles and humans due to road condition".

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

1.2. ROADEX 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”

D2 - “Road friendly vehicles and Tyre Pressure Control”

D3 - “Forest Road policies”

D4 - “Rutting, from theory to practice”

D5 - “Roads on Peat”

D6 - “Health and Vibration”

This report deals with the demonstrations project in the D1 “Drainage Maintenance Guidelines” group carried out in Greenland.

2. INTRODUCTION

This report describes the results of a ROADEX drainage demonstration project in Nuuk, Greenland by the Arctic Technology Centre (ARTEK) in August 2011. The aim of the project was to use ROADEX drainage analysis method in a new Partner area and map the drainage of selected roads. As part of this an investigation was carried out into how the ditches worked using video and laser scanner, and what connection there was between the condition of the road and the drainage.

The report focuses on the practical results of the surveys made. Maps of the drainage condition of the roads surveyed are presented with accompanying comments.

Emphasis is placed on a brief overview of the roads. The accompanying comments are kept deliberately short. These state whether the drainage is good, the ditch should be cleaned, or if a new ditch should be constructed.

The classification of roads and ditches has been carried out in accordance with the ROADEX drainage analysis classifications, as in the “RoadDoctor” software.

Roads:
1: Good road condition without anything to comment

2: Acceptable road condition, but with possible cracks, wear or rutting

3: Bad road condition, very uneven, possibly with many cracks and patches.

Ditches:
1: Drainage is working well. There is either a constructed ditch which is relatively deep and water is running in the right direction, away from the road. Or the slope away from the road is so steep that there is no need for a ditch. Ditches are clean and the water can flow freely.

2: Drainage works partially, or not. Constructed ditch as in (1), but the trench is full of soil/waste/grass, so it must be cleaned. It seems to work in clean condition.

3: No controlled drainage. There has not been constructed any kind of ditch and the slope of the road leads either water in the wrong direction or not away from the road. This can cause wear on the road. Here it is recommended to construct a kind of ditch.

These classifications have been translated into the colour codings of green = 1, yellow = 2, red = 3 on the maps within the report.

All the of the data collected in the demonstration project has been copied on to an external hard drive and given to the Nuuk Municipality as a record of the work. This can be viewed with "Road Doctor Viewer".

3. EQUIPMENT

The following equipment was used in the surveys:

- Video camera for recording the road, Figure 1
- Video camera for recording the ditch, Figure 1
- Laser scanner for the survey of the ditch and road, mounted on a boom above the rear of the vehicle approximately 3.3 metres above the road (Figure 3)

The data collected during the above surveys was analysed using RoadDoctor software (Figure 4). This combined the video and laser scanner data, the road environment & shape and the location & slope of the road to produce an assessment of the drainage condition and its effect on the road.

The combined data can be viewed with a ”RoadDoctor Viewer”, either separately or by opening one of the saved ”views” of multiple data and analysis. These include individual saved views for the respective pavement and ditches.

A “pavement” view contains: a video of the road, road condition, laser scanner and approximated roughness (accelerometer).

A “ditch” view contains: a video of the ditch, a ditch classification, any maintenance history, laser scanner data and the GPS height.

Figure 1 - Camlink box with 2 cameras

Figure 2 - Laserscanner

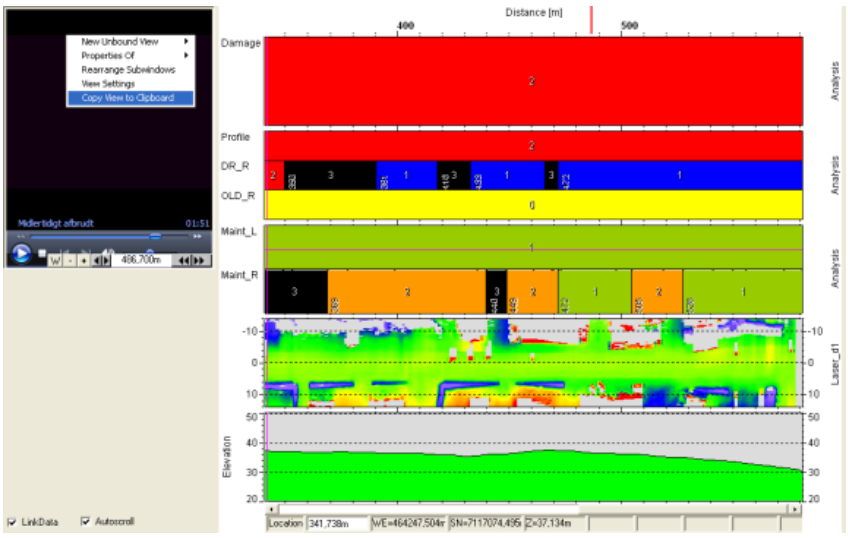

Figure 3 - Example of a ”ditch” view screen in RoadDoctor

Figure 4 - Laserscanner mounting arrangement on the survey vehicle

4. EXAMPLES OF DITCHES IN NUUK

This page and the next give some examples of ditches and drainage issues in Nuuk.

Figure 5 shows a typical example of the type of concrete ditch that is often used in Nuuk. These ditches generally work as intended and are effective in carrying water away from the road. This type of ditch is marked in green on the maps.

Figure 6 and Figure 7 give examples of what can happen if ditches are not provided where they should be

Figure 6 shows that even paved roads can be damaged when ditches are not provided.

Figure 7 shows clearly how gravel and stone can be washed away from unpaved gravel roads where water is permitted to run uncontrolled, and what kind of cracks can be caused. This photograph also shows the patching that becomes necessary to repair the water damage caused.

Places where a ditch should be constructed a ditch are marked with red on the maps.

Figure 7 – Concrete ditch

Figure 6 – wear on paved road

Figure 5 – Wear on gravel road

In some places, where ditches are blocked by gravel, stone or waste pools of stagnant water can be created. These ditches can be well constructed with concrete, but fail to work due to clogged outlet pipes.

An example of stagnant water in a well constructed ditch can be seen in Figure 8.

Figure 9 and Figure 10 give examples of typical materials that can block drainage systems. In some cases, it can be sand and gravel (Figure 10) in other cases, large rocks and waste (Figure 9).

Drainage systems are vitally important for the durability of roads as stagnant water in road construction can cause road materials to lose bearing capacity, and thus be damaged from the traffic load.

Places that should be cleaned out are marked with yellow on the maps.

Figure 8 – Stagnant water in a ditch

Figure 9 – Ditch blocked by stone and garbage

Figure 10 – Ditch filled with sand and gravel

5. THE ROAD NETWORK IN NUUK

Many sections of roads in Nuuk have a wide cycle path on the outer side of the road. This creates a longer drainage distance from the road to the ditch, but as most sections are paved all the way to the ditch, at the correct angle, it is generally not a problem.

Most of the established ditches on the Nuuk road network have a concrete bottom which works really well. Concrete ditches and places that do not need a ditch are marked in green on the maps.

In some places the established ditches are filled with stones or waste, and these should be cleaned. The sections with blocked ditches are marked with yellow on the maps.

Some road sections do not have a ditch, where it would be good to have the ditch. These sections are marked in red on the map.

General direction of the roads
An overall map of the surveyed roads is shown below, with the direction of survey indicated by white arrows (Figure 11). The survey maps for the surveyed road sections can be found under the respective roads sections where the direction of the path is indicated from 0 going toward the end of the road. The direction is only relevant when reading data, and irrelevant when reading the maps.

The direction of the road surveys are basically defined by "centre" roundabouts at "Sipisaq Kangilleq", "400-rtalik" and "Eqalugalinnguit". Direction 1 means going away from the roundabout and direction 2 means going towards the roundabout. On the side roads, direction 1 is defined as going away from the "main road" and direction 2 as going towards the main road. In places with loops, the direction is defined by one of the side roads, and continues until it connects to the main road again.

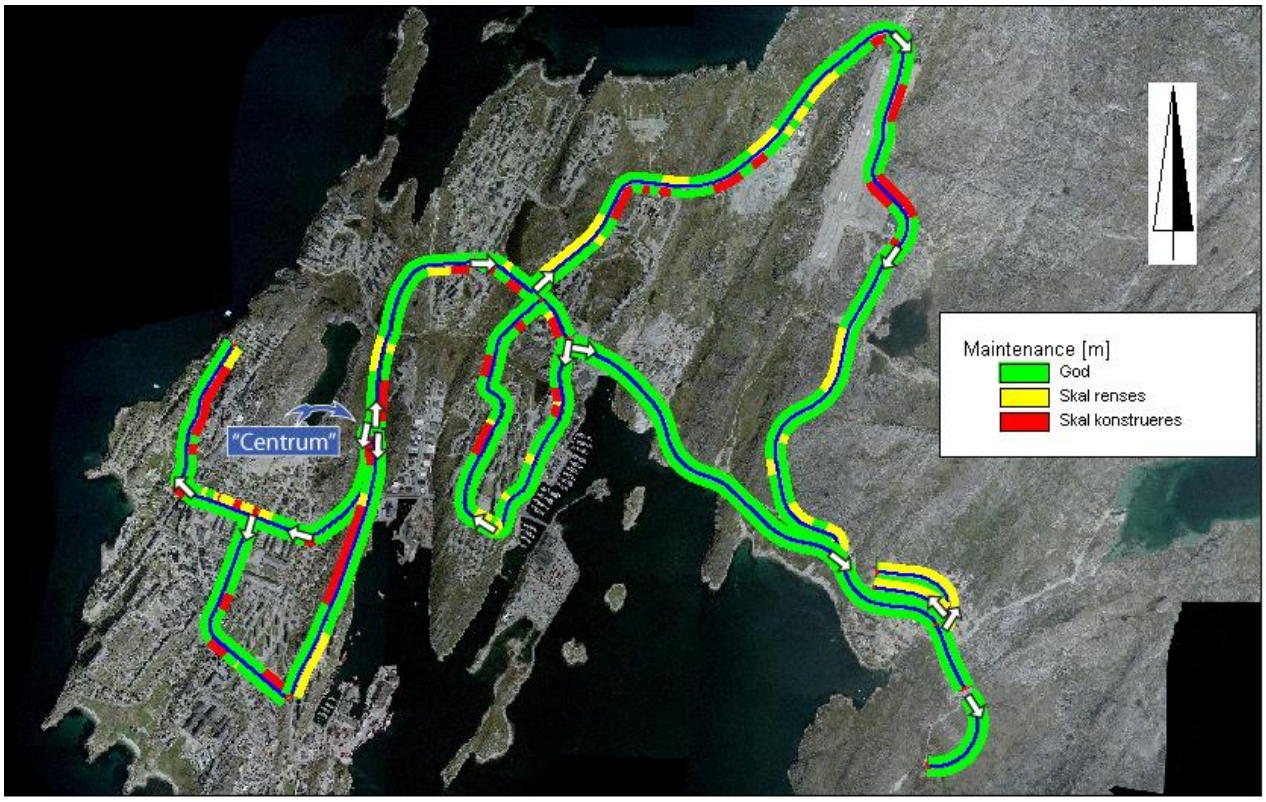

Figure 11 – Map showing the roads surveyed and direction of survey

5.1. AQISSEQARAJOOQ

Aqisseqarajooq has a combination of ditches, with or without concrete, and road sections without ditches. Drainage seems to be acceptable in most places, but it could possibly be improved with new ditches in a few places where the water runs toward the road. There is a steep slope in the local landscape that slopes from left to right, that can lead the water towards the road. See Figure 12.

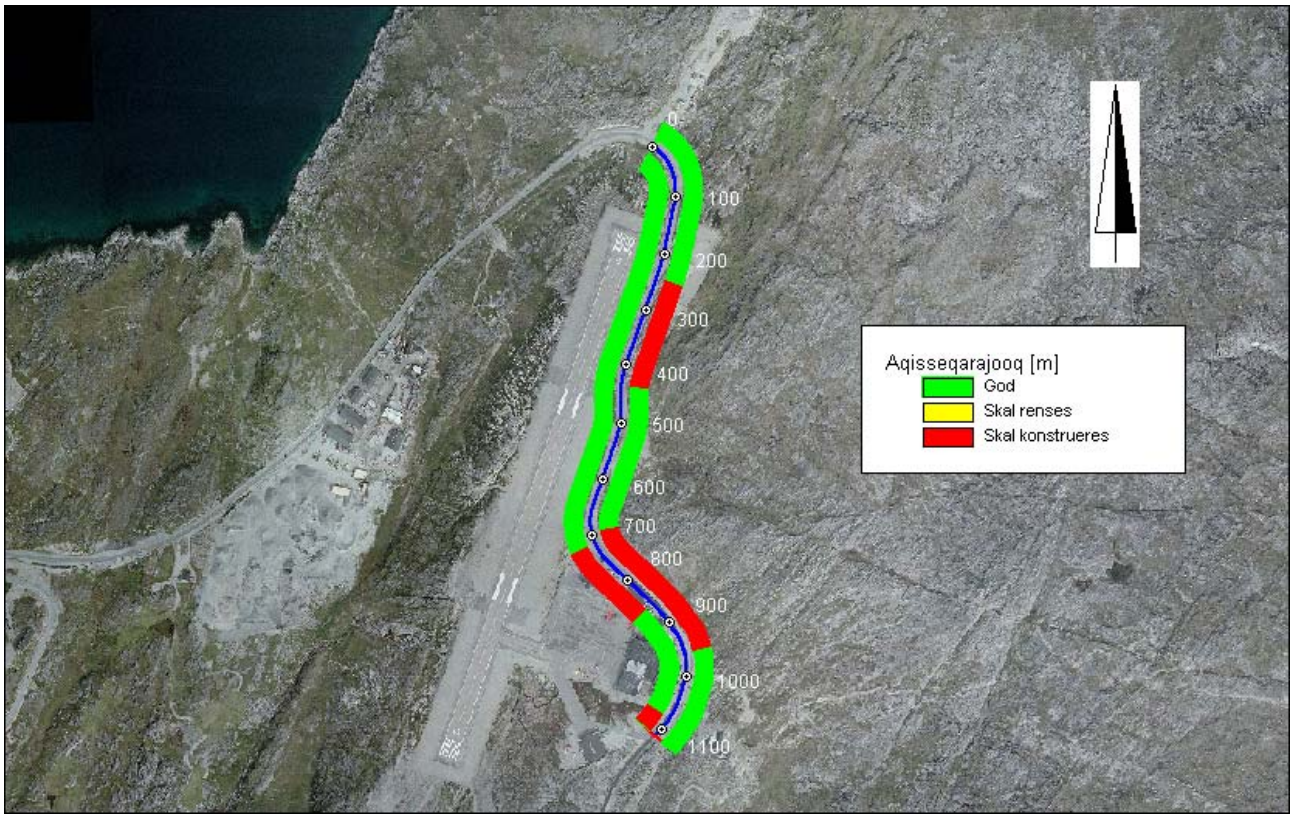

Figure 12 - Aqisseqarajooq

5.2. AQQUSINERSUAQ_NUUK

This road has good ditches with concrete inverts. Most sections have a paved sidewalk/cycle path between the road and ditch. The slope on the road could be changed in some places where the water runs on to the road. There could be need for ditches at the end of the left side. See Figure 13.

Figure 13 - Aqqusinersuaq_Nuuk

5.3. ASIARPAK

There is a ditch on the right side of this road, but it should be cleaned thoroughly. Because of the slope in the surroundings, water will run towards the road. Something could be done to ensure that the ditch is not filled with stones again. The left side of the road does not have a ditch, but it is not strictly necessary, as the slope is fairly steep away from the road. See Figure 14.

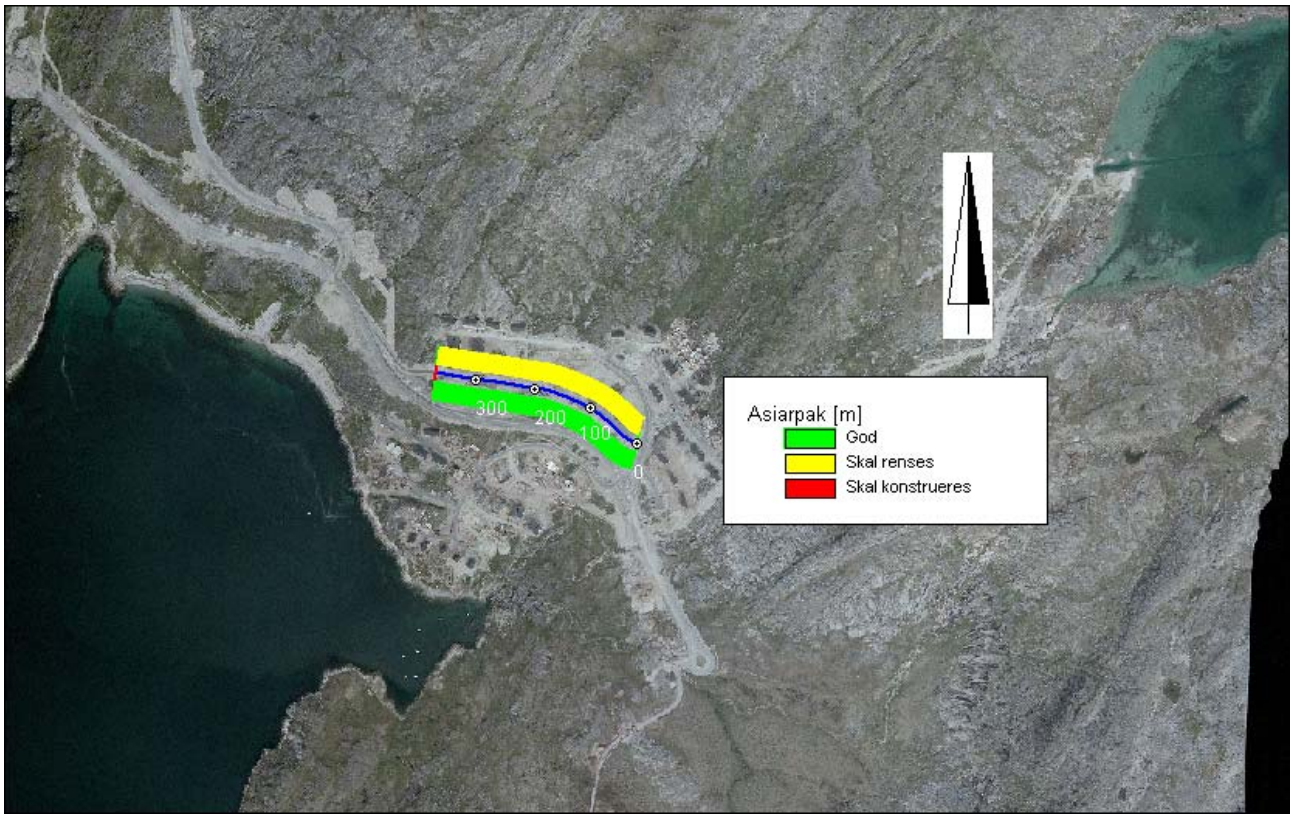

Figure 14 - Asiarpak

5.4. BORGMESTER ANNIITAP AQQ.

New asphalt surfacing was laid on part of this road section during the survey. The beginning of the section has changed since the map shown was made, which explains the change of the road at the beginning of the road. Drainage seems to work very well on both sides. See Figure 15.

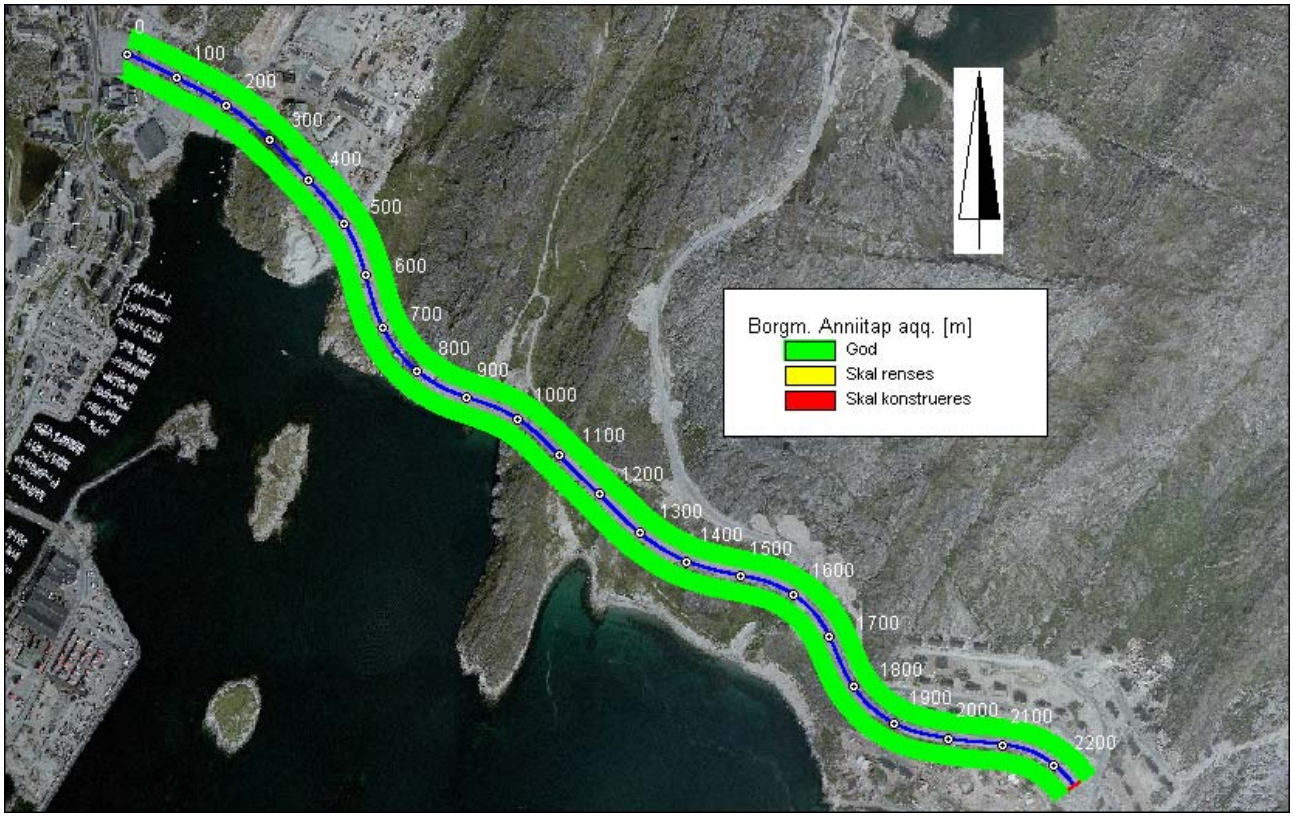

Figure 15 - Borgmester Anniitap aqq.

5.5. EQALUGALINNGUIT

This road section is partly ditched, and parts sloping away from the road. The road is constructed with a wide paved cycle path between the road and ditch. At the beginning of the road there is a very swampy area, where something could be done to direct water away from the area. The road is elevated slightly above the surrounding area, so it should therefore be possible to get the existing drainage pipe to function. The slope on the road on the right shoulder from 840m to 950m should be improved so that water does not run on the shoulder, but away from the road. See Figure 16.

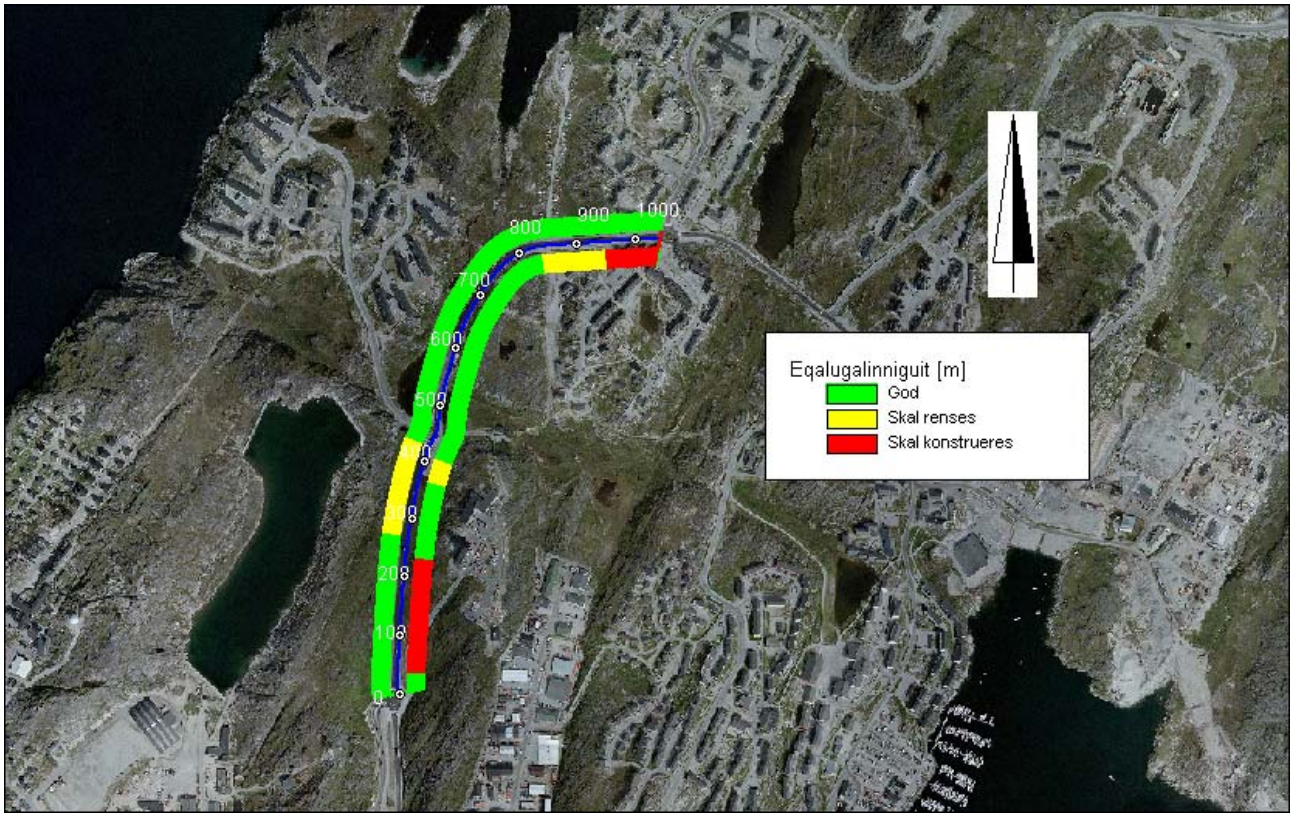

Figure 16 - Eqalugalinnguit

5.6. GERTRUD RASK

This is a narrow single track road. There is a good ditch on the right side at the beginning of the road, but later on it lacks a ditch in some places on the right side, where the surrounding slope towards the road. The surroundings on the left side slope away from the road, and therefore drainage here is generally fine. It is only at the beginning of the road, where the road goes downhill and turns where there could be need of a ditch on the left side. See Figure 17.

Figure 17 - Gertrud rask

5.7. H.J. RINKSVEJ

A ditch has been constructed for most of this road section. The ditches are deep, but should be cleaned. Water accumulates in some places due to waste or stones, and soil materials. This should be checked if it is causing stagnant water, and if is it a failure of design of the slope. The left side appears to be acceptable although it could be cleaned of grass. See Figure 18.

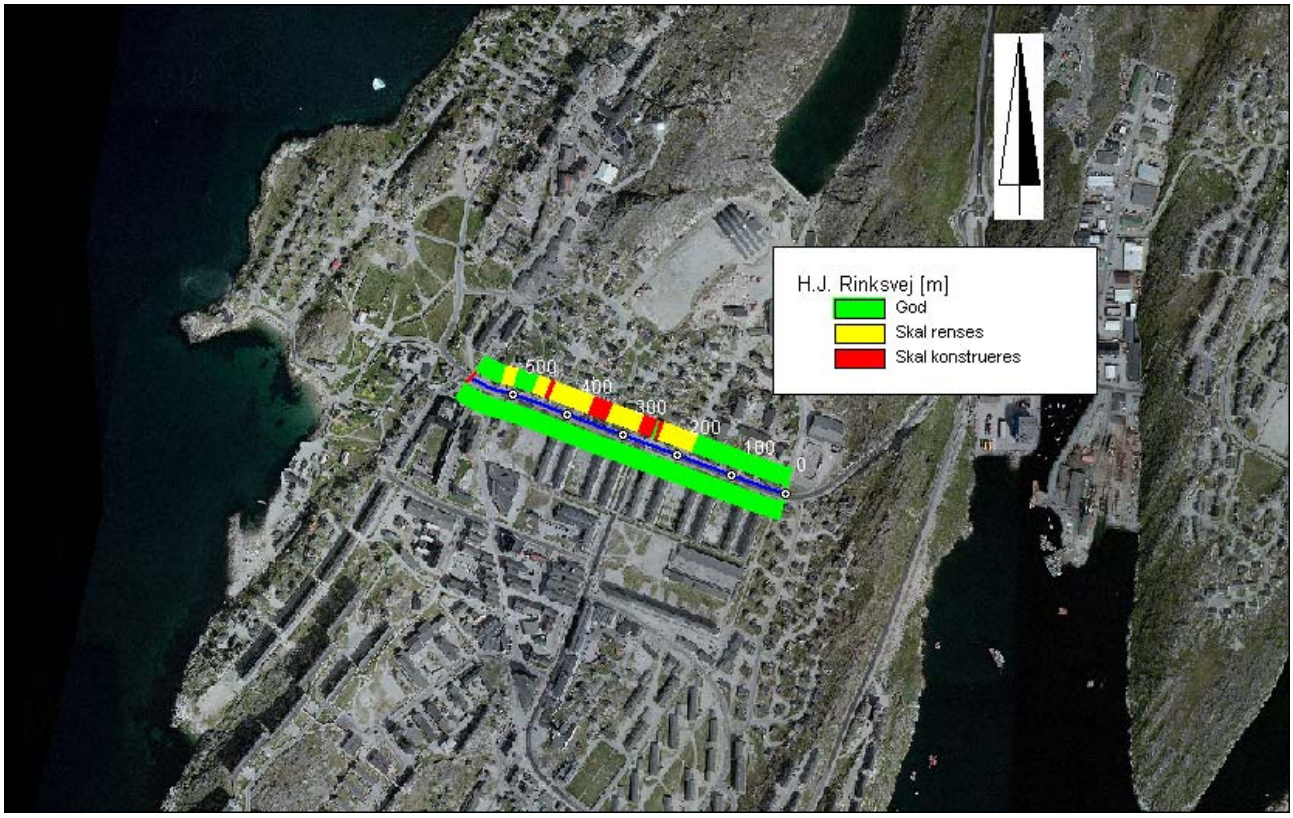

Figure 18 - H.J. Rinksvej

5.8. ILLERNGIT

Concrete ditches have been constructed on some of this road section. Initially these are fine, but later there are places that are filled with sand and stones that should be cleaned. At the end of the road, the surroundings slope steeply away from the road towards the sea, so it works fine. The left side should be cleaned in some places, but otherwise it works fine. See Figure 19.

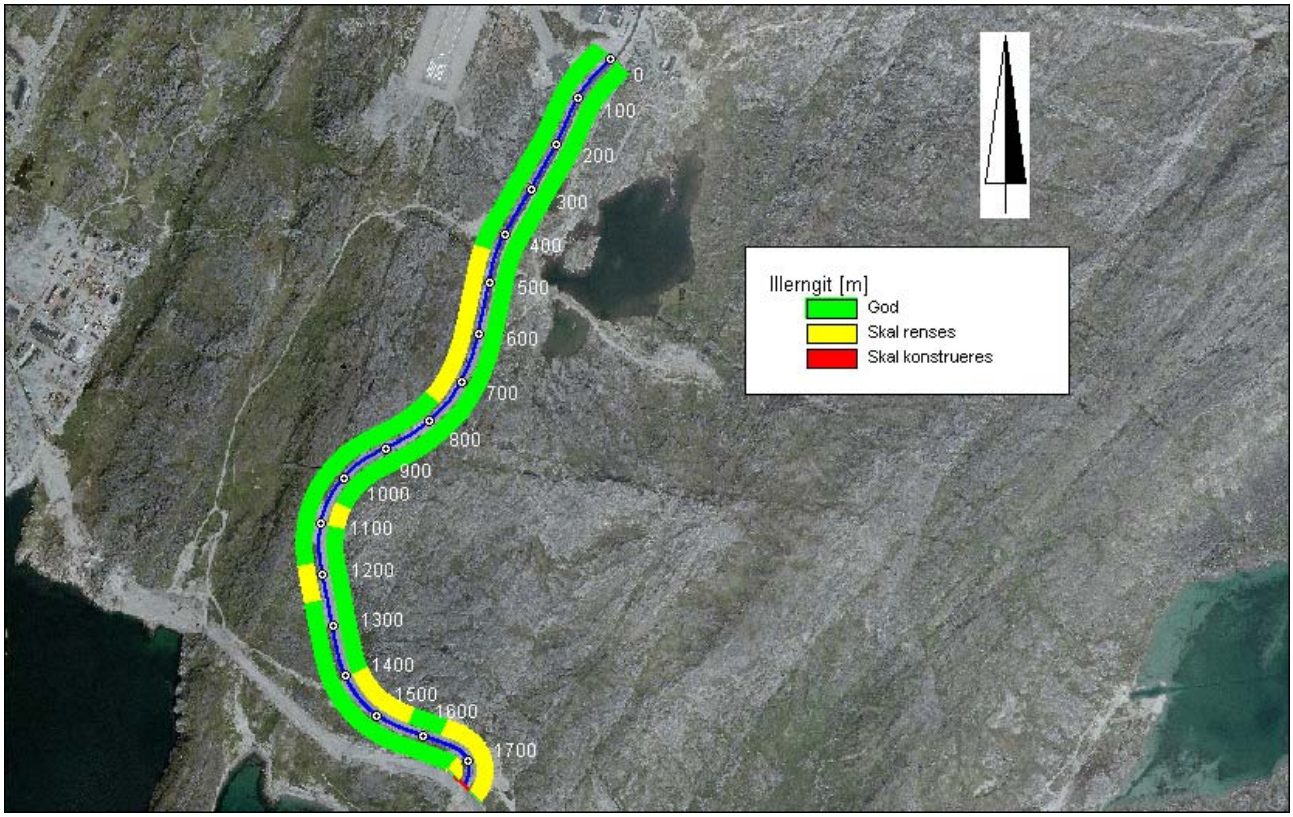

Figure 19 - Illerngit

5.9. MUSAQ

There are many rocks and soils in the right roadside ditch. The ditch is made with concrete bottom, but must be cleaned. Something could be constructed to keep the rocks and soil from entering the ditch. The left side has a ditch in the beginning, and otherwise a steep slope away from the road, so it works well. See Figure 20.

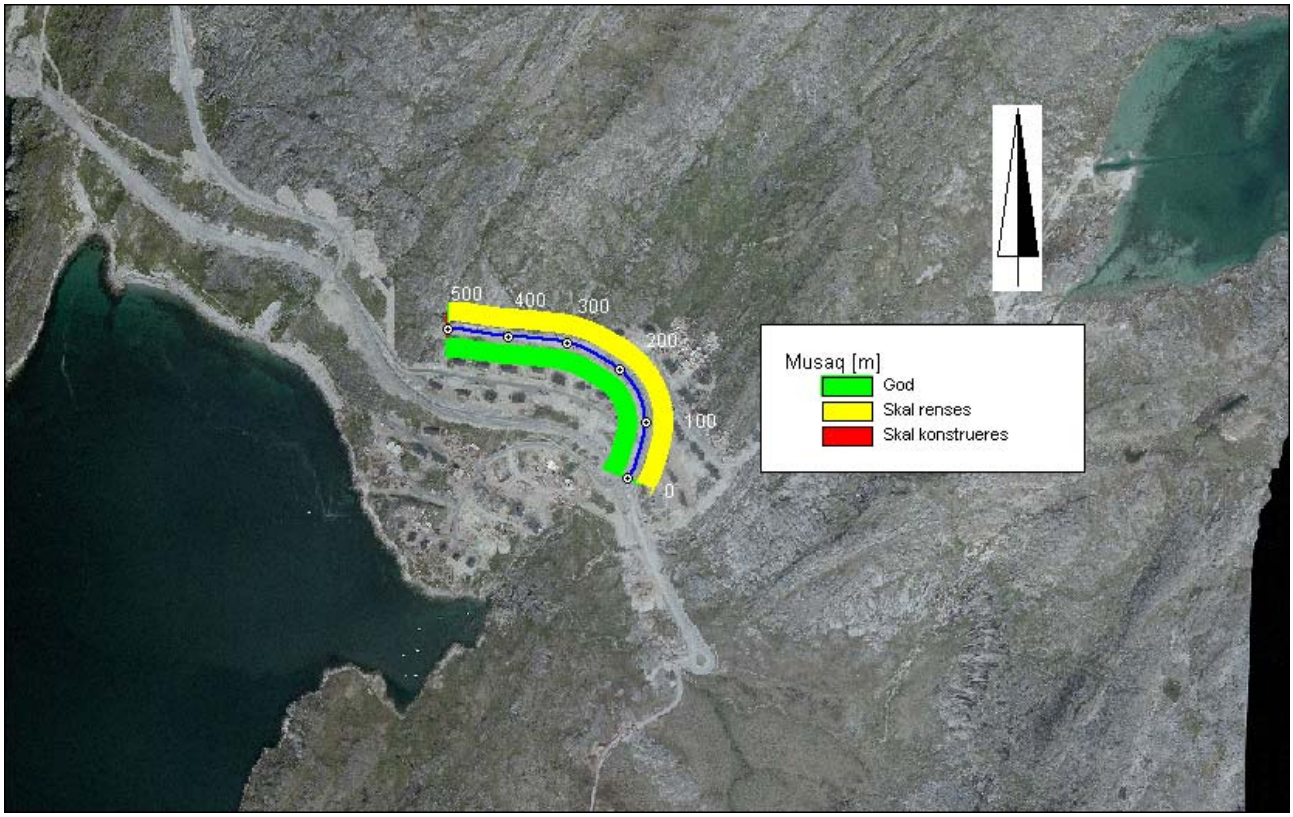

Figure 20 - Musaq

5.10. NUUSSUAQ

On the right side there is either a concrete ditch, or a steep slope away from the road. This works fine. But in the beginning the ditch should be cleaned, as there is stagnant water. The left side has short sections where a ditch could be constructed, but otherwise it is fine. See Figure 21.

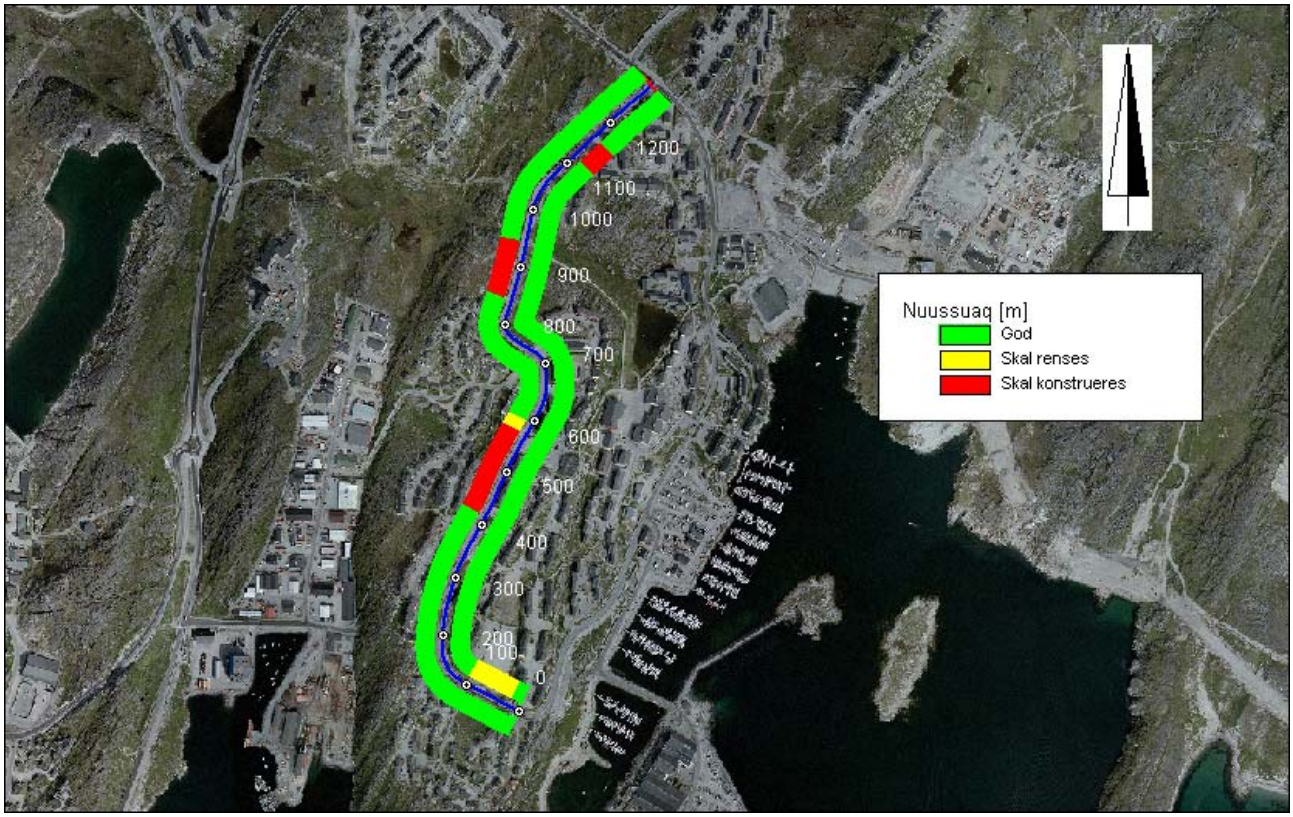

Figure 21 - Nuussuaq

5.11. PETER THÅRUP HOEGHIP AQQUTAA

This section has ditches or a steep slope most of the way. However, there are shorter sections where there is no ditch. Some culvert on the right hand side should be examined. On the left side, there are some places where the water runs between the cycle path and road. Here a ditch could either be constructed or a better slope provided to the road. See Figure 22.

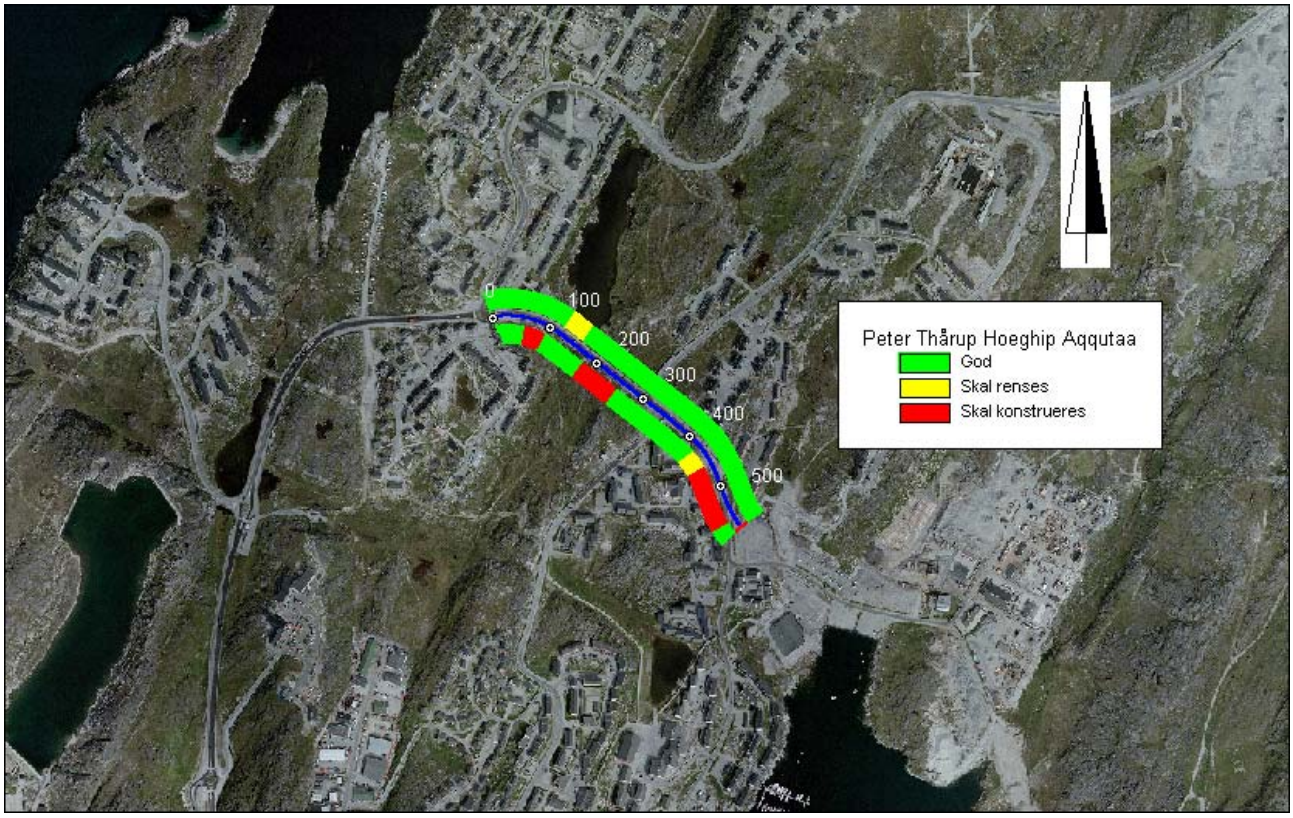

Figure 22 - Peter Thårup Hoeghip Aqqutaa

5.12. PISISSEQ

Pisisseq is a newly constructed road, with good ditches. The left side accumulates a little water in the gap between road and cycle path. There could be a better slope on the shoulder between the road and cycle path, but otherwise the drainage works fine. See Figure 23.

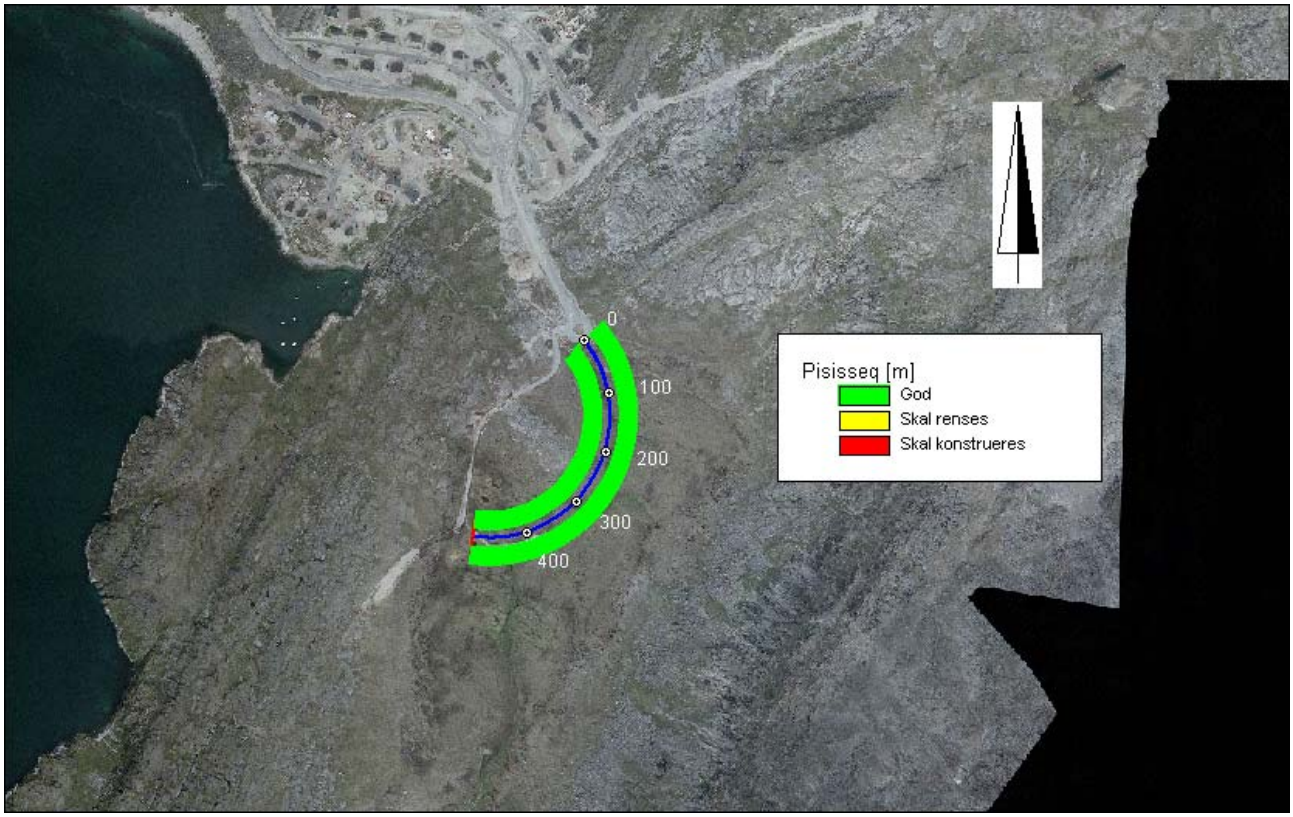

Figure 23 - Pisisseq

5.13. QARSOQ

The right hand side of this road section has no ditch but a steep slope towards the sea, so there is no need for a ditch. The left hand side has ditches, but as the surroundings have a very steep slope toward the road, their capacity should be examined. See Figure 24.

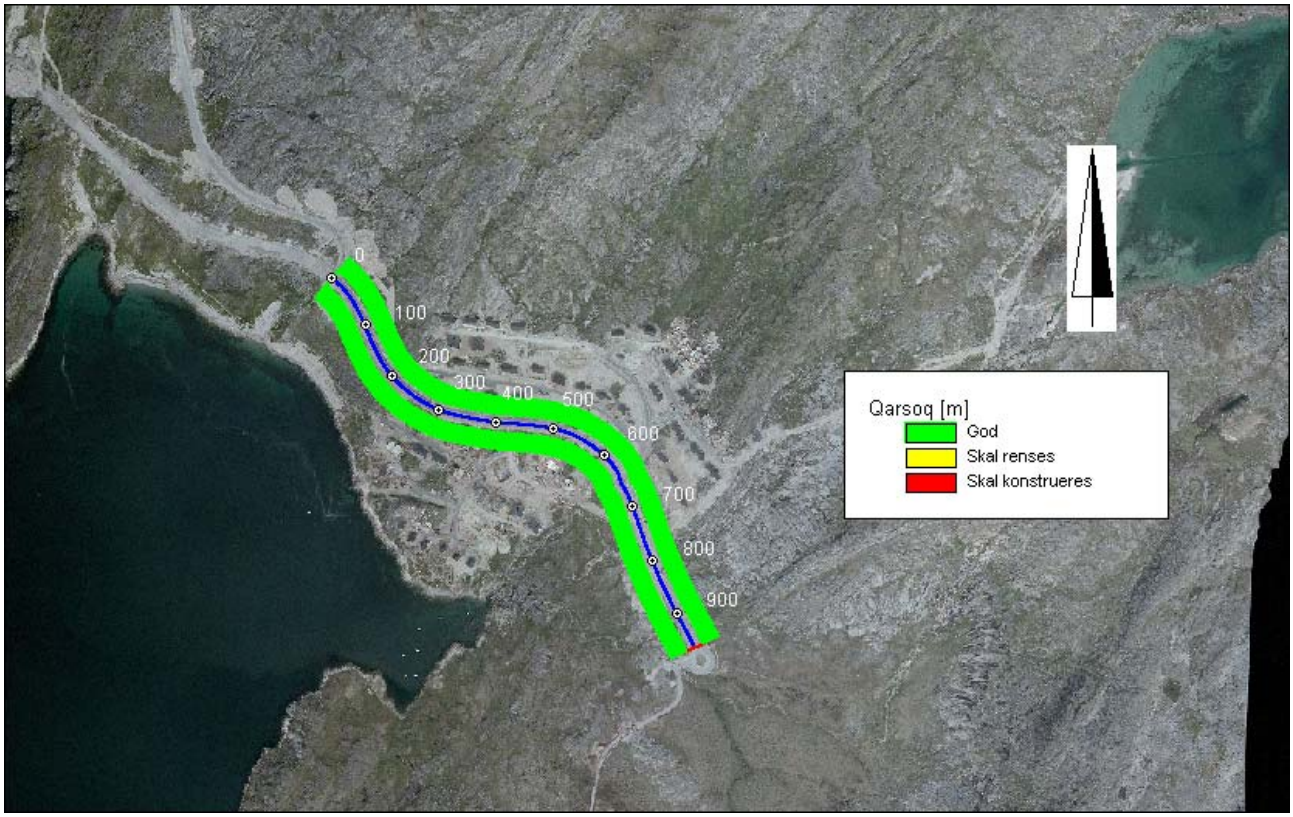

Figure 24 - Qarsoq

5.14. SIAQQINEQ

This road section only has ditches some of the way. In the beginning a ditch is not necessary, but on the right side ditches are missing in some places. The ditches that are present should be cleaned in several places. On the left hand side there are several places where the ditch needs to be cleaned, otherwise the drainage works well. At the end of the road there is either a ditch or a steep slope away from the road towards the sea, which works fine. The slope between the road and cycle path could possibly be better, so that the water is led away from the road. See Figure 25.

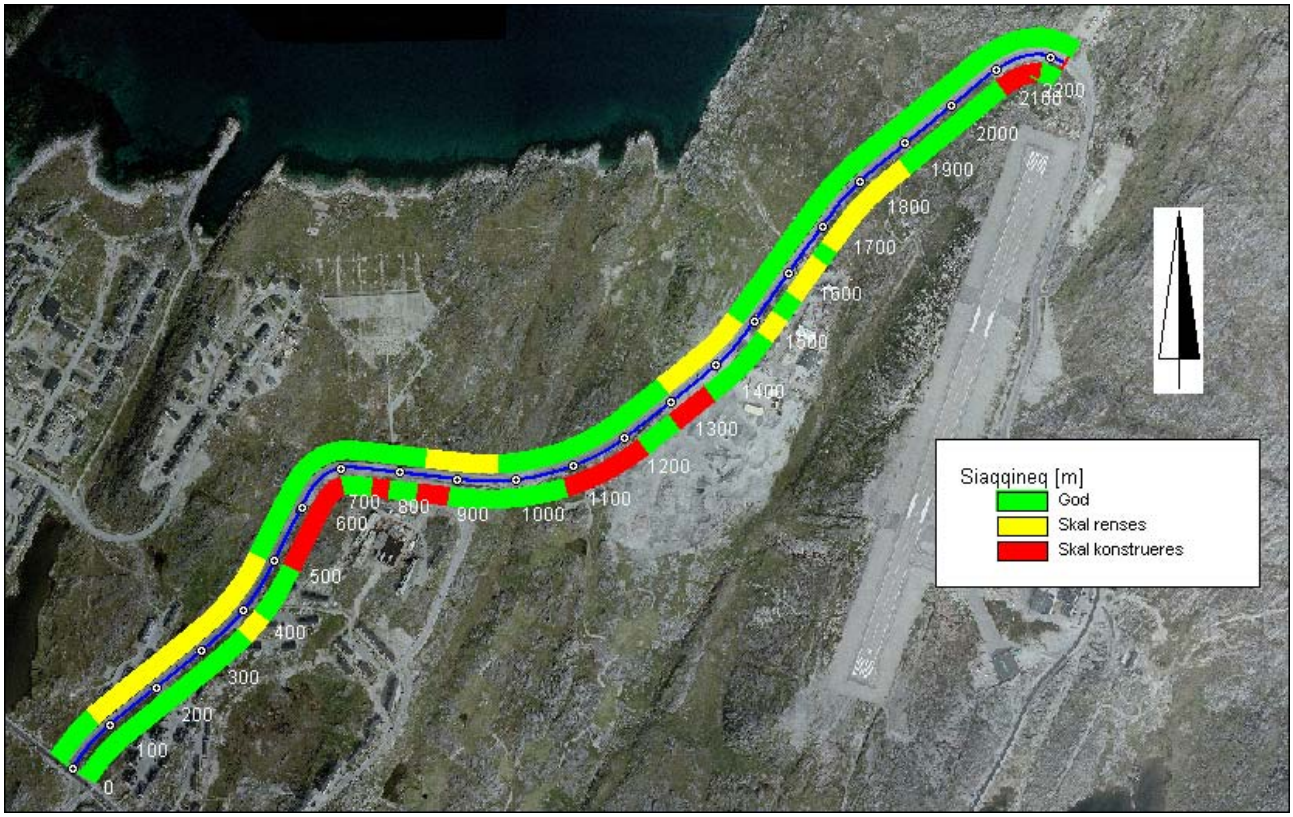

Figure 25 - Siaqqineq

5.15. SIPISAQ KANGILEQ

There is a good concrete ditch all the way on the right hand side on this road section. The left side has a steep slope away from the road in the beginning of the section. Thereafter the road is paved to the rock, so there is no ditch. A ditch and culvert should be constructed on the left hand side at the end of the road section. See Figure 26.

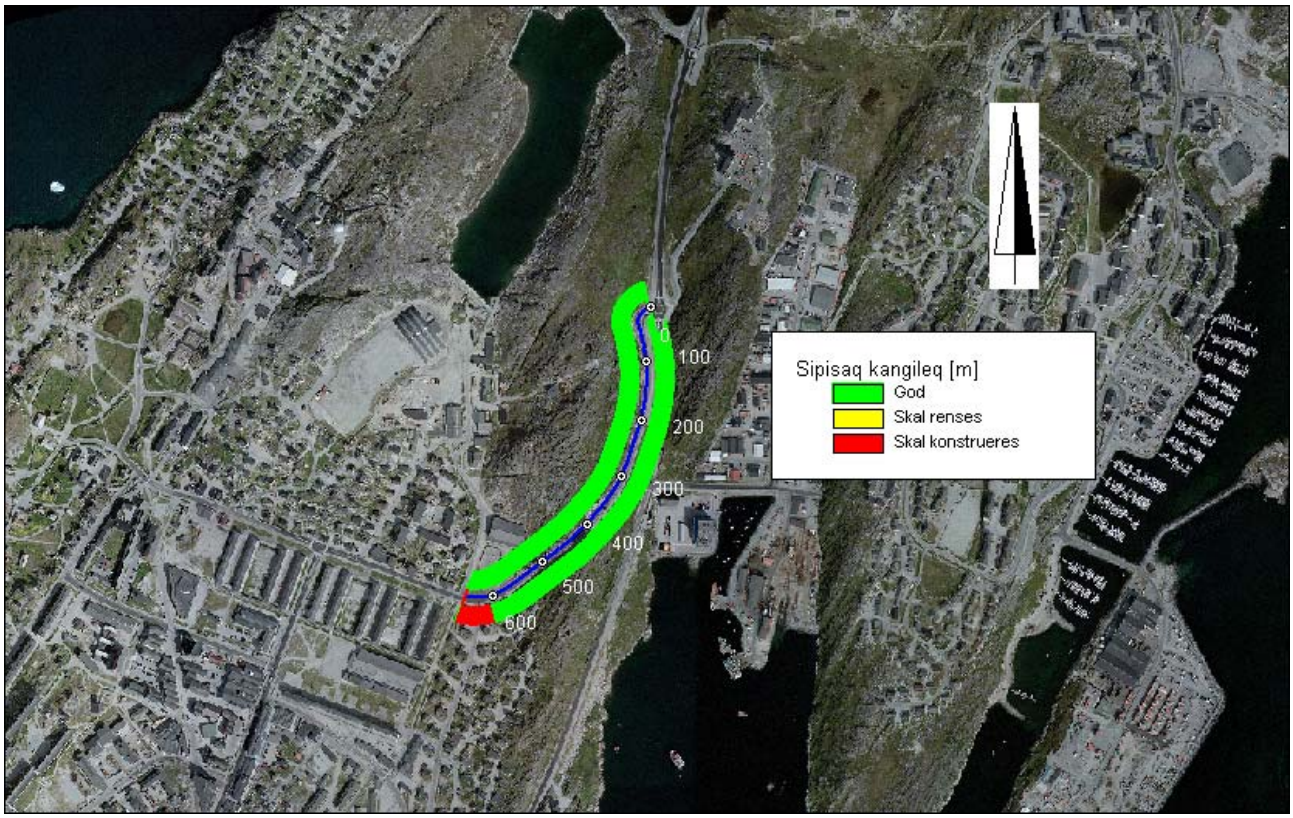

Figure 26 - Sipisaq kangileq

5.16. SORLAAT

The Sorlaat road section has concrete ditches or a steep slope at the beginning which appear to work. However, there is some stagnant water present in places, suggesting lack of ditch from about 200 m. From there, there is stagnant water in the ditch, at approximately about 570 metres. The drainage on the left side works satisfactorily and consists of either a good ditch or a slope towards the water. See Figure 27.

Figure 27 – Sorlaat

6. CONCLUSION

A ROADEX drainage demonstration project was conducted on 18 street sections Nuuk, Greenland. The field measurements were carried out in August 2011. The aim of the project was to use ROADEX drainage analysis method in a new Partner area and map the drainage of selected roads.

The report focuses on the practical results of the surveys made. Maps of the drainage condition of the roads surveyed are presented with accompanying comments.

Emphasis is placed on a brief overview of the roads. The accompanying comments have been kept deliberately short. These state whether the drainage is good, the ditch should be cleaned, or if a new ditch should be constructed.

In general the drainage of the roads in Nuuk was found to be working relatively well. Concrete ditches had been constructed on most of the surveyed sections. However, there were places where the constructed ditches could be cleaned or water will lie stagnant in the ditch. In some places it was recommended that ditches should be provided.

Typically the poorest drainage sections were located in side sloping ground, as was the case in previous ROADEX drainage demonstration projects.

A laser scanner was used in the project. This enabled road features to be detected that affected drainage condition. The laser scanner could even have been more useful if the data could have been combined with ground penetrating radar data. This would have made it possible to compare the bottom of road structure to the bottom of the ditch depth. Drainage guidelines generally specify that the bottom of the ditch should be 20cm lower than the bottom of road structure to assure that drainage functions well.

The experiences and results of the demonstration project confirm that the ROADEX drainage analysis can be applied to urban street areas. However it has to be remembered that urban areas can have different kinds of features than rural roads. These features have to be taken into account when designing future maintenance works.

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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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