TACIS EU KOLARCTIC PROJECT

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Technical Report WP4

Black Spot Management on pilot road leading to the international border crossing in the Murmansk Region

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Foreword

This report forms Technical Report WP4 in the context of the Tacis Kolarctic “Polar Traffic safety”-project. It is concerned with the black spot management of the pilot section of M18 road between Murmansk and Russian-Norwegian international border crossing (Borisoglebsk-Storskog).

Section 1 represents the results of kick-off meeting in Murmansk with representatives of M18 federal road administration and the Murmansk regional road police.

Section 2 discusses the current Russian accident statistics in general with proposals on how it can be improved.

Section 3 is concerned with cost of accidents in Russia, when normative accident costs exist but the evaluation/justification methodologies and the philosophies are missing.

Section 4 discusses full traffic safety analysis on pilot road, which includes accident data analysis for the last 3-5 years, definition of blackspots and visual inspection of possible reasons for high accident concentrations.

Section 5 gives proposals of measures to improve road traffic safety at black spots. The measures include road infrastructure and maintenance improvements.

Section 6 focuses on impact analysis of the proposed improvement measures. Estimation is mainly based on Nordic countries’ experience and smaller amounts of North-West Russia of that how much the measures save lives and prevent injuries.

Section 7 deals with economic justification of the proposed measures. It is based on approved Russian accident unit prices and everyday Western benefit/cost calculations.

Section 8 discusses prioritization of black spots by their costs and danger to the Community. Several methods will be introduced like likelihood of the accident (dangerousness of the road) and accident cost to society.

Section 9 is concerned with the dissemination of the results during the seminar days in Murmansk and Arkhangelsk.

1 Start up the operations, involving the target groups and kick-off meetings.

The first meeting where among other important issues the Work-Package 4 activities were discussed was held on July 4, 2008. The participants of the meeting were as follows:

Vikstrom Elena	Swedish Road Administration
Maksimov Alexey	Arkhangelsk city road police
Kulizhnikov Denis	Arkhavtodor
Razheva Nadezhda	NGO on RTS “Green Wave”
Shabasheva Maria	Road traffic safety expert
Svatkova Elena	EU contact office expert in Arkhangelsk

The decision was made to hold a tender on WP4 in autumn 2008 and choose the best company to execute all the outsourced works within the package. After the Contractor had been chosen the WP4 activities started.

In autumn 2008 the contractor started up negotiations with the Murmansk Regional road police (MGIBDD) and the owner of the pilot M18 road “St.-Petersburg – Russian-Norwegian border” – Uprdor “Kola”. The MGIBDD was asked to represent all the road accident statistics data for the M18 pilot sections “Murmansk-Borisoglebsk” and Access to Murmansk from M18. In December, 2008 the road police got all the necessary data and sent them to the Contractor who started preliminary road accident statistics analysis to prepare for the Murmansk trip and seminar.

The Contractor made several attempts to contact the M18 federal road administration which has its main office in Petrozavodsk. Finally with the help of Mr. Alexander Glebov, the Murmansk regional road police head, the Contractors received the letter from Uprdor “Kola” where Mr. Yuri Polosin was appointed as the contact person. Smooth cooperation started and the Contractor received some more information related to M18 pilot road section black spots, including list of measures implemented by the road administration during the last 3 years.

All this preparation work allowed the Contractor to organize the trip to Murmansk during February, 16-20, 2009. **Annex 1** represents the Murmansk visit Programme within the WP 4.

The kick-off meeting with the representatives of Uprdor “Kola” and the Murmansk regional road police was held on February, 16, 2009. The list of pilot road black-spots was agreed among the Contractor and the partners, the plan for the visual inspection was made and future steps (data analysis, seminar issues) were discussed. **Annex 2** represents the list of pilot road black-spots planned for visual inspection and further analysis.

2 Modern accident statistics

Within the WP 4 a brief analysis of current Russian accident statistics was made. There are some characteristics in Russian road accident cards, which do not open the root-cause of an individual accident without visiting the accident place or interviewing inspectors who recorded the accident data. This may lead to inefficient accident analysis and increased costs of proposed countermeasures, which can not cover the main reason of accidents.

Table 1 summarizes the main Russian road accident statistics shortcomings (disadvantages) and proposals on its improvement.

Table 1 *Summary of the main Russian road accident statistics disadvantages and proposals for statistics improvement*

Russian road accident statistics deficiencies	Proposals to improve initial statistics data quality	Implementation	Forecasted effects
1. Non-accurate accident location (road address).	Indicating more accurate accident location in road accident cards	Indication more accurate address in the road accident cards (e.g. km 1+345)	Higher quality analysis of road accident reasons and higher effectiveness of proposed measures for the specified road section
2. Absence of topographic visualization of road accidents	Topographic addressing of accidents (on the map)	Marking on the road network map (scheme) all fatality and injury accidents with special coloring of accidents by types (e.g. collision with killed people, pedestrian accident with injured people, etc.). Experience of Western countries may be used.	Good visualization and obviousness of road accident black spots on the map together with regularity of accidents on this or that location gives better understanding of the measures that could prevent specific accident types.
3. Absence of additional road accident data like driver age and driving experience, seat belt, head lights usage or children restraint usage, etc.	Mentioning all the accident concomitant conditions in the road accident card	Adding special graphs into the accident card where in formation on seat belt and child restraint usage, driver age and driving experience, etc. may be inserted. Using experience of road traffic safety leader-countries in this field.	Defining influence of different road accident factors (human-vehicle-road) for planning the measures within the Road traffic safety programmes.
4. Lack of full understanding what is “Other accident” in road accident cards	Decoding “Other accident” type in the road accident cards	Inserting a special cell in the road accident card where “Other accident” is explained	Higher quality analysis of road accident reasons and higher effectiveness of measures proposed for this or that section
5. Road accident card doesn’t give any information if	Indicating information about road organization	Inserting a special cell in the road accident card where road organization	Comprehensive analysis of serious road accident reasons as a result of

there were or not road organization representatives on the serious accident place together with the road police.	representative in the road card (Name, surname, position, time of arrival to road accident place)	representative data is written	attracting road organization experts to road accident consequences.
6. Road administration and Road police have no common road accident database.	Creating Common Road Accident Database for joint usage by road administration and road police	Common Road Accident Database jointly filled up by two organizations.	More complete and overall road accident database for identification of accident trends using extended opportunities of quick search Better opportunities of quick development of reports about this or that accident types, roads, etc., i.e.: ▪ All accidents with heavy traffic >16t ▪ All accidents with drivers with <1 year driving experience ▪ All dark time accidents on km12+300 – 12+600 black spot, etc.
7. Poor usage of international experience for road accident card improvements	Making proposals to improve road accident card using best international practices	Comparing Russian road accident cards with those used in Sweden, Finland, USA, etc. And defining the differences	Unification of road accident data collection to prepare for benchmarking analysis between different countries of e.g. Barents region. Comparing road accident statistics deficiencies possible cooperation fields and new know-how transfer projects
8. In Russia the practice of serious accident investigation by a special commission involving experts from different organization is missing	Using international experience of Serious Road Accident Investigation Commissions for more accurate identification of road accident reasons (fatality and injury accidents)	Considering an opportunity of using international experience in serious road accident reasons by efforts of a special Commission involving all the interested parties (Road administration, road police, Department of road supervision (UGADN), medical organizations (doctors, phsycologists), transport companies (if heavy vehicle accident), etc.)	Commission's decision to take these or that specified measures to prevent similar road accidents on this place in future

3 Costs of accidents in Russia

Road traffic safety is a very serious problem in developing and transitional economies. Likelihood to death in Russian roads is about 5 - 7 times higher than those of EU countries. In 1996 in OECD Bulletin it was estimated that the cost of accidents in a set of central European countries averaged 1.5% of GNP, and ranged between 1.2% and 2.0%, while similar studies in Russia in 2005 gave accident costs about 5% GNP. It is therefore important that attention is given both to the incorporation of best practice design features in all road investment projects and to the identification of cost effective direct measures for accident reduction.

Monetary evaluation

While associating a monetary value to the loss of human life may appear repugnant to some, it is clear that in practice resources are limited and governments are not willing to commit unlimited resources to road safety improvement. Given that, implicit judgments about trade-offs are being made in the allocation of resources between major activities, including road safety. Monetary evaluation of accident reduction is therefore important for two reasons:

1. to ensure that safety is consistently taken into account in resource allocation and in project design;
2. to ensure that any expenditure made on safety improvement is deployed cost effectively.

The incorporation of monetary valuation of safety impacts in the cost benefit analysis of projects or programs is a mean of achieving these two objectives.

Currently the most popular approach to monetary valuation of road accidents is the "resource cost aggregation" approach, which involves three components:

1. Current resource costs consequent on an accident (policing, hospital costs, vehicle and road furniture repair, etc)
2. Loss of future output associated with the absence of victims of accidents from the labour force either temporarily (in the case of injury accidents) or permanently (in the case of fatalities).

3. A "pain and grief" premium is sometimes added to reflect the valuation of the suffering of victims or those who care for them. This is the most difficult element to value empirically, and usually reflects a purely political judgement.

The practical application of the approach requires the assembly of five main items:

1. Loss of output
2. Costs of medical treatment
3. Cost of damage to vehicles and other property
4. Administrative and other costs
5. Subjective costs.

Russia has its own methodology to calculate socio-economic damage from road accidents developed by Moscow Road Institute and State scientific research institute of road transport. The first methodology was ordered by the Russian Ministry of Transport in 2000. The methodology has its specifics comparing to that of the Western countries. This comes from different practice of statistic data collection and analysis. However, the main point of both mathodologies is basically the same – calculating road accident damage to the Community in monetary terms to evaluate the accident problem scale.

According to the Russian “Methodology of calculating socio-economic damage of road accidents P-03112199-0502-00” total road accident costs include:

1. Direct costs, i.e.:
   - Expences of the vehicle owner,
   - Losses of the road organization related to elimination of road accident consequences,
   - Losses of the consignor of goods,
   - Expences of the road police and other organization spent to road accident investigation,
   - Expences of medical organizations spent on medical assistance to injured in road accidents,
   - External costs of organizations and enterprises who’s employee was injured/killed in road accident,

- Social service costs.
- Insurance payments to those injured in road accident

2. Indirect costs, i.e.:

- Losses of the economy because of full or partly retirement of employees,
- Losses related to loosing working contacts,
- Moral costs

Thus, Russian and Western methodologies have practically the same list of costs taken into account when calculating road accident damage to the community. However, in Russia there is a differentiation between road accident losses related to death of a man having or having not a family. So, in Russia total road accident costs are calculated using the following formula:

$$L_t = L_f + L_{wf} + L_{inv} + L_{pinv} + L_{phys.dis} + L_{child},$$

where:
L_f – losses from death of people having a family;
L_{wf} – losses from death of people having no family;
L_{inv} – losses related to full invalidization resulted from road accident;
L_{pinv} – losses related to partly invalidization resulted from road accident (a man has partly lost ability to work);
$L_{phys.dis.}$ – losses related to temporary diability to work as a result of an accident;
L_{child} – losses from death of a child

Since 2000 the Methodology has been updated several times and currently it is used in the “Guidelines on black-spot elimination and prevention” (draft) developed by the Federal Road Agency Rosavtodor in 2008.

According to the last draft version of the Methodology, road accident costs in 2008-2010 applied to evaluate road traffic safety measures at road black spots are presented in the **Table 2**.

Table 2 Socio-economic costs of a road accident

Losses of the Community	Socio-economic costs of road accidents, mln.RUR, by years		
	2008	**2009**	**2010**
Road fatality	8.693	8.693	9.258
Road injury	0.265	0.265	0.282
Death of a child in road accident	10.516	10.516	11.200
Damage-only accident	0.139	0.139	0.148

According to version that was in use before the draft issued by Rosavtodor, the accident unit costs have been valued as follows ("Methodology of assessment of normative socio-economic accident costs R-03112199-0502-00"):

Fatality with a man having a family	329 MRUR	250,990 EUR
Fatality with a man having no family	6,930	237,330
Injure with disablement status (no possibilities for further work)	3,622	124,040
Injure with disablement status (with possibility for further work)	2,090	71,575
Injure without disablement status	0,039	1,335
Fatality with a child	8,411 MRUR	288,050 EUR

As there is no percentage of accident by above types the following average normative costs were proposed:

- for fatalities 258,790 $, **212,000 EUR**, for EUR –RUR rate 44,0 - **9.3 MRUR**, for the rate 34,0 – **6,2 MRUR**
- for injuries 65,650 $, **54,000 EUR**, for EUR –RUR rate 44,0 - **2.4 MRUR**, for the rate 34,0 – **1,6 MRUR**

As can be noticed there is a great difference between the last and older version in injury cost. Earlier it was about 1.6 MRUR and in Rosavtodor draft about 0.25 MRUR. The latter is definitely too low and is recommended to be altered. This is why we have used the older unit cost in our calculations.

Let us still give one indicator for those in Russia who in the future will alter and up-date the accident costs. If we compare Russian and Western accident costs, it would be applicable and rationale, if they would roughly follow the GDP per capita difference of the countries. As an example, in Finland, the accident costs for fatality is now 2.0 MEUR and for injury 0.5 MEUR. If to compare the GDP´s of the countries (in Finland 3.1 times higher per capita in

2007), the Russian figures should be 0.65 MEUR (**28 MRUR**) for fatality and for 0.16 MEUR (**7 MRUR**) for injury.

4 Full traffic safety analysis on the pilot road and visual inspections

The full traffic safety analysis on the pilot M18 road section “Murmansk-Borisoglebsk” and its “Access to Murmansk” includes analysis of accident statistics from the last 3…5 years (depending on who provided the Contractor with accident data – Murmansk regional road police or Uprdor “Kola”), definition of the “black sections” or “black spots” (places of high likelihood of traffic accidents) as well as visual inspection of possible physical reasons of high accident concentrations with a group of stakeholders.

The full traffic safety analysis on the pilot sections is presented in **Annexes 3 (Murmansk-Borisoglebsk section of the M18 road)** and **4 (Access to Murmansk from M18)**.

After preliminary analysis of all available road statistics data According to the Murmansk trip Programme (See Annex 1) the visual inspections of together 20 black spots of the pilot M18 road sections Murmansk – Borisoglebsk and Access to Murmansk from M18 were conducted on February 17th, 2009. It should be mentioned that the visual inspection was at the same time a training session made by a group of local Murmansk stakeholder members, representative of the Project Leader Partner (Swedish road administration representative) and outsourced consultant members (including one Finnish expatriate and one local consultant member).

The list of visual inspection participants was as follows:

Stig Carlsson	Swedish road administration, Northern Region
Lars Gosta	NTF Swedish Road Safety Association
Juha Hyvarinen	Contractor, Poyry Infra Oy, expert
Andrey Shulgin	Murmansk regional road police, officer
Yuri Polosin	Uprdor “Kola” (M18) road administration, deputy head
Maria Shabasheva	Sub-contractor, project local expert

Within the visual inspection all 20 black spots were visited, photographed and described using the following observations table (see **Table 3**)

Table 3 Observations of a multinational expert team visiting the location 17.02.2009

AADT on the main road (roughly)	(got from the road owner)	vpd

Percentage of heavy vehicles (roughly)	(got from the road owner)	%
Speed limit	(got from the road owner)	km/h
Carriageway width (roughly)	(got from the road owner)	m
Shoulder width (roughly)	(got from the road owner)	m
Pedestrian path	exists or not	m
Pavement	Asphalt or something other	
Horizontal and vertical alignment	characteristics	
Pedestrians	were on place or not	
Bicyclists	were on place or not	
Traffic lights	were on place or not	
Road lighting	were on place or not	
Road signing	were on place or not	
Other	narrative description of special observations	

Murmansk and Arkhangelsk stakeholder members actively participated in discussions of what were the real reasons for fatality and injury accidents on the spots. In most cases the drivers speeded up, tried overtaking and used the opposite lane for driving and that resulted in severe collisions with the opposite vehicles. High traffic volumes on some Murmansk-Borisoglebsk road sections, commuting traffic between two close settlements (Polyarny and Sputnik), numerous vertical and horizontal curves together with absence additional lanes for slow vehicles on the ascending sections and poor visibility at curves contributed to road accidents. As for the Access to Murmansk section, the main problem is on the junctions of city streets to the public road: too wide junctions without any special engineering arrangements for better driver orientation and traffic regulation, comparatively high traffic volumes, yielding problems led to traffic accidents.

The visual inspection participants registered all available data that would possibly give explanation to road accident root-cause and used them when proposing measures to reduce road accident at considered black-spots.

The tables on visual inspections in Murmansk pilot roads in every accident concentration are introduced in the memoranda as annexes 3 and 4 of this report.

5 Proposals of road safety measures for the blackspots

Proposals of measures to improve road safety on blackspots defined earlier include road infrastructure and road maintenance improvements.

Initial proposed measures include:

- L=Low cost measure 0…300.000 RUR
- M= medium cost measure 300.000…1.500.000 RUR
- H= high cost measure, over 1.5 MRUR

Low cost measures can be i.e. as follows:

- Renewing all horizontal and vertical road markings,
- Installing of targeted speed limit,
- Installing a “dangerous road section” –sign,
- Consultations with the maintenance organization about more targeted winter maintenance,
- Adding high fluorescence reflectors on the road barriers on the black spot,
- Installing the barrier head starting from ground rising up to full height on the black spot
- Installing a unit of three cross sectional rumble strips in entries of the junctions or dangerous sections
- Installation of rumble strips parallel to centre line and both edge lines (audio markings) either marked on the pavement or sink into asphalt

Medium cost measures can be i.e. as follows:

- Constructing a long traffic separation islands
- Construction of roundabouts
- Reconstruction of current road lights
- Installing road lighting (made by wooden poles and air cable decreasing the costs down to 23.000 Euros per km)
- Construction of crash barriers
- Installation of traffic lights to a dangerous junction
- Raise pedestrian crossings to the level of curb (pedestrian crossing on the hump)
- Raise the whole junction
- Improving winter maintenance with the measures that corresponds the next upper maintenance class

High cost measures include:

- Reconstructing to a 4-lane road with a centre dividing island on the whole black spot,
- Paving shoulders (incl. widening them on the barrier sections) on the black section

- Constructing the central metal barrier and one additional lane
- Construction of interchange

Specific measures addressed to all 20 black spots in question are represented in **Annexes 3 (Murmansk-Borisoglebsk section of the M18 road)** and **4 (Access to Murmansk from M18)**. As well, more of them are introduced in the following chapter.

6 Impact analysis of the proposed road safety measures

Impact analysis of the proposed improvement measures is mainly based on Nordic countries' experience as they have been collecting this data for years. Some data of that how much the measures save lives and injuries are taken from recent North-West Russia experience.

Road safety measure monitoring data accumulated in the Nordic countries and recommended to forecast impacts are presented in the annex 5.

Impacts of the implemented measures (mostly in the Nordic countries) with justification (numbering follows the numbering of the Norwegian traffic safety hand book)

Measure	Accident type, to which the measure will impact on	Impact	Justification
1. ROAD DESIGN AND FACILITATION			
1.1. PEDESTRIAN AND BICYCKLE ROADS			
Construction of new pedestrian and bicycle path along the public road or a street	Fatal pedestrian and bicycle accidents	-10%	Finnish impact. Norwegian impact: -7% of fatal and injury accidents, when the light traffic path has been raised 10…20 cm above the road pavement level.
Grade separation of vehicles and pedestrians/bicyclists on roads and streets (underpass, overpass)	Fatal pedestrian and bicycle accidents	-30%	Finnish impact. Norwegian impact: -30% of fatal and injury accidents.
Add pedestrian over/underpass	All accidents		World experience: - 20…-37%
Add a pedestrian path behind curb	All accidents		World experience: - 6…-18%
Add separate pedestrian path	All accidents		World experience: - 10…-30%
Add cycle track	All accidents		World experience: - 9…-30%
1.2 MOTORWAYS, HIGHWAYS			
Construction of new motorway	Fatal accidents	- 65%	Finnish impact. Norwegian impact: -7% of fatal and injury accidents.
Construction of new motorway instead of an old semi-motorway	All accidents	- 20%	Finnish impact. Norwegian impact: -7% of fatal and injury accidents.
Physical barriers against	Fatal and injury	- 11%	Finnish impacts. Applied to

blinding effect in motorways	accidents in the dark		motorways without road lighting and ADT under 15.000 veh./d.
1.3 BY-PASS ROADS			
Construction of by-pass road	All fatal and injury accidents	-25%	Norwegian impact.
1.5 CANALIZATION OF INTERSECTIONS			
Canalization of X-intersection in public roads and streets	All fatal accidents	-10%	Finnish impacts. World experience: - 2…-38% to all accidents.
Canalization of T-intersection in public roads and streets	All fatal accidents	-5%	Finnish impacts. World experience: - 0…-20% to all accidents.
Mid-island on a minor road	All accidents		World experience: - 3…-22%
Median (mid-island) on a sharp bend	All accidents		World experience: - 10…-30%
Add right turning lane	All accidents		World experience: - 10…-21%
Construction of by-pass area in T-intersection in public roads and streets	All fatal accidents	-5%	Finnish impacts.
1.6 ROUNDABOUTS			
Construction of roundabout in public road or street	All fatal accidents	-75%	Finnish impacts. Norwegian impact: -11% - 41% of fatal and injury accidents.
Construction of roundabout in the city or in the public road	Fatal or injury accident in the cities Fatal or injury accident in rural public roads	-50 % -85 %	Danish impacts from 82 roundabouts.
Construction of roundabouts.	Fatal or injury accident All accidents	-70 % -50 %	Netherlands impact from 201 roundabouts.
Construction of roundabouts.	Fatal or injure accidents	- 65 %	Finnish impacts from 87 roundabouts. Average traffic speed is higher than before in the on those junctions.
Construction of roundabout in the place of X-junction	All accidents		World experience: 20…-58%
1.7-1.8 IMPROVEMENTS OF INTERSECTIONS			
Improvement of geometric parameters	All fatal and injury accidents in the intersection	-20%	Norwegian impact. Changing of intersection angle to 90 degrees: -50%, Smoothing the steep slope on accessing road: -17%.
Changing X-intersection into two T-intersections.	All fatal and injury accidents in the intersection	Vehicle-transport -28%, Pedestrians -10%	Finnish impact. Norwegian impact: -20% of all fatal and injury accidents in the intersection.

Changing X-intersection into two T-intersections (staggering)	All accidents		World experience: -12…-31%
Reduce space on the large junction area	All accidents		World experience: 0…-25%
Main road widening on the T-junction	All accidents		World experience: - 6…-25%
Improve junction angle from 60 to 80…100 grades	All accidents		World experience: - 10…-60%
Improve junction angle from 135 to 80…100 grades	All accidents		World experience: - 8…-25%
Improve junction visibility	All accidents		World experience: - 6…-28%
1.9 INTERCHANGES			
Construction of interchange instead of X-intersection	All fatal accidents	-49%	Finnish impact. Norwegian impact: -50% of all fatal and injury accidents in the intersection.
Increasing of radius in the loop- ramp of interchange	All accidents in the ramp	-23%	Norwegian impact.
Prolonging of length of accelerating and breaking lanes of interchange of 30 meters.	All accidents in the accelerating and breaking lanes	-10%	Combination of two Norwegian impacts: Prolonging of length of accelerating lane: -11% and prolonging of breaking lane: -7%.
Construction of pedestrian and bicycle road under- or overpass	All pedestrian and bicycle accidents	-30%	
1.11 IMPROVING ROAD CROSS SECTION			
Construction of a long middle island into 4-lane street	All fatal and injury accidents	-30%	Combination of two Norwegian impacts: Construction of middle-island to two-lane street:-39% and to several-lane street:-22%.
Add median (long centre island)	All accidents		World experience: - 12…-21%
Improve shoulder >1.25 m	All accidents		World experience: - 10…-70%
1.12 IMPROVING ROAD ENVIRONMENT			
Making the slopes less steep in public roads	Fatal accidents (excluding light traffic accidents)	-15%	Finnish impact. Norwegian impact: Making the slopes less step form 1:3 to 1:4: -42% of all fatal and injury accidents and from 1:4 to 1:6: -22%.
Slope reform from 1:2 to 1:(3-4)	All accidents		World experience: - 1…-15%
Slope reform from 1:(3-4) to 1:(6-7)	All accidents		World experience: - 1…-25%
Reducing gradient of slopes close to the road shoulder to 1:6 or lower	All accidents		World experience: - 9…-28%

Removing obstacle from near the road carriageway	Fatal accidents (excluding light traffic accidents)	-15%	Finnish impact. Norwegian impact: Removing obstacles form 1m to 5m: -22% of all accidents and from 5m to 9m: -22%.
1.13 IMPROVING ROAD GEOMETRY			
Improving vertical and horizontal road geometry	Fatal accidents	-15%	Finnish impact. Norwegian impact: Several separate measures: between 0 – 50%.
Improving the visibility by removing the vegetation on public roads.	Fatal animal accidents	-10%	Finnish impact. Norwegian impact: Removing of an obstacle from he road side: -20% of all accidents, removing vegetation: -20% to all animal accidents.
1.14 ROAD RECONSTRUCTION			
Rural road reconstruction	All fatal and injury accidents	- 20%	Norwegian impact.
Road reconstruction in densely populated area	All fatal and injury accidents	- 7%	Norwegian impact.
1.15 ROAD BARRIERS AND SMOOTHING OF ROAD ENVIRONMENT			
Construction of road barrier	Fatal accidents (excluding light traffic accidents)	-23,5%	Finnish impact. Norwegian impacts: New barrier on the road slope: -44% of driving-off-the-road fatal accidents, barrier before the solid obstacle: -69% of fatal accidents resulting to collision to solid obstacle. Barrier to middle island of several-carriageway road: - 43% to fatal accidents.
Adding one lane plus middle barrier	Fatal vehicle accidents Fatal light traffic accidents Fatal animal accidents	-45% -64% +15%	Finnish impact.
Adding an overtaking or climbing/crawling lane	All accidents		World experience: - 2…-17%
Add guard rail on the road edge	All accidents		World experience: - 10…-60%
Softening environment including structures up to 6 m from the road	All accidents		World experience: - 15…-35%
1.16 PREWENTING ANIMAL ACCIDENTS			
Construction of animal fence	Fatal animal accidents	-15%	Finnish impact. Norwegian impacts: Animal fence: -25% to animal accidents.

1.17 IMPROVING HORZONTAL CURVES			
Marking a small-radius curve	Vehicle fatal accidents	-20%	Finnish impact. Norwegian impacts: Warning sign of the curve: -30%. Speed recommendation in the curve: -13%. Sign showing the shape of the curve: -39%. Road marking and background signs (chevrons) in the curve:-19%.
Add yellow/black chevrons on the road edge	All accidents		World experience: - 29…-40%
1.18 ROAD LIGHTING			
New road lighting	Fatal vehicle accidents Fatal light traffic accident Fatal animal accidents	-25 % -32% -10%	Finnish impacts. Norwegian impacts: -64% of the dark time fatal accidents.
Changing ridged (solid) poles into bracing ones.	Fatal vehicle accidents excl. light traffic and animal accidents.	-20%	Finnish impacts. Norwegian impacts: -50% of accidents, when crushing on the pole.
Doubling the light volume	Fatal vehicle accidents on the dark time	-8%	Norwegian impact.
2. ROAD MAINTENANCE			
2.6 WINTER ROAD MAINTENANCE			
Increasing the maintenance class from 1B to 1 on those roads having heavy traffic over 250 veh./day	Fatal accidents	-2%	Norwegian impact. Increasing the maintenance class by one class: -12% of all winter time fatal and injury accidents
Increased readiness to start winter maintenance efforts in winter time	All winter time fatal and injury accidents	-8%	Norwegian impact.
Make pavement patching	All accidents		World experience: - 7…-13%
2.8 CORRECTING A MISSING OR WRONG ROAD SIGNS			
Installing a new (if missing) or correcting (if incorrect or misleading) sign.	Fatal accidents.	-3%	Finnish impact.
2.9 TRAFFIC MANAGEMENT DURING ROAD WORKS			
Improving (doubling) the road warnings during road	Fatal and injury accidents on the	-40%	Norwegian impact.

works	road works section		
3. TRAFFIC MANAGEMENT			
Access and junction reduction – 50%	All accidents		World experience: - 5…-40%
Access and junction reduction – 70%	All accidents		World experience: - 6…-65%
3.5 REGULATION OF NO OF ACCESSES			
Organization of private accesses	Fatal vehicle accidents	-10%	Finnish impacts. Norwegian impacts: -25% -31% of fatal and injury accidents.
Improvement of the road guidance	All accidents		World experience: - 5…-24%
3.7 YIELDING RULES IN THE INTERSECTIONS			
Showing the yielding rules	Fatal and injury accidents in the intersection	-3%	Norwegian impact.
Add the yield -sign	All accidents		World experience: - 0…5%
3.8 STOP-SIGN IN THE INTERSECTION			
Adding stop-sign to the intersection	Fatal accidents in the intersection	-10%	Finnish impacts. Norwegian impacts: 1 stop-sign in T-intersection:-19%, 2 stop-signs in X-intersection:-35%, 4 stop-signs in X-intersection:-45% of fatal and injury accidents.
Add the stop -sign	All accidents		World experience: - 6…-32%
3.9 TRAFFIC LIGHTS			
Adding new traffic lights to the intersection	Fatal accidents in the intersection	-37%. In T-junction -15%.	Finnish impacts. Norwegian impacts: in T-intersection: -15%, in X-intersections:-30% of fatal and injury accidents.
Improving of traffic lights on the intersection	Fatal accidents in the intersection	-10%	Finnish impact.
Adding pedestrian traffic lights and a mid-island to pedestrian crossing	Fatal light traffic accidents in the intersection Fatal vehicle accidents in the intersection	-32,5% -10%	Finnish impacts. Norwegian impacts: -12% to light traffic and -7% to vehicle fatal and injury accidents.
Add fixed time signal traffic lights	All accidents		World experience: - 12…-20%
Add actuated time signal traffic lights	All accidents		World experience: - 15…-80%
3.11 SPEED LIMITS			
Making the average speed limit 70 km/h instead of current 80.	Fatal accidents in those road sections	- 10%	Finnish impact. Norwegian impacts: When 12% the average speed limit degrees from 70 km/h to 60 or from 60

			to 50, the average speed degrees 3 km/h. This reduces fatalities – 23%.
Adding variable speed limit	Fatal accidents in those road sections	-10%	Finnish impact.
Making the speed limit 100 km/h instead of current 80.	Fatal accidents in those road sections	- 40%	Norwegian impact.
40 km/h speed limit applied under the validation of "densely populated area" – sign.	Fatal vehicle accidents Fatal light traffic accident Fatal animal accident	-22% -58% -44%	Impact applied from the Norwegian impacts.
Make the speed limit 10 km/h lower on the speed limit area 40…80km/h	All accidents.	-9%	Finnish impact.
Make the speed limit from 80 to 60 km/h	All accidents.	-17%	Finnish impact. World experience: - 10…-30%.
Make the speed limit from 100 to 80 km/h	All accidents.	-13%	Finnish impact. World experience: - 12…-31%.
Make the speed limit from 80 to 50 km/h	All accidents.	-24%	Finnish impact.
Area speed limit from 60 to 50 km/h	All fatal and injury accidents	-10%	Impact from Switzerland on the year 1980 in five cities.
Area speed limit from 60 to 50 km/h	All fatal and injury accidents Fatal accidents	-9% -24%	Impact from Denmark on 1986 in all Danish cities.
Area speed limit from 50 to 40 km/h	All fatal and injury accidents	-48%	Impact from Finland on 1993 in Joensuu city.
Speed limit in the city centre from 50 to 40 km/h	All fatal and injury accidents	-30%	Impact is from Helsinki, Finland in 1990's. Average speeds reduced 1-2 km/h. 60 % of inhabitants considered that 40 km/h is a good decision. Traveling times did not increase. Fewer stops and standing (idling) of traffic flow. Traffic flow run smoother. Pollution by the traffic did not increase or decrease. Fuel consumption decreased.
Speed limit in the city centre from 50 to 40 km/h	Injuries in accidents Fatalities in accidents	-10…15% -30…40%	Impacts are from the city of Tampere, Finland in 1990's. Average speeds reduced 3-6 km/h. 70-75 % of inhabitants considered it as a good decision (taxies opposed). 60 % of inhabitants felt safer. Over speeding increased 27-40 %.
3.12 SPEED REDUCING PHYSICAL MEASURES			
Adding speed humps on the streets	Fatalities in light traffic accidents Fatalities in all other	-20% -15%	Finnish impact. Norwegian impacts: - 48 % in the street in question

	accidents		and -6 % in the neighboring streets.
Add a speed bump	All accidents		World experience: - 5…-50%
Add a raised zebra crossing	All accidents		World experience: - 5…-50%
Add raised zebra crossing and refuge (small island) in the middle	All accidents		World experience: - 15…-65%
Adding 30km/h limit and speed humps to the residential area streets.	Fatalities in light traffic accidents Fatalities in all other accidents	-47,5% -44%	Finnish impact.
Adding rumbling line to the accesses of the intersection.	Fatal accidents in that intersection.	-5%	Finnish impact. Norwegian impacts: - 33% of all fatal and injury accidents.
Add set of rumbling strips	All accidents		World experience: - 10…-28%
3.13 ROAD MARKINGS			
Adding the missing road marking edge line	Fatal accidents in that road section	-5%	Finnish impact. Norwegian impacts: - 3% of all fatal and injury accidents.
Adding the rumbling road marking edge line	Fatal vehicle accidents in that road section	-3%	Finnish impact. Norwegian impacts: - 31% of all driving-off-the-road fatal and injury accidents.
Add the rumbling road marking edge line (shoulders)	All accidents		World experience: - 1…-30%
Adding the rumbling middle road marking line	Fatal vehicle accidents in that road section	-3%	Finnish impact.
Adding the reflecting studs	Fatal and injury accidents in that dark time	-8%	Norwegian impact.
Add the reflecting studs	All night-time accidents		World experience: - 7…-30%
Adding reflective side poles in speed limit 100 km/h roads	Fatal accidents	-5%	Finnish impact. Reflective poles add accidents according to Norwegian and Finnish impacts in speed limit 80km/h.
Reflectors in curves and junctions	All accidents		World experience: - 7…-21%
Adding the missing edge and middle road marking lines	Fatal accidents	-10%	Finnish impact. Norwegian impacts: - 24% of all fatal and injury accidents
Road edge and centre line marking	All accidents		World experience: - 5…-30%
Audio marking to road edge and centre line	All accidents		World experience: - 5…-30%
Zebra pedestrian crossing marking	All accidents		World experience: - 5…-14%

3.14 LIGHT TRAFFIC MANAGEMENT			
Adding missing pedestrian crossing	Fatalities in light traffic accidents Fatalities in all other accidents	-10% -5%	Finnish impact. Norwegian impacts: -39% in raised pedestrian crossing, -13% adding mid-island to the pedestrian crossing -21% adding guiding fence to the pedestrian crossing
Add pedestrian fence	All accidents		World experience: - 10…- 35%
Add mid-island (refuge) in the middle of pedestrian crossing	All accidents		World experience: - 11…- 40%
Add pedestrian/cycle ways or service roads	All accidents		World experience: - 22…- 60%
3.15 PARKING MANAGEMENT			
Forbidding the parking along the street	Fatal and injury accidents	-20%	Norwegian impact. World experience: - 10…-31% to all accidents.
From free parking into regulated parking	Fatal and injury accidents	-6%	Norwegian impact.
From free parking into time-regulated parking	All accidents	-11%	Norwegian impact.
From cross-parking to parallel-to-curb-parking	All accidents	-35%	Norwegian impact.
3.16 ONE WAY STREETS			
Making street from two-way to one-way	Fatal and injury accidents	-1%	Norwegian impact.
3.18 TRAM STOPS			
Moving tram stops from the middle of the street into the side of the street	Fatal and injury accidents	-55%	Norwegian impact.
3.20 MOVABLE ROAD SIGNS			
Boards giving information to driver about his current speed	All accidents.	-5%	Finnish impact.
3.21 RAILROAD CROSSINGS			
From at-grade to two-level crossing	Fatal accidents	-64%	Finnish impact.
Adding half-“schlackbaum” to at-grade crossing	Fatalities in vehicle accidents Fatalities in light traffic accidents	-55% -19%	Finnish impact. Norwegian impacts: -45% of all accidents when installing half-schlackbaum to the crossing where earlier was warning light and voice equipment. -67% of all accidents when installing half-schlackbaum to the crossing where earlier was

			warning only warning signs.
Improving of the at-grade crossing	Fatal accidents	-5%	Finnish impact. Norwegian impacts: -25% of all accidents when warning signs to the crossing. -50% when installing lights and voice equipment to the crossing where earlier was warning only warning signs. - 44% when improving the visibility on the crossing.
4. VEHICLE AND SAFETY EQUIPMENT			
4.1-4.2 TIRES			
Roughness of the tire from under 2mm to 2…3mm	All accidents occurring to vehicles having these tires	-19%	Norwegian impact.
Roughness of the tire from 2…3mm to 3…5mm	All accidents occurring to vehicles having these tires	-9%	Norwegian impact.
4.8-4.11 REFLECTORS AND HELMETS			
Reflector usage	Dark time pedestrian accidents	-85%	Norwegian impact.
Usage of bicycle helmets	Head injuries of cyclists	-50%	Norwegian impact.
Usage of moped helmets	Fatal head injuries of moped users	-44%	Norwegian impact.
4.12-4.13 SEAT BELTS AND SEFETY SEATS			
Usage of seat belt	All fatal accidents	Drivers -50% Front seat passengers -45% Back seat passengers -25%	Norwegian impact.
Children's safety seats	Injuries	See next column.	Norwegian impact. -24% if children without seat belts or safety seats are sitting in back seat instead of a front seat -15% if children in seat belts or safety seats are sitting in back seat instead of a front seat -25% if in infants seat -50% usage of infant seat for children 0-4 years, face showing front -80% usage of infant seat for children 0-4 years, face showing back

			-32% usage of seat belt without a seat for children 0-4 years -52% usage of safety seat for children 5-9 years -19% usage of safety belt without safety seat for children 5-9 years
5. VEHICLE INCPECTION			
5.3 TECH INSPECTIONS ON THE ROAD SIDE			
Adding road side inspections for light vehicles for 50%	All light vehicle accidents	-0,7%	Norwegian impact.
Adding road side inspections for heavy vehicles for 50%	All heavy vehicle accidents	-2%	Norwegian impact.
6. DRIVERS TRAINING			
6.1 DRIVER LICENSE			
Driver license age from18 to 19 years	First year accidents	-6%	Norwegian impact.
6.9 TWO PHASE DRIVER'S LICENSE			
New driver license owner is allowed to drive only between 6-22 hours	Fatal and injury accidents of the new drivers	-6%	Norwegian impact.
7. PUBLIC TRAINING			
7.2 TRAINING IN SCHOOLS			
Training way to cross the street to 6-12 years old.	Fatal and injury accidents when crossing the street	-13%	Norwegian impact.
Training right bicycling rules to 6-16 years old.	Fatal and injury accidents when biking	-6%	Norwegian impact.
7.3 CAMPAINS			
Campaign against driving-off-the-road	off-the-road accidents	-3%	Norwegian impact.
Campaign against driving too close to each others	Driving-on-the-back accidents	-9%	Norwegian impact.
Campaign against drunk driving	Drunk driving accidents	-2%	Norwegian impact.
8. POLICE ENFORSEMENT			
8.1-8.2 PERMANENT SPEED CONTRAL			
Radar measuring three times frequent than today	Fatal accidents	-7%	Impact applied from the Norwegian impact: -14% for radar measuring in general for fatal accidents.
Police patrolling three times	Fatal accidents	-4%	Impact applied from the

frequent than today			Norwegian impact.
Intensify police enforcement	All accidents		World experience: - 10…-50%.
8.3-8.4 DRUNKEN DRIVING			
Degreasing of drunken driving limit from 0,5 to 0,2 o/oo (promile).	Fatal accidents, where some of the involving person is affected by 0,2-0,5 o/oo	-8%	Finnish impact. Norwegian impacts: -8% to all fatal accidents.
Three times more frequent drunken driving control	Fatal accidents	-3%	Norwegian impact.
8.6-8.7 SPEED CAMERAS			
Installing and managing automatic speed camera on the main road	Fatal accidents	-30%	Finnish impact. Norwegian impacts: -17% to fatal and injury accidents.
Installing and managing cameras for traffic light controlling	Fatal and injury accidents	-12%	Norwegian impacts.
8.10 WARNINGS			
Mistake point – system, certain amount leads to warning or canceling of the driving license	Fatal accidents	-17%	Norwegian impact.

7 Economic justification of the proposed road safety measures

Economic justification of the proposed measures is based on the approved Russian accident unit prices (see **Section 3**) and everyday Western benefit/cost calculations.

The methodology that has been used in the memoranda in annexes 3 and 4 is simplified of the general method from Western countries. In that:

1. Impact of the proposed measure or measure package will be evaluated (improving situation in %)
2. This impact of the measure or measure package will be counted in “saved” killed, injured and material-damage-only (MDO) if applied. Rather often the latter will be left off as the statistics in MDO accidents in rather weak. This is carried out by forecasting the difference between the measure and “do-nothing” in one year. Forecast will be made based on last 3…5 years accident statistics development.
3. “Saved” killed, injured (and MDO) will be turned into money equivalent using unit costs approved in Russia.
4. If the measure or the measure package includes a speed limit, the losses of travel time should be counted as drawbacks to the measure. As Russian travel time value unit costs are not yet available, can be used the Western unit costs in dividing them to relation of GDP´s of the countries. In this way Russian unit value for travel time would be about three times lower than the Finnish one.
5. Saved money because of the measure and spent money for the measure will be compared. The result is a paying-.back period. The investment is feasible in developing economies if this figure is some months or only few years.

In proposed method have been ignored some factors, which are typical for Western methods, like:

- Accidents with only material damage, because of small economic effect and vague statistics. Statistic in MDO accidents is weak in Russia
- Vehicle costs (petrol, lubricant, tires etc,) do not much differ between variants

- Maintenance costs, which may be slightly increased, because some measure may increase manual work in street maintenance (e,g, snow removing near traffic islands)
- Pollution costs, which will be lower with lower speeds
- Noise costs, which will be lower with lower speeds
- Residual value, because of the short paying back periods (normally 25% aftr 30 years)
- Discounting, because of very short paying back periods (some months or few years). The discounting rate is normally 5%.
- Traffic growth, because is very short paying back periods

These ignoring make the proposed method rather simple to use. At the same time it gives quite good indication for assessing the effectiveness of the investment compared to other investments in the society and very good indication to compare traffic and transport investments among themselves.

8 Prioritizing methods

There are two stages of prioritizing in accident analyzing.

Evaluation of current black spots

Firstly, the current accident situation can be rated either in costs to society or likelihood to an accident. Costs to society can be counted in few years in all black spots and the most expensive is rated the highest. Likelihood is simply a factor when accident figures are compared to traffic volume (dangerousness of the road) in certain time (e.g. accidents in million vehicles). The higher likelihood gets higher rating.

Secondly, proposed measures should be prioritized by their economic effectiveness. The highest rating gets the measure that has shortest paying-pack period (or highest benefit-cost ratio).

In the table below is counted as an example rating in the situation in the pilot roads M18 and Access to M18 in Murmansk.

M18, Fatal and injury accidents in black spots and their impacts 1/2004-9/2008 (GIBDD data, 4.75 years) and 1/2006-12/2008 (Uprdor Kola data, 3 years)

#	Location: Start point – end point	Length of the section m and ADT v/d	Statistics period, years	Number of fatal and injury accidents	Number of killed people	Number of injured people	Accident costs. mln.RUR annually	Accident likelihood. Fatal and inj. accidents in 1 milj. km
1	1381+140 – 1381+420	280 7700	3	4	0	5	4.01	1.6
2	1386+066 – 1386+970	904 6100	3	8	1	9	10,27	1.3
3	1393+000 – 1393+934	934 6100	4,75	10	0	17	8.59	1.0
4	1394+250 – 1394+500	250 5200	4,75	4	3	6	8.88	1.7
5	1399+800 – 1400+350	550 5200	4,75	3	0	3	4.8	0.6
6	1414+050 – 1414+650	600 3100	3	4	0	8	6.41	1.9
7	1440+007 – 1440+700	693 1400	3	5	7	7	27.26	4.7
8	1497+929 – 1498+200	271 750	4,75	3	1	5	4.47	8.5

9	1534+043 – 1534+470	427 1400	3	4	0	8	6.41	.6.1
10	1535+205 – 1535+935	730 1400	3	3	1	6	7.87	2.6
11	1537+820 – 1538+550	730 1400	4,75	5	0	8	4.03	2.8
	Total	**6369**		**53**	**13**	**82**	**93.0**	**3.0**

As can be observed from the table above, the top 3 in accident costs to the society are sections number 7, 2 and 4. However, the likelihood to get killed or injured is highest in sections number 8, 9 and 7.

Fatality and injury accidents in black spots and their impacts 1/2004-9/2008 (GIBDD data, 4.75 years) and 1/2006-12/2008 (Uprdor Kola data, 3 years)

#	Location: Start point – end point	Length of the section m and ADT v/d	Statistics period	Number of fatal and injury accidents	Number of killed people	Number of injured people	Accident costs. mln.RUR annually	Accident likelihood. Fatal and inj. accidents in 1 milj. km
1	1+000 – 1+550	550 7700	4,75	6	1	8	5.98	0.8
2	1+750 – 2+700	950 7700	4,75	16	1	22	13.06	1.2
3	4+100 – 5+000	900 7700	3	4	0	5	4.01	0.5
4	5+000 – 5+600	600 7700	4,75	10	3	13	12.44	1.2
5	7+150 – 8+000	850 7700	3	4	0	4	3.19	0.5
6	8+000 – 8+502	502 7700	4,75	4	0	5	2.52	0.5
7	9+080 – 9+500	420 7700	3	4	0	5	4.01	1.1
8	11+100 – 11+855	755 7700	3	5	0	8	6.41	0.7
9	14+000 – 14+451	451 7700	4,75	4	0	4	2.02	0.6
	Total	**5978**		**57**	**5**	**74**	**53.64**	**0.8**

As can be observed from the table above, the top 3 in accident costs to the society are sections number 2, 4 and 8. The likelihood to get killed or injured is highest in sections number 2, 4 and 7. It means that the two methods give about the same result.

Just for curiosity, we may compare the accident likelihood Murmansk and Finnish public roads. In Finland, on the main public roads (ADT under 6000 veh./day) the accident likelihood is 0.1 fatal and injury accidents per million km and in main public roads going through the densely populated areas 0.23 fatal and injury accidents per million km (ADT

under 6000 veh./day). In Access to Murmansk from M18 road (Murmansk by-pass road) the figure is 0.50.

Prioritizing of the proposed measures

Prioritizing of the proposed measures is to be done by their economic effectiveness.

In the pilot road M18 it is recommended to carry out in the first possible budget round the package of small measures (road markings, warning signs, rumble strips in start of the section or junction, the speed limit 60km/h in most of the spots or even 40 km/h and linear rumbles strips i.e. audio marking). This is because the paying pack period of the measures (effectiveness) is between 0.5 to 6 months. It is recommended to start preparation works to next budget round for mid cost measures (road lights, roundabout, mid-islands in some targeted locations). This is because the paying pack period of these measures (effectiveness) is between 1 to 11 months. It is recommended to start preparation works to next budget round for high cost measures (road crash barrier and additional lane in some targeted locations). This is because the paying pack period of these measures (effectiveness) is between 0.6 to 12 years.

In the pilot road Murmansk access to M18 (Murmansk by-pass) it is recommended to carry out in the first possible budget round the package of small measures (road markings, warning signs, the speed limit 60km/h in all of the spots and linear rumbles strips i.e. audio marking). This is because the paying pack period of the measures (effectiveness) of these packages are between 1 to 17 months. If to take installation of the audio marking separately to whole length of the road, it would give 1 months baying pack period and makes the measure very recommended. It also is recommended to start preparation works to next budget round for mid cost measures as road lights to whole of the road length and roundabouts in some targeted locations. This is because the paying pack period (effectiveness) of road light measure is 6 months and roundabouts between 8 to 32 months. It is recommended to start preparation works to next budget round for high cost measures (road crash barrier and additional lane in some targeted locations). This is because the paying pack period of these measures (effectiveness) is between 0.6 to 12 years.

9 Dissemination

Dissemination of the results to the neighboring regions was provided via Final project dissemination seminar (joint to WP4 and WP5) in Archangelsk May 20, 2009. The representatives from the Arkhangelsk and Murmansk regions as well as from neighboring regions were invited to the seminar.

Annex 1 Murmansk visit Programme within the WP 4 of the «Polar Traffic Safety»-project

Murmansk visit Programme within the Tacis EU Kolarctic Project «Polar Traffic Safety»

Date:	February, 16-20, 2009
Venue:	Murmansk city
Objective:	Preparing proposals to reduce road hazards on a pilot Murmansk public road network section (Murmansk-Borisoglebsk) within the Work Package 4 “Black spot management in the Murmansk region”
Tasks:	1. Full traffic safety analysis on the pilot road; 2. Proposals of measures to improve traffic safety on black spots; 3. Impact analysis of the proposed measures; 4. Economic justification of the proposed measures; 5. Prioritization of the proposed measures; 6. Dissemination seminar of WP 4.
Target group:	Representatives of organizations and services aimed at traffic safety improvements on the Murmansk regional public road network
Number of participants:	10 persons
Trainers:	Stig Carlsson – project expert Juha Jyvarinen – project expert Maria Shabasheva – local expert

Visit programme

February, 16 (Monday)

Time	Actions	Participants
morning	Arrival to the Murmansk airport, transfer to the hotel	
	Meeting with Project partners	

February, 17 (Tuesday)

Time	Actions	Participants
Whole day	Visiting black spots on the pilot road Murmansk-Borisoglebsk/Storskog to make proposals on road safety improvements	▪ Stig Carlsson ▪ Juha Hyvarinen ▪ Maria Shabasheva ▪ Murmansk Road Police representative Andrey Shulgin

		▪ Representative of M18 road administration UprDor KOLA

February, 18 (Wednesday)

Time	Actions	Participants	Comments
Whole day	1. Road data processing and analyzing, and integrating them with the previous information obtained from Murmansk road police. 2. Making road accident analysis for the most typical black spots. 3. Preparing proposals to reduce road hazards on the above sections. 4. Economic justification of the proposed measures	▪ Juha Hyvarinen ▪ Maria Shabasheva	The most typical road black spots will be considered during the seminar. The full package of all analytical and graphical materials on black spots analysis and proposals will be represented later on the final seminar of the project in Arkhangelsk.
	5. Preparations for the seminar (checking the equipment, etc.)		

February, 19 (Thursday)

Time	Actions	Participants
9:00-14:00	Seminar aimed at know-how transfer in the sphere of road traffic safety (black spot elimination technologies and methods)	10 persons

February, 20 (Friday)

Time	Actions	Participants
evening	Departure to Arkhangelsk	

Seminar Programme

Venue: **Murmanskavtodor**
Date: February, 19, 2009

Time	Presentations	Lecturer
9.00 – 9.15	Brief presentation of the Tacis EU Kolarctic project «Polar Traffic Safety»	Juha Hyvarinen, project expert
9.15 – 9.30	Road safety on the Murmansk public road network and pilot Murmansk-Borisoglebsk road	Murmansk regional Road Police representative – Andrey Shulgin

9.30 – 9.50	Measures implemented by road administrations to reduce road accidents on the pilot road Murmansk-Borisoglebsk and Murmansk regional public road network	Road administration UprDor Kola representative – Yury Polosin, Vice Head
9.50 – 10.20	General information on road hazard reasons and their systematization in modern practice	Svatkova Elena , ADC Ltd, director
10.30 – 10.50	Vision Zero	Stig Carlsson, Project expert, Swedish Road Administration
10.50 - 11.20	Inexpensive and effective measures to reduce road accidents. Traffic calming	Maria Shabasheva, local expert (senior engineer, ADC Ltd)
11.20 – 11.35	**Coffee-break**	
11.35 – 12.05	Road safety audit concept. Basic principles	Maria Shabasheva, local expert (senior engineer, ADC Ltd)
12.05 - 12.35	The movie about road traffic safety shot by the Arkhangelsk city Road Police in Norway «Her Majesty Safety». Comments to the movie	Alexey Maksimov, head of the Arkhangelsk city road police
12.35 – 12.55	Road safety audit practices in the Arkhangelsk Region	Denis Kulizhnikov, Engineer of Arkhangelskavtodor
12.20-13.00	Results of the project “Traffic Safety Improvement on E18 (M10) “Scandinavia” 2007-2008	Juha Hyvarinen Project expert
13.15 – 13.25	Economic analysis applied in EU for traffic safety measures justification	Maria Shabasheva, local expert (senior engineer, ADC Ltd)
13.25 - 13.50	Pre-study of road accidents situation on “Access to Murmansk” automobile road	Juha Hyvarinen Project expert
13.50 – 14.10	Intermediate results of “Accident reduction on pilot Murmansk-Borisoglebsk black-spots” project	Juha Hyvarinen Project expert
	Discussions. Conclusions. Further steps within the project	

List of participants

№	Name	Organization
1	Juha Hyvarinen	Project expert, Poyry Infra Oy
2	Stygg Karlsson	Swedish road administration, Region Norr, Representative of leading partner
3	Denis Kulizhnikov	Road regional administration “ArkhangelskAvtodor”, Project partner representative
4	Maria Shabasheva	Local expert on traffic Safety, “ADC” ltd.
5	Jury Polosin	Road administration UprDor Kola, representative of beneficiar

6	Andrey Shulgin	Murmansk regional road police, representative of project partner
7	Eduard Piletsky	Murmansk regional administration “MurmanskAvtodor”, representative of project partner
8	Alexander Melentjev	Murmansk regional administration “MurmanskAvtodor”, representative of project partner
9	Lars Gosta	Swedish association on traffic safety improvement NTF
10	Elena Svatkova	Moderator

Annex 2 Fatality and injury accidents on Murmansk-Borisoglebsk and Access to Murmansk road black spots

Table 1 Fatality and injury accidents on Murmansk-Borisoglebsk road black spots and their impacts 1/2004-9/2008 (GIBDD data, 4,75 years) and 1/2006-12/2008 (Uprdor Kola data, 3 years)

No of the "black section"	Location: Start point – end point	Length of the section m	Statistics period, years	Number of fatal and injury accidents	Number of killed people	Number of injured people
1.	1381+140 – 1381+420	280	3	4	0	5
2.	1386+066 – 1386+970	904	3	8	1	9
3.	1393+000 – 1393+934	934	4,75	10	0	17
4.	1394+250 – 1394+500	250	4,75	4	3	6
5.	1399+800 – 1400+350	550	4,75	3	0	3
6.	1414+050 – 1414+650	600	3	4	0	8
7.	1440+007 – 1440+700	693	3	5	7	7
8.	1497+929 – 1498+200	271	4,75	3	1	5
9.	1534+043 – 1534+470	427	3	4	0	8
10.	1535+205 – 1535+935	730	3	3	1	6
11.	1537+820 – 1538+550	730	4,75	5	0	8
	Total	**6369**		**53**	**13**	**82**

Table 2 Fatality and injury accidents on Access to Murmansk black spots and their impacts 1/2004-9/2008 (GIBDD data, 4,75 years) and 1/2006-12/2008 (Uprdor Kola data, 3 years)

No of the "black section"	Location: Start point – end point	Length of the section m	Statistics period	Number of fatal and injury accidents	Number of killed people	Number of injured people
1.	1+000 – 1+550	550	4,75	6	1	8
2.	1+750 – 2+700	950	4,75	16	1	22
3.	4+100 – 5+000	900	3	4	0	5
4.	5+000 – 5+600	600	4,75	10	3	13
5.	7+150 – 8+000	850	3	4	0	4

6.	8+000 – 8+502	502	4,75	4	0	5
7.	9+080 – 9+500	420	3	4	0	5
8.	11+100 – 11+855	755	3	5	0	8
9.	14+000 – 14+451	451	4,75	4	0	4
	Total	**5978**		**57**	**5**	**74**

Annex 3 Full traffic safety analysis on the pilot road section "Murmansk-Borisoglebsk"

Polar Traffic Safety project 2007 - 2009

Statistic and expert analysis, proposed measures and economic evaluation of traffic accident concentration sections ("black spots") in Murmansk – Borisoglebsk section of M18 federal road St Petersburg – Russian/Norwegian border

Content of this memorandum:

1. General

This memorandum is based on statistics delivered by the Murmansk Regional Traffic Police (GIBDD) and the Federal road administration of M18 road (Uprdor "Kola") for the section between Murmansk and Borisoglebsk.

As for the data we chose all the accidents that caused injuries and fatalities as they are more thoroughly registered in statistics. From the preliminary analysed material we have chosen 11 black spots from the following criteria:

- 3 or more injury or fatality accidents in 5 years in maximum 1000 m section
- 2 injury or fatality accidents in 5 years in maximum 400 m section

The overall picture of the data is the following:

Fatality and injury accidents in black spots and their impacts 1/2004-9/2008 (GIBDD data, 4,75 years) and 1/2006-12/2008 (Uprdor Kola data, 3 years)

#	Location: Start point – end point	Length of the sectio	Statistics period, years	Number of fatal and injury	Number of killed people	Number of injured	Accident costs. mln.RUR

		n m		accidents		people	annually
1	1381+140 – 1381+420	280	3	4	0	5	4.01
2	1386+066 – 1386+970	904	3	8	1	9	10,27
3	1393+000 – 1393+934	934	4,75	10	0	17	8.59
4	1394+250 – 1394+500	250	4,75	4	3	6	8.88
5	1399+800 – 1400+350	550	4,75	3	0	3	4.8
6	1414+050 – 1414+650	600	3	4	0	8	6.41
7	1440+007 – 1440+700	693	3	5	7	7	27.26
8	1497+929 – 1498+200	271	4,75	3	1	5	4.47
9	1534+043 – 1534+470	427	3	4	0	8	6.41
10	1535+205 – 1535+935	730	3	3	1	6	7.87
11	1537+820 – 1538+550	730	4,75	5	0	8	4.03
	Total	**6369**		**53**	**13**	**82**	**93.0**

2. Executive summary and recommendations

The Polar Traffic Safety project among other things studied the accident concentrations in Murmansk- Borisogledsk federal road (about 172 km). Firstly, the project made a short statistic and expert analysis, which was based on all fatal and injury accidents recorded by GIBDD (4.5 years) and the road owner, Kola federal road administration (3 years). Secondly, a multinational Russian-Swedish-Finnish group made a site visit to the problematic road and photographed it. Thirdly, the project proposed measures, estimate their impacts and assessed costs and benefits of proposed measures for 11 black sections as well as for the whole road.

In 11 black sections representing a bit more than 6 km of length of the road there occur 4 deaths annually and about 20 injured annually (see table below).

#	Location: Start point – end point	Length of the section m	Statistics period, years	Number of fatal and injury accidents	Number of killed people	Number of injured people	Number of killed annually	Number of injured annually
1	1381+140 – 1381+420	280	3	4	0	5		1.67
2	1386+066 – 1386+970	904	3	8	1	9	0.33	3
3	1393+000 – 1393+934	934	4,75	10	0	17		3.58
4	1394+250 – 1394+500	250	4,75	4	3	6	0.63	1.26
5	1399+800 – 1400+350	550	4,75	3	0	3		0.63
6	1414+050 – 1414+650	600	3	4	0	8		2.67
7	1440+007 – 1440+700	693	3	5	7	7	2.33	2.33
8	1497+929 – 1498+200	271	4,75	3	1	5	0.33	1.05
9	1534+043 – 1534+470	427	3	4	0	8		2.67
10	1535+205 – 1535+935	730	3	3	1	6	0.33	2
11	1537+820 – 1538+550	730	4,75	5	0	8		1.68
	Total	**6369**		**53**	**13**	**82**	**4**	**19.87**

The project assessed several levels of traffic safety measures to those spots. The impacts were taken mainly from the analogical measures implemented in Scandinavian countries as there are no

long term study results of the measures in Russia. The accident costs were taken from the Russian "Methodology of assessment of normative socio-economic accident costs R-03112199-0502-00" developed by the Scientific Research Institute of Motor transport (NIIAT) for the Russian Ministry of Transport. As for the accident cost to society, was used 9.3 Million RUR for a lost life and 2.4 Million RUR for an injury.

The analyzed measures and prognosis of them to 11 black sections are the following:

- Small physical improvement (e.g. road markings, warning signs, cross sectional rumble strips in start of the section or junction, in most of the spots the speed limit 60km/h or even 40 km/h and audio marking) in 11 black spots with about 6 km of road would cost 3 million rubles and would save annually 1.2 lives and 8 injuries annually. The economic impact of the measures is very high as the paying back period of investment is about 2 months. The measures are recommended.

- Road lights in 3 sections, mid-islands in 2 sections and roundabouts in one dangerous section (mostly junctions) would cost 9 million rubles and would save annually 1 life and 6 injuries. The economic impact of the measure is high as the paying back period of investment is about 4 months. The measures are recommended.

- If to construct crash barrier and additional lane to 8 black sections, it would cost 112 million rubles and would save annually about 2 lives and 15 injuries. The economic impact of the measure is good as the paying back period of investment is about 4 years. The measures are recommended to those 8 black sections.

3. Analysis, proposals of measures, impacts and economic

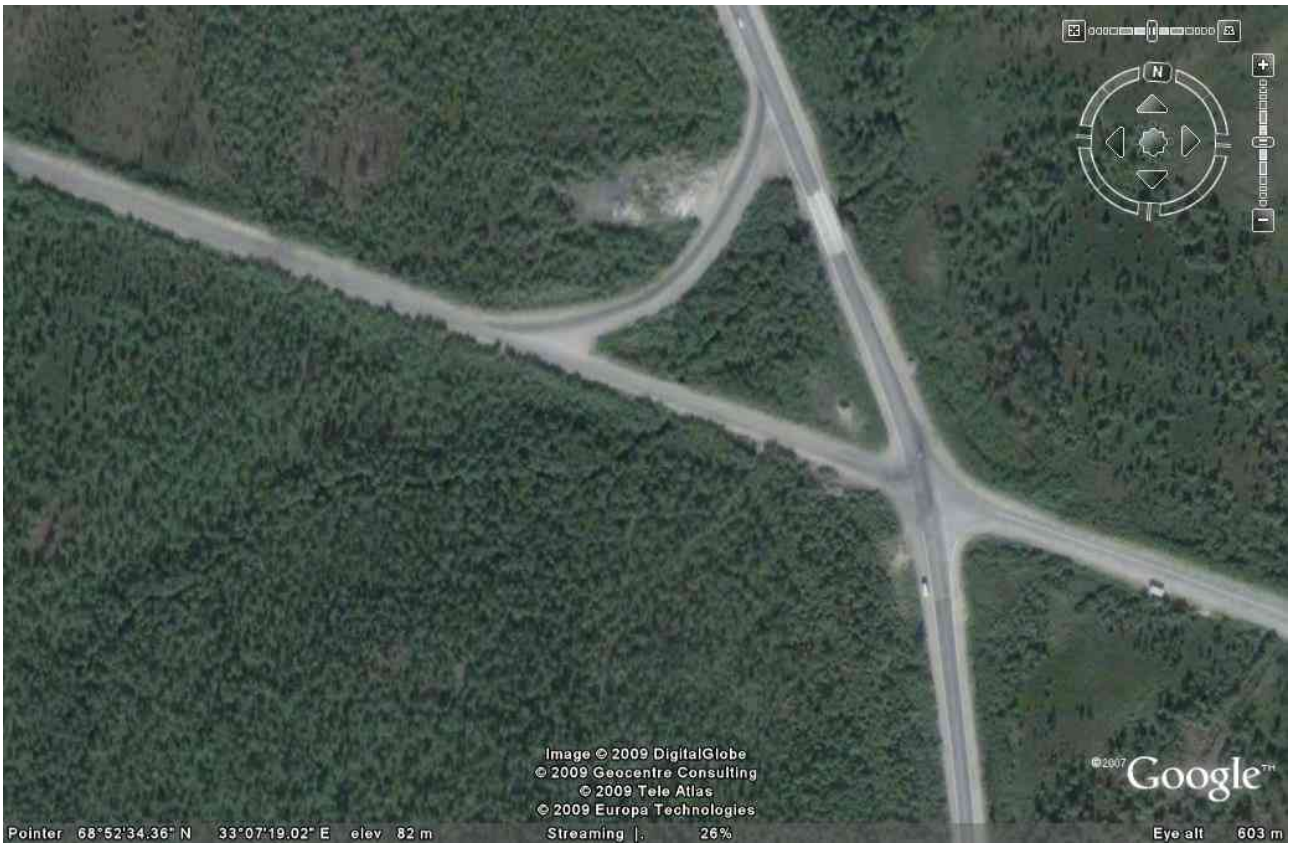
1. M18 1381+140 – 1381+420, junction

Detailed analysis on the "black spot"

Fatal and injury accidents 1/2006 -12/2008	4
In these:	
Persons killed	0 (0 annually)
Persons injured	5 (1,67 annually)
Accidents costs to the society, mln.RUR 1)	4.01 annually
In darkness (or bad visibility)	0 %
In Winter period:	0 % (1.10-30.4)
Special characteristics of accidents:	no information
Safety rule violation:	no information
Road factor during the accidents:	Low skid resistance (1 acc.)

Photo from the black section

) The accident unit costs are counted based on the Russian method based on “Methodology of assessment of normative socio-economic accident costs R-03112199-0502-00” is developed by Scientific Research Institute of Motor transport (NIIAT) for the Russian Ministry of Transport (annex 1). The average costs used in this calculation are: 9.3 MRUR for fatalities and 2.4 MRUR for injuries. Russian Rosavtodor is in process of issuing the traffic safety guidelines for the federal roads. They propose 8.7 MRUR fatality cost and 0.3 MRUR injury cost. The latter is definitely too low and this is why in this study we decided to use the “older” values.



Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	7700	vpd
Percentage of heavy vehicles (roughly)	30	%
Speed limit	90	km/h
Carriageway width (roughly)	3.75x2	m
Shoulder width (roughly)	2x2	m
Pedestrian path	no	m
Pavement	Asphalt concrete	
Horizontal and vertical alignment	Intersection, main road changes direction	
Pedestrians	no	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	+	
Other	The problem of non-yielding on the intersection results in collisions	

Infrastructure development for the next 3 years on the spot:

- Road marking is planned to be done according to the capital repair works plan (rehabilitation plan) in 2011
- Missing road signs are to be installed in 2011.

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of **60 km/h speed limit**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** marked on the asphalt in entries of the junction, L

Constructing a long traffic separation **islands** to enable safely left turning, M

Constructing a **roundabout,** M

Assessed improvement packages and their economic evaluation:

Low cost measure package, 224.000 RUR

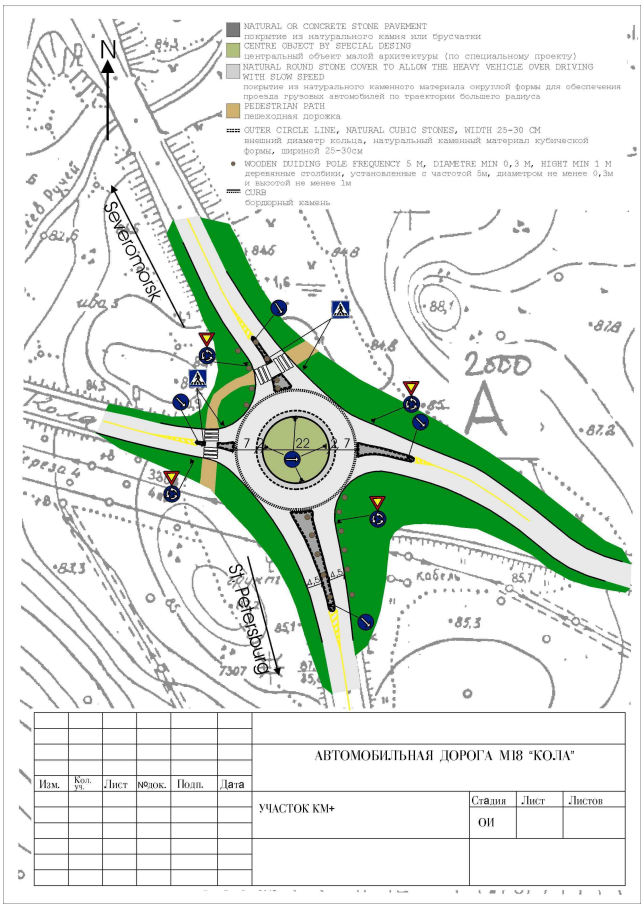
Measure	**RUR**
Renewing all horizontal and vertical road **markings**	90.000
Installment of **60 km/h speed limit**	22.000
Installment of a **"dangerous road section"** –signs, 4	90.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	22.000

Mid cost measure package 1, about 2.4 MRUR

Measure	**Euro**
Constructing of a long traffic separation **islands** to enable safely left turning and small islands on the accessing roads	2.120.000
Low cost package	224.000

Mid cost measure package 2, about 2.4 MRUR

Measure	**Euro**
Constructing a **roundabout**	2.200.000
Low cost package	224.000



Proposed measure in the black section, mid package 2. The drawing is from project in bilateral co-operation with the Finnish Road Administration and Murmansk Region Road Administration 2005 "Black spot analysis of Murmansk by-pass road".

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**224.000 RUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0 killed
	1.67 injured
Forecasted annual impact with the measure, less	**0 killed** (RUR)
	0,5 injured (0.135 MRUR)
Annual economic savings of the society	**1,2MRUR**
Annual loss of time 7.000 veh./24h. x 365 days x 2 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,25 MRUR**
Paying-pack period	(0,2245/1,2-0,25)x12 = **3 months**

Package 1 of mid-cost measures (mid-islands)	**2.4 MRUR**
Rough estimate of impacts, decrease of injury accidents	**- 40%**
Impact without the measure, annually	0 killed
	1.67 injured
Forecasted annual impact with the measure, less	**0 killed** ( )
	0,67 injured (1.6 MRUR)
Annual economic savings of the society	**1,6 MRUR**
Annual loss of time 7.000 veh./24h. x 365 days x 2 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,25 MRUR**
Paying-pack period	(2,4/1,6-0.25)x12 months = **21 months**

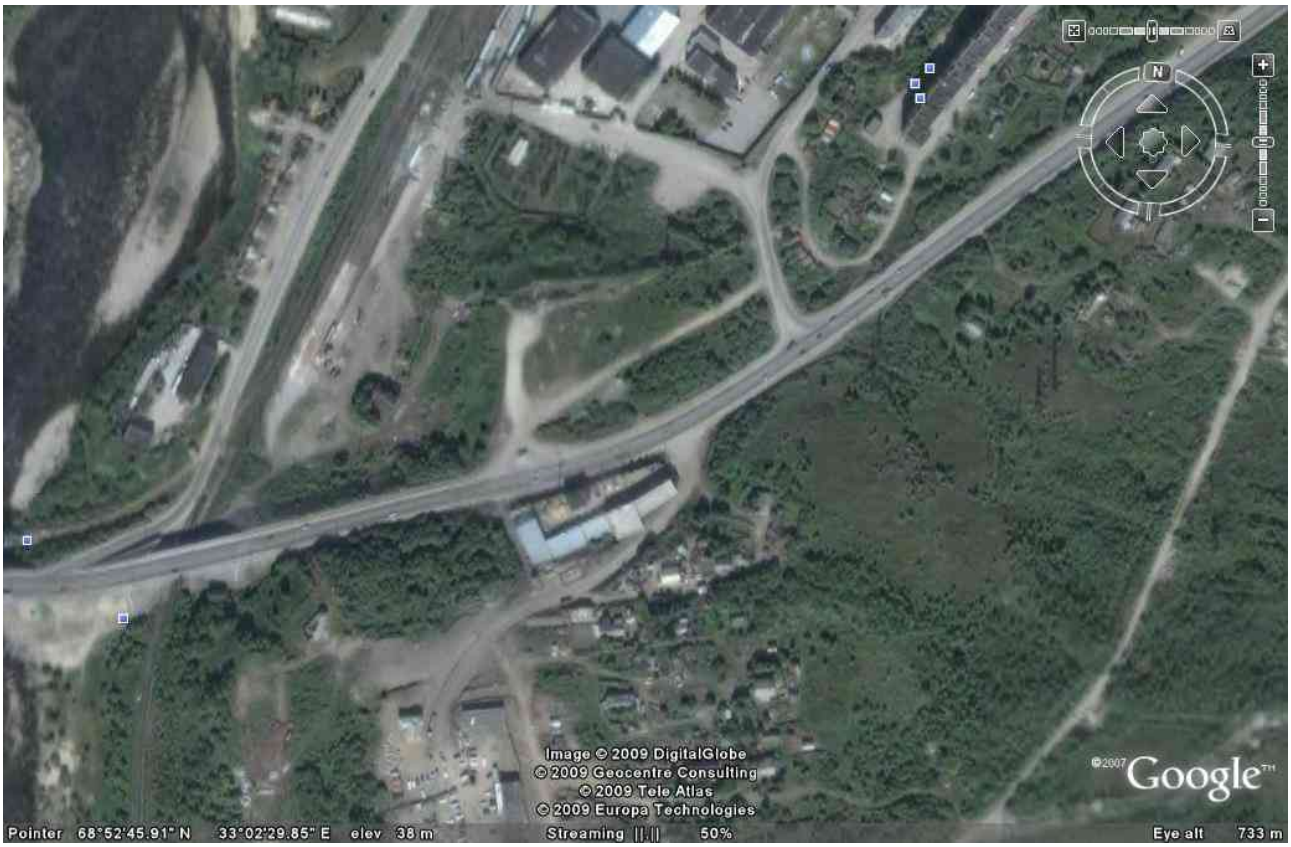
Package 2 of mid-cost measures (roundabout)	**2.4 MRUR**
Rough estimate of impacts, decrease of injury accidents	**- 70%**
Impact without the measure, annually	0 killed
	1.67 injured
Forecasted annual impact with the measure, less	**0 killed** ( )
	1,17 injured (2.8 MRUR)
Annual economic savings of the society	**2,8 MRUR**
Annual loss of time 7.000 veh./24h. x 365 days x 2 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,25 MRUR**
Paying-pack period	(2,4/2,8-0.25)x12 months = **11 months**

2. M18 1386+066 – 1386+970 (Kola city)

Detailed analysis on the "black section"

Fatal and injury accidents 1/2006-12/2008	8
In these:	
Persons killed	1 (0,33 annually)
Persons injured	9 (3,00 annually)
Accidents costs to the society, mln.RUR	10.27 annually
In darkness (or bad visibility)	50 %
In Winter period:	63 % (1.10-30.4.)
Special characteristics of accidents:	50% driving on pedestrian 25% head-on collisions 12.5% driving off the road 12.5% other
Safety rule violation:	2,7,10,17,28,31,42
Road factor during the accidents:	Access to petrol station, descending section, turn, bus stop, pedestrian crossing.

Photo from the black section



Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	6100	vpd
Percentage of heavy vehicles (roughly)	25	%
Speed limit	60	km/h
Carriageway width (roughly)	10	m
Shoulder width (roughly)	3.5x2	m
Pedestrian path	no	m
Pavement	Asphalt concrete	
Horizontal and vertical alignment	Turn, ascending section	
Pedestrians	yes	
Bicyclists	yes	
Traffic lights	no	
Road lighting	+	
Road signing	+	
Other	High traffic volume, junction within the city borders with non-traffic lighted pedestrian crossing near the bus stop. Special problem for vehicles to exit the petrol station and join the traffic flow.	

Infrastructure development for the next years

- Rehabilitation works are planned in 2009. Road markings are to be done.
- In 2008 road signs with high-reflector properties were installed.

Initial proposed measures

Renewing all horizontal and vertical road **markings**, L
Installment of **40 km/h speed limit**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** in on the asphalt entries of the dangerous section, L

Improving of **road lighting** for whole km length, M

Assessed improvement packages and their economic evaluation:

Low cost measure package, 224.000 RUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	90.000
Installment of **40 km/h speed limit**	22.000
Installment of a **"dangerous road section"** –signs, 4	90.000
Install a unit of three cross sectional **rumble strips** in entries of the section	22.000

Mid cost measure package, 0.55 MRUR

Measure	**RUR**
Improving of **road lighting** for whole km length (changing of the lamps)	0,3 M
Low cost package	224.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.22 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0.33 killed
	3,00 injured
Forecasted annual impact with the measure, less	**0.1 killed** (1,0 MRUR)
	0.9 injured (2,2 MRUR)
Annual economic savings of the society	**3.2 MRUR**
Annual loss of time 6.100 veh./24h. x 365 days x 2 (100 м) x 3 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.3 MRUR**
Paying-pack period	(0.22/3,2-0.3) x 12 = **1 month**

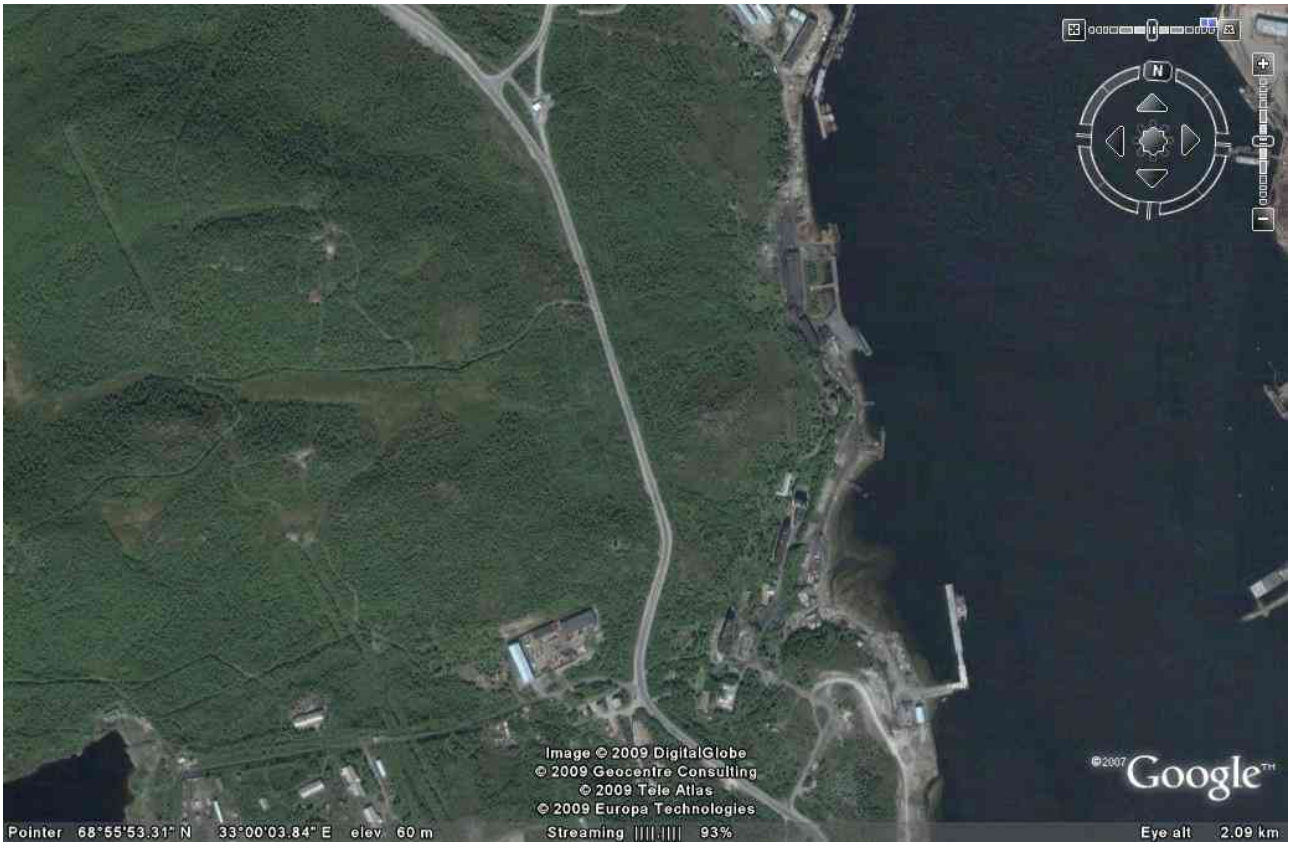
Package of mid-cost measures (road light improvement)	**0.55 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-45% (30% speed limit, 15% road lights)**
Impact without the measure, annually	0.33 killed
	3.00 injured
Forecasted annual impact with the measure, less	**0.15killed** (1.4 MRUR)
	1.35 injured (3.3 MRUR)
Annual economic savings of the society	**4.7 MRUR**
Annual loss of time 6.100 veh./24h. x 365 days x 2 (100 м) x 3 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.3 MRUR**
Paying-pack period	(0.55/4.7-0.3)x12 months = **1.5 months**

3. M18 1393+000 – 1393+934

Detailed analysis on the “black section”

Fatal and injury accidents 1/2004-9/2008	10
In these:	
Persons killed	0 (0 annually)
Persons injured	17 (3.58 annually)
Accidents costs to the society, mln.RUR:	8.59 annually
In darkness (or bad visibility)	50 %
In Winter period:	40% (1.10-30.4.)
Special characteristics of accidents:	50% head-on collisions 50% driving off the road
Safety rule violation:	03,04,05,06,07,08,14,22,28
Road factor during the accidents:	Left and right turn, ascending section, obstacle on the shoulder, low skid resistance, Drovyanoye settlement

Photo from the black section



Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	6100	vpd
Percentage of heavy vehicles (roughly)	25	%
Speed limit	90	km/h
Carriageway width (roughly)	4.1x2	m
Shoulder width (roughly)	2x3	m
Pedestrian path	The path near the bus stop is under design, width 1.5m, length 75m (km1393+826-km1393+901)	m
Pavement	Asphalt concrete	
Horizontal and vertical alignment	Horizontal curve	
Pedestrians	no	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	7.3,6.13,3.20,2.3.2,1.22,5.16,5.19	
Other	Long curve provokes drivers to overtaking, which sometimes results in collision with the opposite lane vehicle. Km 1393+975 “Tri ruchya” T-junction with pedestrian paths, which are under design	

Initial proposed measures

Renewing all horizontal and vertical road **markings**, L
Installment of a **“dangerous road section”** –sign, L
Install a unit of three cross sectional **rumble strips** on the asphalt in entries of the dangerous section, L
Install **rumble strips** (audio marking) parallel to centre line and both edge lines sink into asphalt, L

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 250.000 RUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	90.000
Installment of a **“dangerous road section”** –signs, 2	45.000
Install a unit of three cross sectional **rumble strips** in entries of the section	22.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane	13,7 M
Low cost package	250.000

Proposed measure in the black section in the low cost package (rumble strip parallel to edge line).

Proposed measure in the black section, high cost package.

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**250.000 RUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from linear rumble strips)
Impact without the measure, annually	0 killed
	3,58 injured
Forecasted annual impact with the measure, less	**0 killed** (MRUR)
	1,1 injured (2.7 MRUR)
Annual economic savings of the society	**2,7 MRUR**
Annual loss of time	**non**
Paying-pack period	(0.25/2,7) x 12 = **1 month**

Package of high-cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80% (30% low pack, 50% mid-barrier)**
Impact without the measure, annually	0 killed
	3.58 injured
Forecasted annual impact with the measure, less	**killed** (MRUR)
	2.9 injured (7 MRUR)
Annual economic savings of the society	**7 MRUR**
Annual loss of time	**non**
Paying-pack period	(14/7)x12 months = **24 months**

4. M18 1394+250 – 1394+500

Detailed analysis on the “black spot”

Fatal and injury accidents 1/2004-9/2008	4
In these:	
Persons killed	3 (0,63 annually)
Persons injured	6 (1.26 annually)
Accidents costs to the society, mln.RUR	8.88 annually
In darkness (or bad visibility)	75%
In Winter period:	75% (1.10-30.4.)
Special characteristics of accidents:	75% head-on collisions 25% driving on pedestrian
Safety rule violation:	05,06,07,14,32,42
Road factor during the accidents:	Poor shoulder condition, ascending section, steep turn, low skid resistance

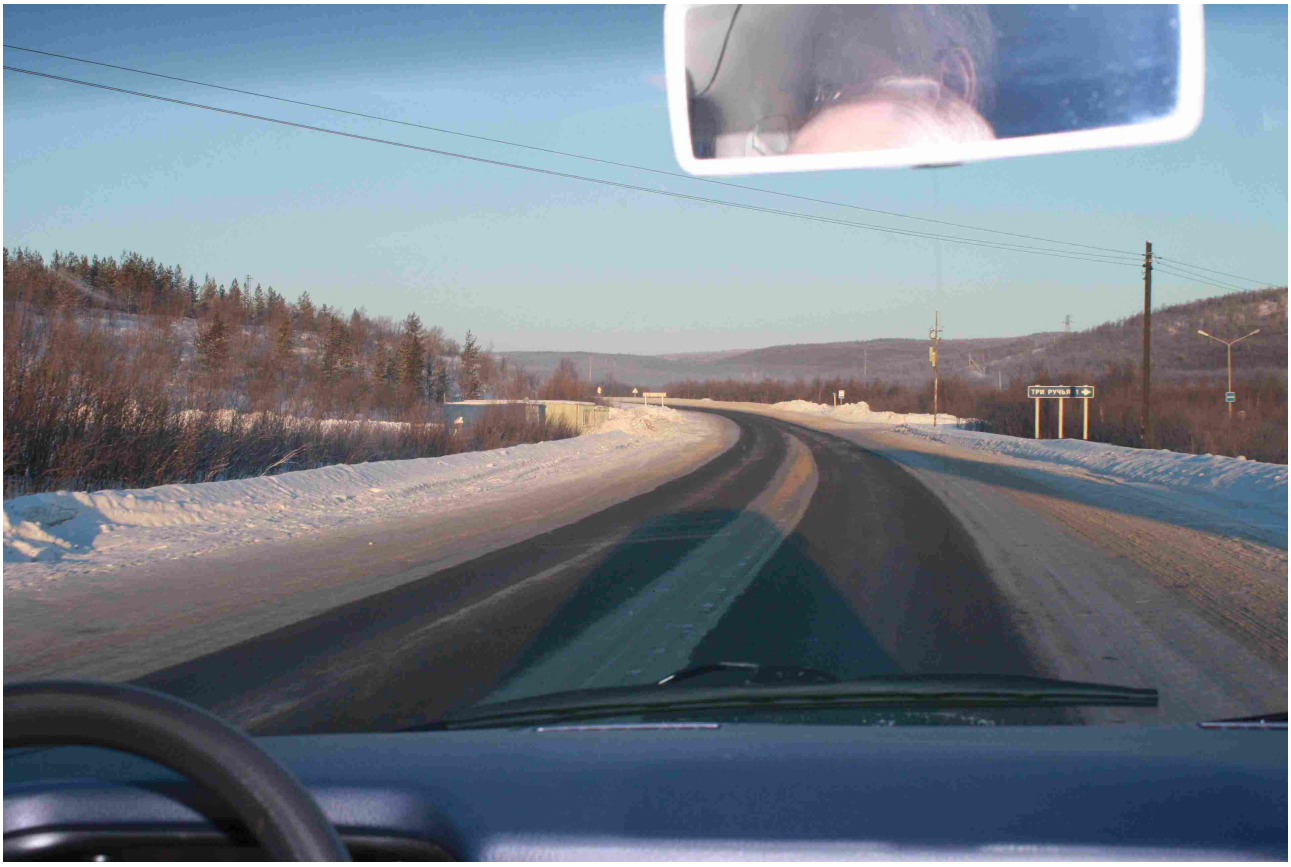
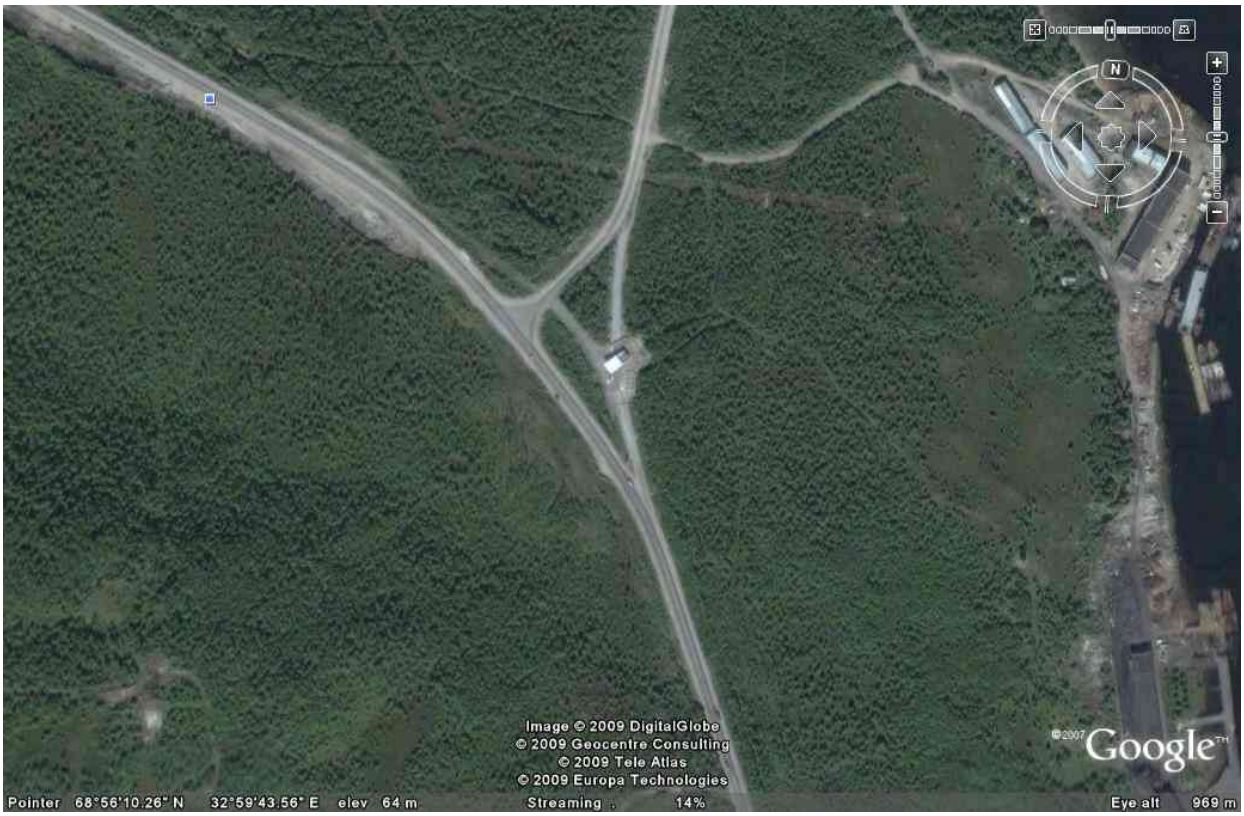


Photo from the black section



Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	5200	vpd
Percentage of heavy vehicles (roughly)	37	%
Speed limit	90	km/h
Carriageway width (roughly)	4.1x2	m
Shoulder width (roughly)	3,1x2	m
Pedestrian path	No	m
Pavement	Asphalt concrete	
Horizontal and vertical alignment	Horizontal curve	
Pedestrians	yes	
Bicyclists	No	
Traffic lights	No	
Road lighting	No	
Road signing	6.13,2.3.3,7.3,3.20,	
Other	Straight section, then steep curve plus overtaking results in collisions	

Initial proposed measures

Renewing all horizontal and vertical road **markings**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** on the asphalt in entries of the junction, L
Installment of **60 km/h speed limit**, L

Installing of **road lighting** for 0,5 km length, M

Constructing a long traffic separation **islands** to enable safely left turning, M

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.2 MRUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	90.000
Installment of a **"dangerous road section"** –signs, 2	45.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	22.000
Installment of **60 km/h speed limit**	45.000

Mid cost measure package 1, 0.7 MRUR

Measure	**MRUR**
Installing of **road lighting** for 0,5 km length (made by wooden poles and air cable decreasing the costs down to 1 MRUR per km, 20 poles a 54.000 RUR	0,5
Low cost package	0.2

Mid cost measure package 2, 2.3 MRUR

Measure	**MRUR**
Constructing a long traffic separation **islands** on he main road to enable safely left turning and small mid island to the accessing road	2.1 M
Low cost package	0.2

Proposed measure in the black section, mid-islands

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.2 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0.63 killed
	1.26 injured
Forecasted annual impact with the measure, less	**0.2 killed** (1,8MRUR)
	0.4 injured (1.0 MRUR)
Annual economic savings of the society	**2.8 MRUR**
Annual loss of time 5.200 veh./24h. x 365 days x 2 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.2 MRUR**
Paying-pack period	(0.2/2.8-0.2)x12 = **1 month**

Package 1 of mid-cost measures (road lights)	**0.7 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80% (30% for low package and 50% for road lights)**

Impact without the measure, annually	0.63 killed
	1.26 injured
Forecasted annual impact with the measure, less	**0.5 killed** (4.8 MRUR)
	1.0 injured (2.5 MRUR)
Annual economic savings of the society	**7.3 MRUR**
Annual loss of time 5.200 veh./24h. x 365 days x 2 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.2MRUR**
Paying-pack period	(0.7/7.3-0.2)x12 months = **1 month**

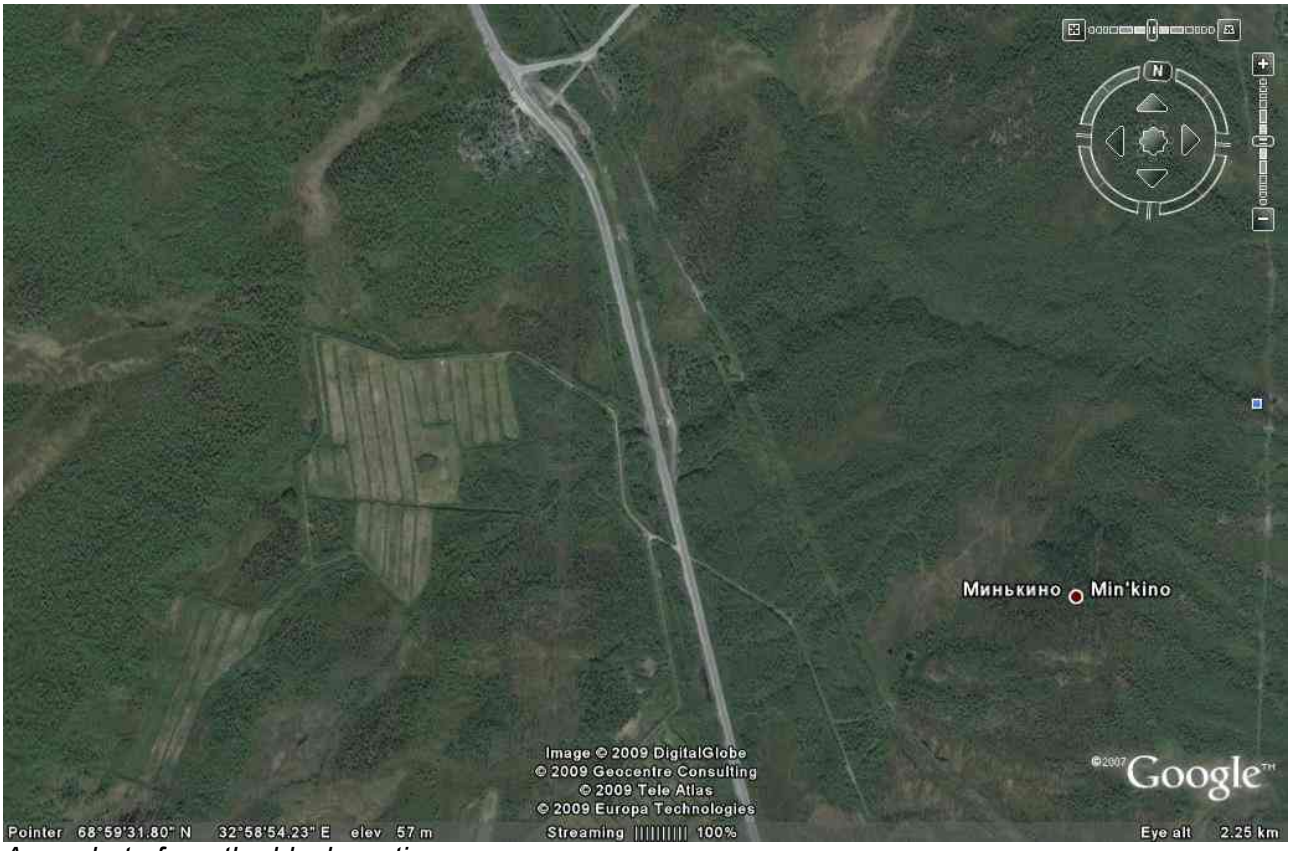
Package 2 of mid-cost measures (mid-island)	**2.2 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-45%**
Impact without the measure, annually	0.63 killed
	1.26 injured
Forecasted annual impact with the measure, less	**0.28 killed** (2.7 MRUR)
	0.57injured (1,4 MRUR)
Annual economic savings of the society	**4.1 MRUR**
Annual loss of time 5.200 veh./24h. x 365 days x 2 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	0.2 MRUR
Paying-pack period	(2.2/4.1-0.2)x12 months = **7 months**

5. M18 1399+800 – 1400+350

Detailed analysis on the "black section"

Fatal and injury accidents 1/2004-9/2008	3
In these:	
Persons killed	0 (0 annually)
Persons injured	4 (2 annually)
Accidents costs to the society, mln. RUR	4.8 annually
In darkness (or bad visibility)	30%
In Winter period:	0% (1.10-30.4.)
Special characteristics of accidents:	33% head-on collisions 67% driving off the road
Safety rule violation:	04,05,06
Road factor during the accidents:	Low skid resistance, descending access section to Abramov-mys, poor visibility

Photo from the black section



Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	5200	vpd
Percentage of heavy vehicles	37	%

(roughly)		
Speed limit	90	km/h
Carriageway width (roughly)	4.1x2 after Abram-Mys junction section where (3.5m+speeding lane 3.5m)x2	m
Shoulder width (roughly)	3.1x2	m
Pedestrian path	no	m
Pavement	Asphalt concrete	
Horizontal and vertical alignment	Descending and ascending section	
Pedestrians	no	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	5.15.5,3.20,6.13,	
Other	Road narrowing after Abram Mys bus stop infrastructure. Poor visibility of the lowest point of the vertical curve.	

Initial proposed measures

Renewing all horizontal and vertical road **markings**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** on the asphalt in entries of the dangerous section, L
Install **rumble strips** (audio marking) parallel to centre line and both edge lines sink into asphalt, L

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 250.000 RUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	90.000
Installment of a **"dangerous road section"** –signs, 2	45.000
Install a unit of three cross sectional **rumble strips** in entries of the section	22.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.25**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from rumble strips)
Impact without the measure, annually	0 killed
	0.63 injured
Forecasted annual impact with the measure, less	**0 killed** (E)
	0.19 injured (0.5 MRUR)
Annual economic savings of the society	**0.5 MRUR**
Annual loss of time	**non**
Paying-pack period	(0.25/0,5)x12 = **6 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0 killed
	0.63 injured
Forecasted annual impact with the measure, less	**0 killed** (E)
	0.5 injured (1.2 MRUR)
Annual economic savings of the society	**1.2 MRUR**
Annual loss of time	**no**
Paying-pack period	(14/1.2)x12 months = **12 years**

6. M18 1414+050 – 1414+650

Detailed analysis on the "black spot"

Fatal and injury accidents 1/2006-12/2008	4
In these:	
Persons killed	0 (0 annually)
Persons injured	8 (2,67 annually)
Accidents costs to the society, mln. RUR	6.41 annually
In darkness (or bad visibility)	50%
In Winter period:	100% (1.10-30.4.)
Special characteristics of accidents:	75% head-on collisions 25% driving off the road
Safety rule violation:	06,14
Road factor during the accidents:	Obstacle on the shoulder, poor visibility

Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	3100	vpd
Percentage of heavy vehicles (roughly)	37	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5x2	m
Shoulder width (roughly)	4.6x2	m
Pedestrian path	no	m
Pavement	Asphalt concrete	
Horizontal and vertical alignment	Horizontal curve	
Pedestrians	no	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	+	
Other	Rest area for vehicles available	

Infrastructure development on the spot

- Road marking is made. In 2008 road signs with high-reflector properties were installed. Repair works on the section were made. The number of road accidents is the same as before.

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of a **"dangerous road section"** –sign, L
Installment of **60 km/h speed limit**, L
Install a unit of three cross sectional **rumble strips** on the asphalt in entries of the dangerous section, L
Install **rumble strips** (audio marking) parallel to centre line and both edge lines sink into asphalt, L

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.3 MRUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	90.000
Installment of a **"dangerous road section"** –signs, 2	45.000
Installment of **60 km/h speed limit -** signs, 2	45.000
Install a unit of three cross sectional **rumble strips** in entries of the section	22.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

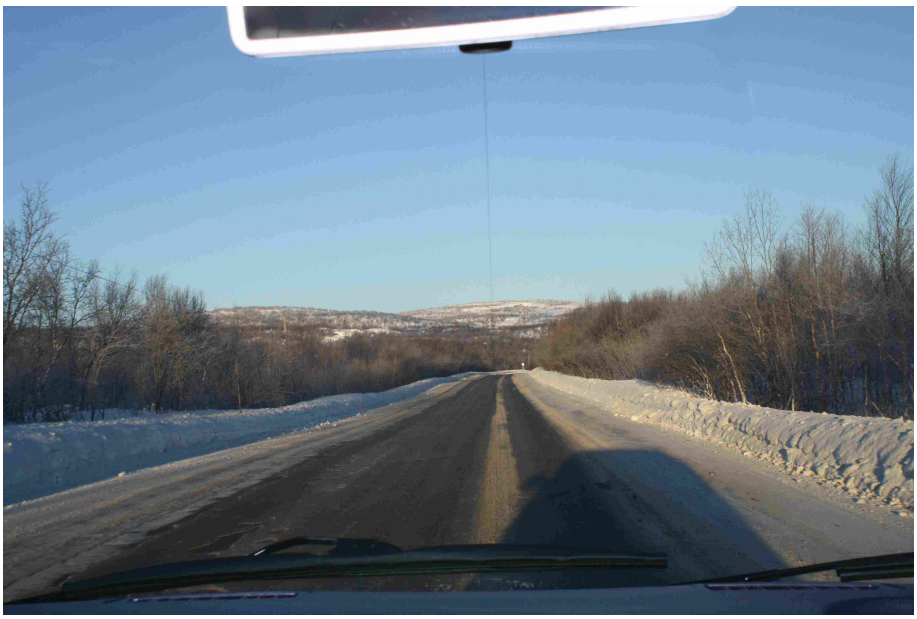
Package of low-cost measures	**0.3**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed limit and rumble strips)
Impact without the measure, annually	0 killed
	2.67 injured
Forecasted annual impact with the measure, less	**0 killed** (E)
	0.8 injured (1.9 MRUR)
Annual economic savings of the society	**1.9 MRUR**
Annual loss of time 3100 veh./24h. x 365 days x 4 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.25 MRUR**
Paying-pack period	(0.3/1.9 – 0.25)x12 = **2 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0 killed
	2.67 injured
Forecasted annual impact with the measure, less	**0 killed** (E)
	2.1 injured (5.2 MRUR)
Annual economic savings of the society	**5.2 MRUR**
Annual loss of time 3100 veh./24h. x 365 days x 4 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.25 MRUR**
Paying-pack period	(14/5.2 – 0.25)x12 months = **2,5 years**

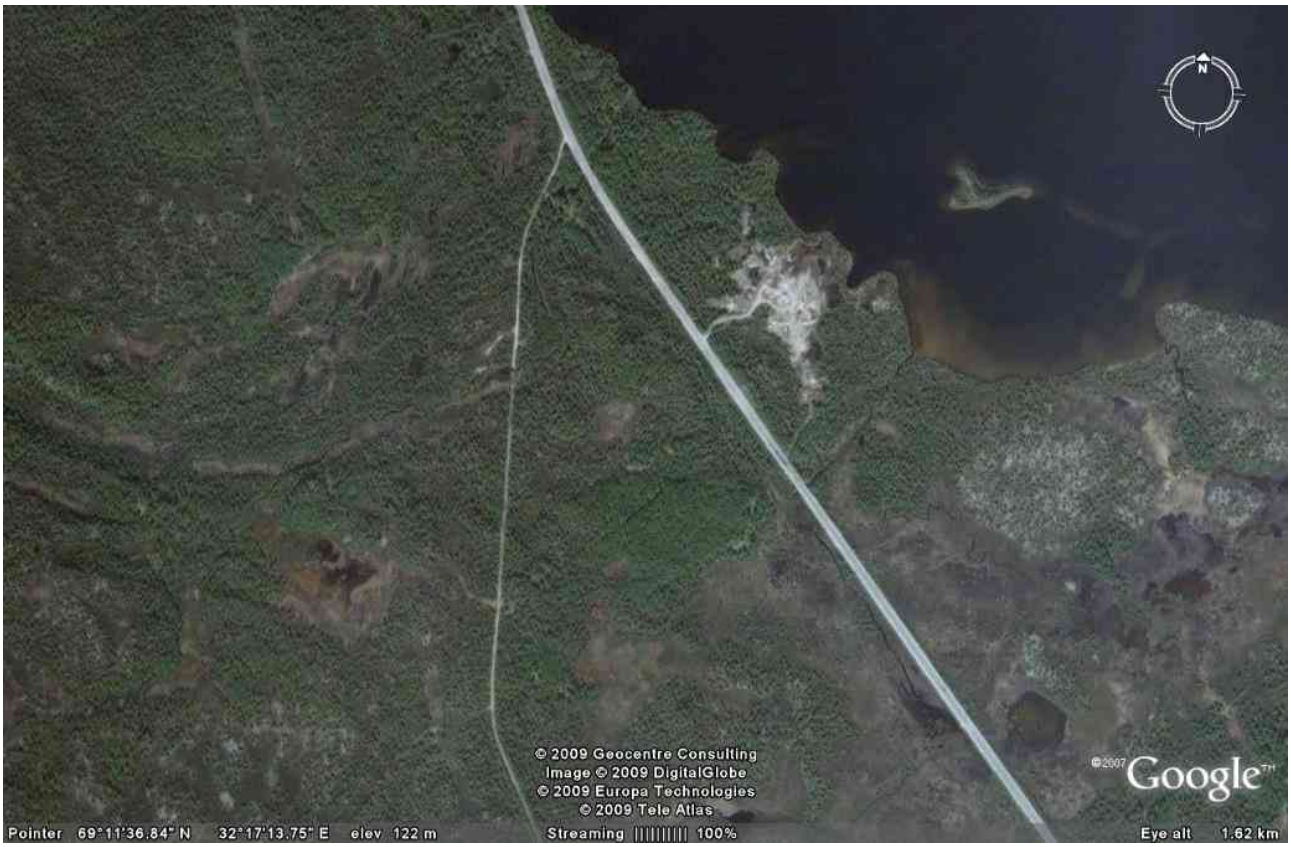
7. M18 1440+007 – 1440+700

Detailed analysis on the “black section”

Fatal and injury accidents 1/2006-12/2008	5
In these:	
Persons killed	7 (2.33 annually)
Persons injured	7 (2.33 annually)
Accidents costs to the society, mln. RUR	27.26 annually
In darkness (or bad visibility)	%
In Winter period:	% (1.10-30.4.)
Special characteristics of accidents:	80% head-on collisions 20% driving off the road
Safety rule violation:	
Road factor during the accidents:	Changes in vertical alignment, poor visibility



Photos from the black section



Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	1400	vpd
Percentage of heavy vehicles (roughly)	37	%
Speed limit	90	km/h
Carriageway width (roughly)	3.25x2	m
Shoulder width (roughly)	3.65x2	m
Pedestrian path	no	m
Pavement	Asphalt concrete	
Horizontal and vertical alignment	Ascending and descending sections changing one another	
Pedestrians	yes	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	1.14,3.20 (km1440+370-1440+570),6.13,	
Other	Poor visibility	

Infrastructure development on the spot

- In 2008 road signs with high-reflective properties were installed. The section was repaired.
- Road marking is planned to be done in next 3 years plan.

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of a **"dangerous road section"** –sign, L
Installment of **60 km/h speed limit**, L
Install a unit of three cross sectional **rumble strips** on the asphalt in entries of the dangerous section, L
Install **rumble strips** (audio marking) parallel to centre line and both edge lines sink into asphalt, L

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.3 MRUR

Measure	RUR
Renewing all horizontal and vertical road markings	90.000
Installment of a "dangerous road section" –signs, 2	45.000
Installment of 60 km/h speed limit - signs, 2	45.000
Install a unit of three cross sectional rumble strips in entries of the section	22.000
Install rumble strips parallel to centre line and both edge lines sink into asphalt	90.000

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.3**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from rumble strips and speed limit)
Impact without the measure, annually	2,33 killed
	2.33 injured
Forecasted annual impact with the measure, less	**0.7 killed** (6.7 MRUR
	0.7 injured (1.7 MRUR)
Annual economic savings of the society	**9.4 MRUR**
Annual loss of time 1400 veh./24h. x 365 days x 10 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.25**
Paying-pack period	(0.3/9.4 – 0.25)x12 = **0,5 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	2.33 killed
	2.33 injured
Forecasted annual impact with the measure, less	**1.9 killed** (18MRUR)
	1.9 injured (4.6 MRUR)
Annual economic savings of the society	**22.6 MRUR**
Annual loss of time 1400 veh./24h. x 365 days x 10 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.25**
Paying-pack period	(14/22.6 – 0.25)x12 months = **7 months**

8. M18 1497+929 – 1498+200

Detailed analysis on the “black spot”

Fatal and injury accidents 1/2004-9/2008	3
In these:	
Persons killed	1 (0,21 annually)
Persons injured	5 (1.05 annually)
Accidents costs to the society, mln. RUR	4.47 annually
In darkness (or bad visibility)	100 %
In Winter period:	33% (1.10-30.4.)
Special characteristics of accidents:	33% head-on collisions 33% obstacle accident 33% no accident type registered
Safety rule violation:	02,05,06
Road factor during the accidents:	Curvy road, ascending section, poor visibility

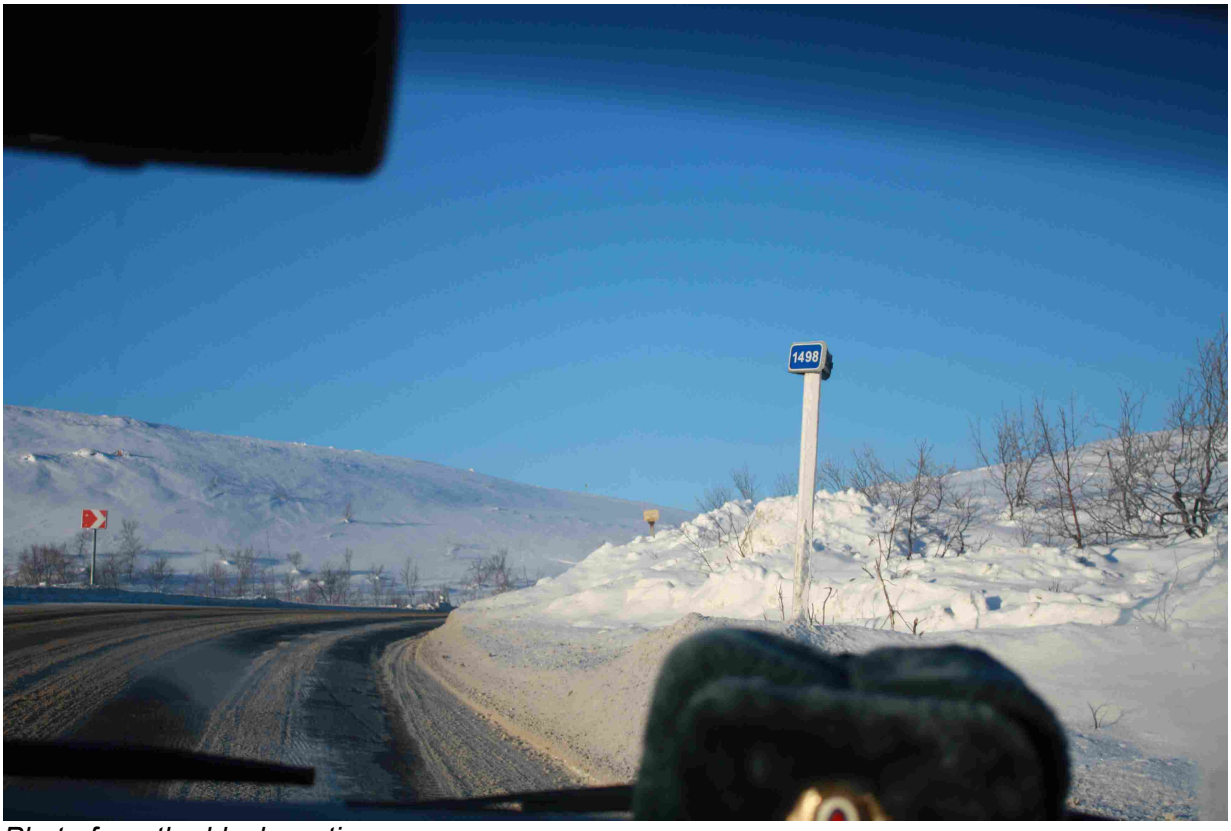
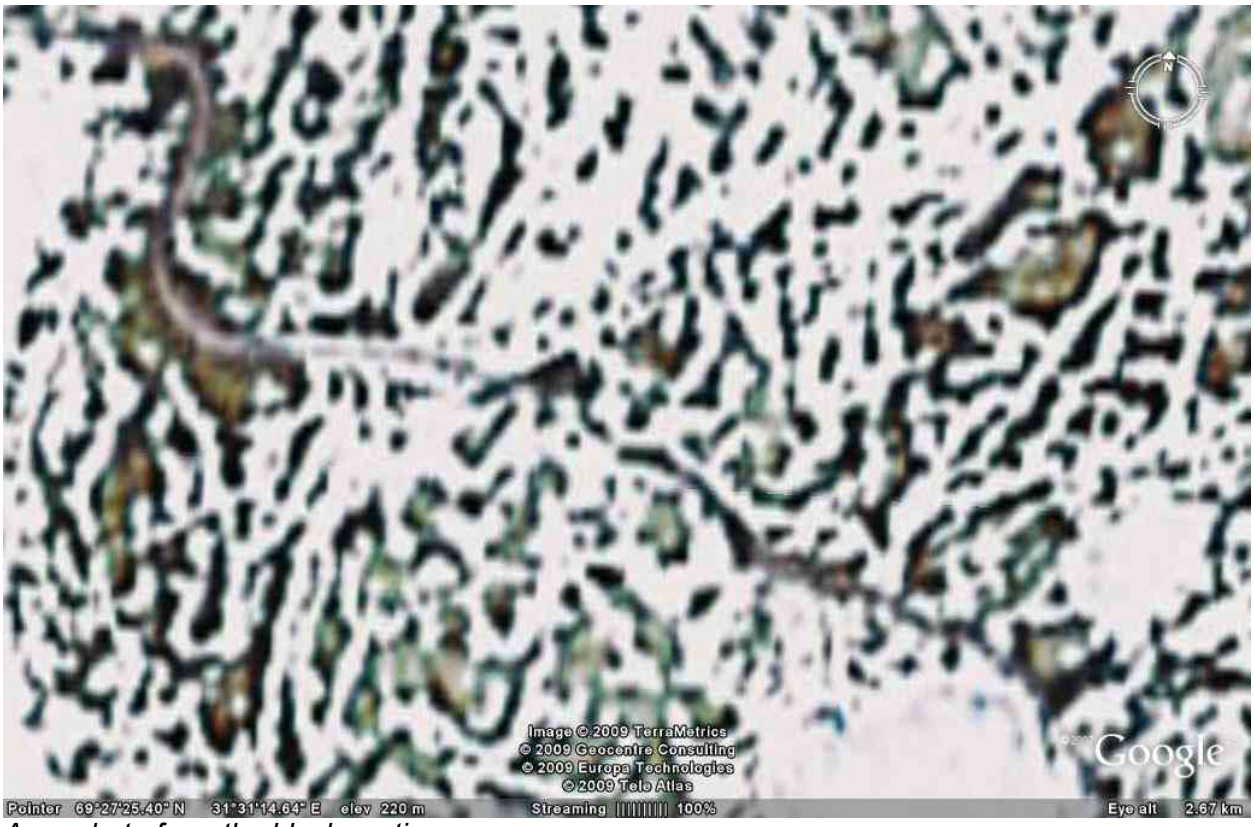


Photo from the black section



Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	750	vpd
Percentage of heavy vehicles (roughly)	38	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5x2	m
Shoulder width (roughly)	2,0x2	m
Pedestrian path	no	m
Pavement	Asphalt concrete	
Horizontal and vertical alignment	Ascending section, 2 horizontal curves	
Pedestrians	no	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	1.12,6.13,3.20	
Other		

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of a **"dangerous road section"** –sign, L
Installment of **60 km/h speed limit**, L
Install a unit of three cross sectional **rumble strips** on the asphalt in entries of the dangerous section, L
Install **rumble strips** (audio marking) parallel to centre line and both edge lines sink into asphalt, L

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.3 MRUR

Measure	RUR
Renewing all horizontal and vertical road markings	90.000
Installment of a “dangerous road section” –signs, 2	45.000
Installment of 60 km/h speed limit - signs, 2	45.000
Install a unit of three cross sectional rumble strips in entries of the section	22.000
Install rumble strips parallel to centre line and both edge lines sink into asphalt	90.000

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.3**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from rumble strips and speed limit)
Impact without the measure, annually	0,21 killed
	1.05 injured
Forecasted annual impact with the measure, less	**0.06 killed** (0.6 MRUR
	0.3 injured (0.8 MRUR)
Annual economic savings of the society	**1.4 MRUR**
Annual loss of time 750 veh./24h. x 365 days x 10 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.1**
Paying-pack period	(0.3/1.4 - 0.1)x12 = **3 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0,21 killed
	1.05 injured
Forecasted annual impact with the measure, less	**0.17 killed** (1.6MRUR)
	1.9 injured (2.0 MRUR)
Annual economic savings of the society	**3.6 MRUR**
Annual loss of time 750 veh./24h. x 365 days x 10 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.1**
Paying-pack period	(14/3.6 – 0.1)x12 months = **4 years**

9. M18 1534+043 – 1534+470

Detailed analysis on the “black spot”

Fatal and injury accidents 1/2006-12/2008	4
In these:	
Persons killed	0 (0 annually)
Persons injured	8 (2.67 annually)
Accidents costs to the society, mln. RUR	6.41 annually
In darkness (or bad visibility)	50 %
In Winter period:	50 % (1.10-30.4.)
Special characteristics of accidents:	50% head-on collisions

	50% driving off the road
Safety rule violation:	06,11,28,43,54,55
Road factor during the accidents:	Steep descent, curvy road, poor road marking

Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	1400	vpd
Percentage of heavy vehicles (roughly)	31	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	4.4 x 2	m
Pedestrian path	no	m
Pavement	Asphalt concrete, numerous pavement defects	
Horizontal and vertical alignment	vertical small and horizontal big radius curve	
Pedestrians	no	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	+	
Other		

Infrastructure development on the spot

- In 2008 road signs with high-reflective properties were installed.
- The section was inserted in the Rehabilitation Plan 2010.
- Road marking is planned to be done.

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L

Installment of a **"dangerous road section"** –sign, L
Installment of **60 km/h speed limit**, L
Install a unit of three cross sectional **rumble strips** on the asphalt in entries of the dangerous section, L
Install **rumble strips** (audio marking) parallel to centre line and both edge lines sink into asphalt, L

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.3 MRUR

Measure	RUR
Renewing all horizontal and vertical road markings	90.000
Installment of a "dangerous road section" –signs, 2	45.000
Installment of 60 km/h speed limit - signs, 2	45.000
Install a unit of three cross sectional rumble strips in entries of the section	22.000
Install rumble strips parallel to centre line and both edge lines sink into asphalt	90.000

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.3**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from rumble strips and speed limit)
Impact without the measure, annually	0 killed
	2,67 injured
Forecasted annual impact with the measure, less	**killed**
	0.8 injured (1.9 MRUR)
Annual economic savings of the society	**1.9 MRUR**
Annual loss of time 1400 veh./24h. x 365 days x 10 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.25**
Paying-pack period	(0.3/1.9 - 0.25)x12 = **2 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0 killed
	2.67 injured
Forecasted annual impact with the measure, less	**killed** (MRUR)
	2.1 injured (5.1 MRUR)
Annual economic savings of the society	**5.1 MRUR**
Annual loss of time 1400 veh./24h. x 365 days x 10 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.25**
Paying-pack period	(14/5.1 – 0.25)x12 months = **3 years**

10. M18 1535+205 – 1535+935

Detailed analysis on the “black section”

Fatal and injury accidents 1/2006-12/2008	3
In these:	
Persons killed	1 (0.33 annually)
Persons injured	6 (2.00 annually)
Accidents costs to the society, mln. RUR	7.87 annually
In darkness (or bad visibility)	%
In Winter period:	% (1.10-30.4.)
Special characteristics of accidents:	67% head-on collisions 33% pedestrian accident
Safety rule violation:	
Road factor during the accidents:	Horizontal curve, 2 access roads, limited visibility

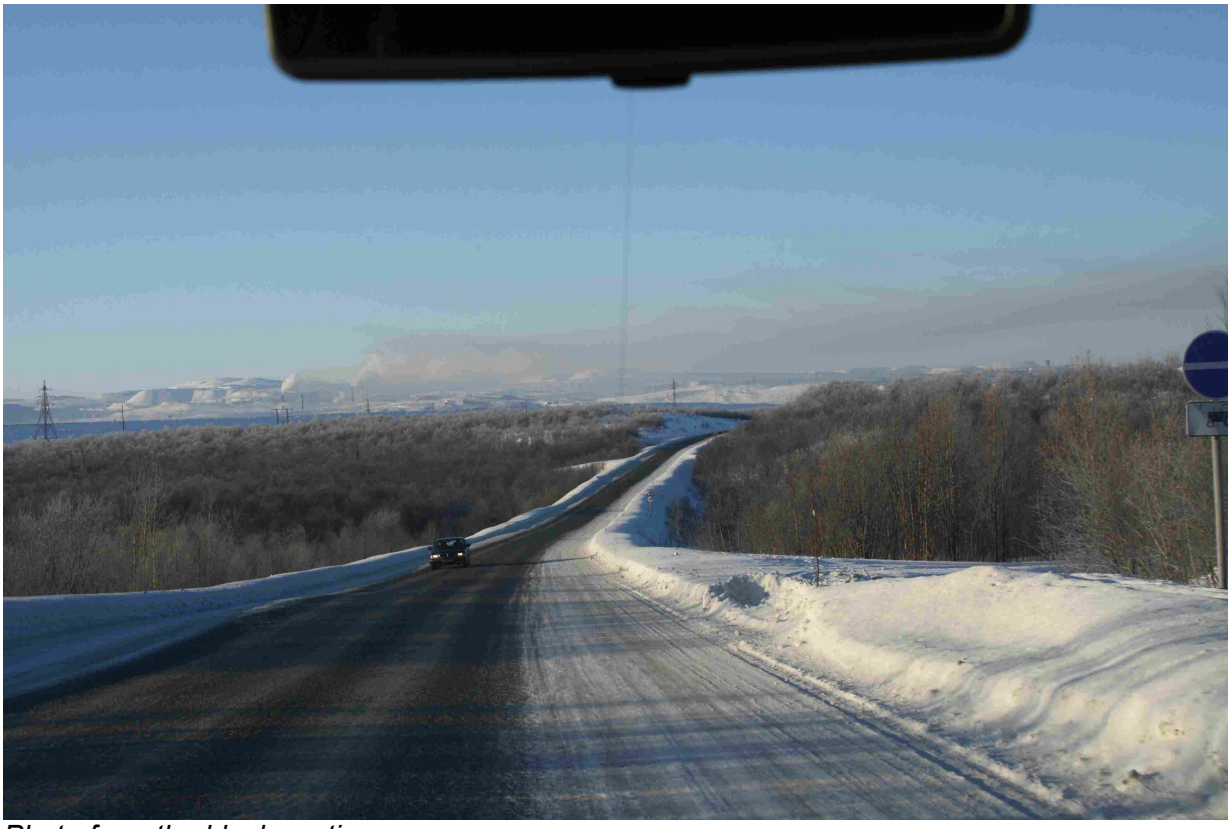


Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	1400	vpd
Percentage of heavy vehicles (roughly)	31	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	4,5 x 2	m
Pedestrian path	no	m
Pavement	Asphalt concrete, pavement defects	
Horizontal and vertical alignment	Horizontal curve (right turn), big radius	
Pedestrians	no	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	+	
Other	Commuting traffic between Zapolyarny and Sputnik	

Infrastructure development on the spot

- In 2008 road signs with high-reflective properties were installed.
- Road marking is to be done.
- The section is inserted into the Rehabilitation Plan 2010.

Initial proposed measures

Renewing all horizontal and vertical road **markings**, L
Installment of a **"dangerous road section"** –sign, L
Installment of **60 km/h speed limit**, L

Install a unit of three cross sectional **rumble strips** on the asphalt in entries of the dangerous section, L
Install **rumble strips** (audio marking) parallel to centre line and both edge lines sink into asphalt, L

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.3 MRUR

Measure	RUR
Renewing all horizontal and vertical road markings	90.000
Installment of a “dangerous road section” –signs, 2	45.000
Installment of 60 km/h speed limit - signs, 2	45.000
Install a unit of three cross sectional rumble strips in entries of the section	22.000
Install rumble strips parallel to centre line and both edge lines sink into asphalt	90.000

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.3**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from rumble strips and speed limit)
Impact without the measure, annually	0.33 killed
	2,00 injured
Forecasted annual impact with the measure, less	**0.1 killed** (1.0 MRUR)
	0.8 injured (1.5 MRUR)
Annual economic savings of the society	**2.5 MRUR**
Annual loss of time 1400 veh./24h. x 365 days x 10 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.25**
Paying-pack period	(0.3/2.5 - 0.25)x12 = **2 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0.33 killed
	2.00 injured
Forecasted annual impact with the measure, less	**0.26 killed** (2.5 MRUR)
	1.6 injured (3.9 MRUR)
Annual economic savings of the society	**6.4 MRUR**
Annual loss of time 1400 veh./24h. x 365 days x 10 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.25**
Paying-pack period	(14/6.4 – 0.25)x12 months = **2,3 years**

11. M18 1537+820 – 1538+550

Detailed analysis on the “black section”

Fatal and injury accidents 1/2004-9/2008	5
In these:	
Persons killed	0 (0 annually)

Persons injured	8 (1.68 annually)
Accidents costs to the society, mln. RUR	4.03 annually
In darkness (or bad visibility)	60%
In Winter period:	20% (1.10-30.4.)
Special characteristics of accidents:	100% head-on collisions
Safety rule violation:	05,06,07,10,11,43,54,55
Road factor during the accidents:	Access to Zapolyarny, horizontal section, ascending section

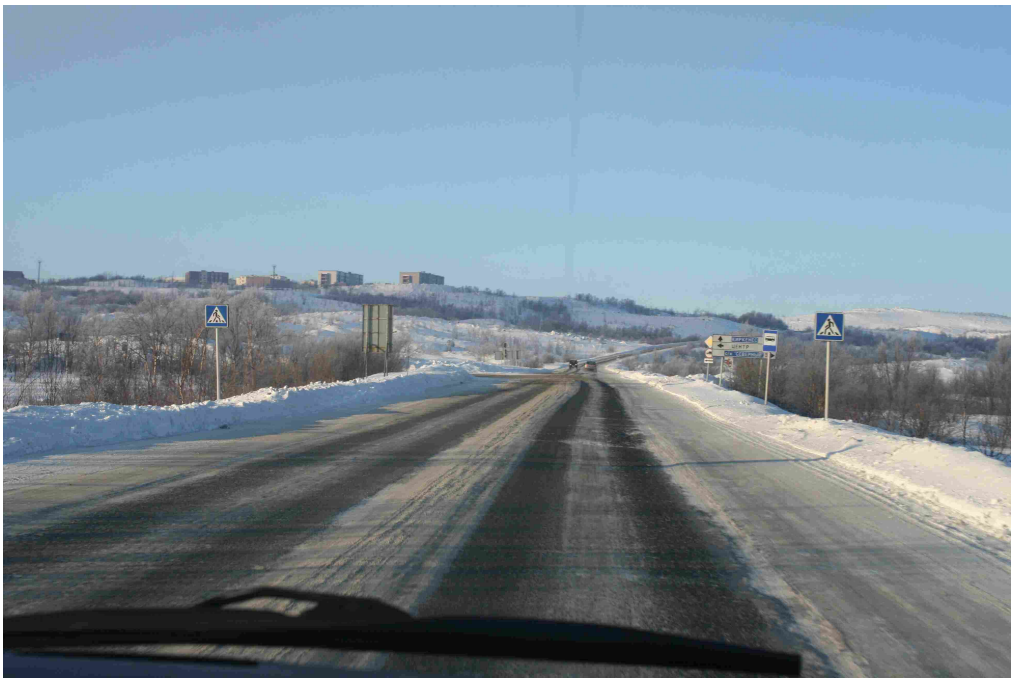


Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	1400	vpd
Percentage of heavy vehicles (roughly)	31	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	4.0 x 2	m
Pedestrian path	no	m
Pavement	Asphalt concrete	
Horizontal and vertical alignment	straight	
Pedestrians	yes	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	+	
Other	High traffic volumes, heavy vehicles, buses, commuting traffic	

Renewing all horizontal and vertical road **markings**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** on the asphalt in entries of the junction, L
Installment of **60 km/h speed limit**, L

Installing of **road lighting** for 0,5 km length, M

Constructing a long traffic separation **islands** to enable safely left turning, M

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.2 MRUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	90.000
Installment of a **"dangerous road section"** –signs, 2	45.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	22.000
Installment of **60 km/h speed limit**	45.000

Mid cost measure package 1, 0.7 MRUR

Measure	**MRUR**
Installing of **road lighting** for 0,5 km length (made by wooden poles and air cable decreasing the costs down to 1 MRUR per km, 20 poles a 54.000 RUR	0,5
Low cost package	0.2

Mid cost measure package 2, 2.3 MRUR

Measure	**MRUR**
Constructing a long traffic separation **islands** on he main road to enable safely left turning and small mid island to the accessing road	2.1 M
Low cost package	0.2

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane	13,7 M
Low cost package	250.000

Proposed measure in the black section, mid-islands

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.2 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0 killed
	1.68njured
Forecasted annual impact with the measure, less	**0 killed**
	0.5 injured (1.2 MRUR)
Annual economic savings of the society	**1.2 MRUR**
Annual loss of time 1.400 veh./24h. x 365 days x 4 (100	**0.1 MRUR**

м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	
Paying-pack period	(0.2/1.2-0.1)x12 = **2 months**

Package 1 of mid-cost measures (road lights)	**0.7 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%** (30% for low package and 50% for road lights)
Impact without the measure, annually	0 killed
	1.68jured
Forecasted annual impact with the measure, less	**0 killed**
	1.3 injured (3.3 MRUR)
Annual economic savings of the society	**3.3 MRUR**
Annual loss of time 1.400 veh./24h. x 365 days x 4 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.1 MRUR**
Paying-pack period	(0.7/3.3-0.1)x12 months = **3 months**

Package 2 of mid-cost measures (mid-island)	**2.2 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-45%** (30% for low package and 15% for mid islands)
Impact without the measure, annually	0 killed
	1.68njured
Forecasted annual impact with the measure, less	**0 killed**
	0.8 injured (1,9 MRUR)
Annual economic savings of the society	**1.9 MRUR**
Annual loss of time 1.400 veh./24h. x 365 days x 4 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.1 MRUR**
Paying-pack period	(2.2/3.9-0.1)x12 months = **7 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0 killed
	2.00 injured
Forecasted annual impact with the measure, less	**0 killed** (MRUR)
	1.68 injured (4 MRUR)
Annual economic savings of the society	**4 MRUR**
Annual loss of time 1400 veh./24h. x 365 days x 10 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0.25**
Paying-pack period	(14/4 – 0.25)x12 months = **3.8 years**

Summary of costs and expected impacts of proposed black spot measures

Low cost measures (0…300.000 RUR) on BLACK SECTIONS

Road markings, warning signs, rumble strips in start of the section or junction, in most of the spots the speed limit 60km/h or even 40 km/h and linear rumbles strips (audio marking)

Black Spot Address KM	Implementation cost (Million RUR)	Forecasted amount of fatalities less annually*)	Forecasted amount of Injuries less annually*)	Saving for the society annually (MRUR)**)	Paying back period (Months)
1. 1381+140 – 1381+420	0.22 (incl 60km/h)	0	0.5	0.95	3
2. 1386+066 – 1386+970	0.22 (incl 40km/h)	0.1	0.9	2.9	1
3. 1393+000 – 1393+934	0.2 (incl audio marking)	0	1.1	2.7	1
4. 1394+250 – 1394+500	0.2 (incl 60km/h)	0.2	0.4	2.6	1
5. 1399+800 – 1400+350	0.25 (incl audio marking)	0	0.19	0.5	6
6. 1414+050 – 1414+650	0.3 (incl 60km/h)	0	0.8	1.6	2
7. 1440+007 – 1440+700	0.3 (incl 60km/h)	0.7	0.7	9.1	0.5
8. 1497+929 – 1498+200	0.3 (incl 60km/h)	0.1	0.3	1.3	3
9. 1534+043 – 1534+470	0.3 (incl 60km/h)	0	0.8	1.6	2
10. 1535+205 – 1535+935	0.3 (incl 60km/h)	0.1	0.8	2.2	2
11. 1537+820 – 1538+550	0.2 (incl 60km/h)	0	1.5	1.1	2
Total	**2.8 million RUR**	**1.2**	**8.0**	**26.7**	**2 Month**

*) based on the before-after studies in similar climate conditions at Nordic Countries.

**)
The Russian method is based on unit costs adapted from the “Methodology of assessment of normative socio-economic accident costs R-03112199-0502-00”, which is developed by Scientific Research Institute of Motor transport (NIIAT) for the Russian Ministry of Transport.

Mid cost measures (300.000 RUR … 1.500.000) on BLACK SECTIONS

Road lights, roundabout, mid-islands (plus low cost package)

Black Spot Address KM	Implementation cost (Million RUR)	Forecasted amount of fatalities less annually*)	Forecasted amount of Injuries less annually*)	Saving for the society annually (MRUR)**)	Paying back period (Months)
1. 1381+140 – 1381+420	2.4 (roundabout)	0	1.17	2.5	11
2. 1386+066 – 1386+970	0.55 (road lights impr.)	0.15	1.35	4.4	1.5
3. 1393+000 – 1393+934	non				
4. 1394+250 – 1394+500	0.7 (road lights constr.)	0.5	1.0	7.1	1
4. 1394+250 – 1394+500	2.2 (incl. mid-island)	0.28	0.57	3.9	7
5. 1399+800 – 1400+350	non				
6. 1414+050 – 1414+650	non				
7. 1440+007 – 1440+700	non				
8. 1497+929 – 1498+200	non				
9. 1534+043 – 1534+470	non				
10. 1535+205 – 1535+935	non				
11. 1537+820 – 1538+550	0.7 (road lights constr.)	0	1.3	3.2	3
11. 1537+820 – 1538+550	2.2 (mid-island)	0	0.8	3.8	7
Total	**8.8 million RUR**	**0.93**	**6.2**	**25**	**4 Month**

High cost measures (over 1 .5 MRUR) on BLACK SECTIONS

Road crash barrier and additional lane (plus low cost package)

Black Spot Address KM	Implementation cost (Million RUR)	Forecasted amount of fatalities less annually*)	Forecasted amount of Injuries less annually*)	Saving for the society annually (MRUR)**)	Paying back period (Years)
1. 1381+140 – 1381+420	non				
2. 1386+066 – 1386+970	non				
3. 1393+000 – 1393+934	14	0	2.9	7	2
4. 1394+250 – 1394+500	non				
5. 1399+800 – 1400+350	14	0	0.5	1.2	12
6. 1414+050 – 1414+650	14	0	2.1	4.9	2.5
7. 1440+007 – 1440+700	14	1.9	1.9	22.3	0.6
8. 1497+929 – 1498+200	14	0.17	1.9	3.5	4
9. 1534+043 – 1534+470	14	0	2.1	4.8	3
10. 1535+205 – 1535+935	14	0.26	1.6	6.1	2.3
11. 1537+820 – 1538+550	14	0	1.7	3.7	3.8

Total	**112**	**2.33**	**14.7**	**53.5**	**3.8**

Some explanations of method used in economic evaluation
ANNEX 1

The Russian method is based on "Methodology of assessment of normative socio-economic accident costs R-03112199-0502-00" is
developed by Scientific Research Institute of Motor transport (NIIAT) for the Russian Ministry of Transport, It is based on the following cost formation:

Fatality with a man having a family	7,329 MRUR	250,990 EUR
Fatality with a man having no family	6,930	237,330
Injure with disablement status (no possibilities for further work)	3,622	124,040
Injure with disablement status (with possibility for further work)	2,090	71,575
Injure without disablement status	0,039	1,335
Fatality with a child	8,411 MRUR	288,050 EUR

As there is no percentage of accident by above types we propose the following average normative costs

for fatalities **258,790 $, 212,000 EUR,** for the EUR –RUR rate 44,0 - **9.3 MRUR**
for injuries **65,650 $, 54,000 EUR,** for the EUR –RUR rate 44,0 - **2.4 MRUR**

Russian Rosavtodor is in process of issuing the traffic safety guidelines for the federal roads with **8.7 MRUR** fatality cost and **0.3 MRUR** injury cost. The latter is definitely too low and is recommended to be altered.

Some explanations of chosen economic assessment method

Time value

Because some of the measures, namely speed limits, decrease directly the trip time, we have decreased the effectiveness of that measure by assessing time losses. The values were counted for Scandinavia road E18 (Leningrad Region, 2004) and should be up-dated if used in detailed economy calculations:

Speed limits decrease from 90 km/h to 60 km/h lower the speed and add the trip time through those black spots, which 60 km/h limit has been proposed. We have counted that, when every vehicle will slow down the speed about 30 km/h in the length of the particular section, this makes a loss of 2 seconds for every vehicle per 100 metres. The annual loss depends on traffic volume in each section in concern. As there are no current Russian values of travel time available, we propose to use the values:

- 1,23 euros/hour for light vehicle and
- 2,97 euros/hour for buses and heavy vehicles

The values have been estimated by dividing the analogical values used in Finland by factor, when dividing Russian GDP to Finnish GDP. The Finnish time costs by vehicle hour are 11,1 Euros for light vehicles and 26,7 Euros for heavy vehicles. As the share between light vehicles and heavy vehicles are 60 % - 40 % in Scandinavia this make the time value losses equal to 1,23E x 60 % plus 2,97E x 40 %, which makes **1,93 Euro per vehicle hour**, We have used this value in calculations in this memo to assess time losses when proposing speed limit reductions.

Ignored things

In proposed method have been ignored some factors, which are typical for Western methods, like:

- Accidents with only material damage, because of small economic effect and vague statistics

- Vehicle costs (petrol, lubricant, tires etc,) do not differ between proposed variants
- Maintenance costs, which may be slightly increased, because some measure may increase manual work in street maintenance (e,g, snow removing near traffic islands)
- Pollution costs, which will be lower with lower speeds,
- Residual value, because of the short paying back periods
- Discounting, because of very short paying back periods (some months)
- Traffic growth, because is very short paying back periods

These ignoring make the proposed method rather simple to use. At the same time it gives quite good indication for assessing the effectiveness of the investment compared to other investments in the society and very good indication to compare traffic and transport investments among themselves.

Annex 4 Full traffic safety analysis on the pilot road section "Access to Murmansk from M18 road"

Polar Traffic Safety project 2007 - 2009

Statistic and expert analysis, proposed measures and economic evaluation of traffic accident concentration sections ("black spots") in the Murmansk federal by-pass road

Content of this memorandum:

1. General

This memorandum is based on statistics delivered by the Murmansk Regional Traffic Police (GIBDD) and the Federal road administration of M18 road (Uprdor "Kola") for the Access to Murmansk from M18 road.

In 2005, the Finnish Road Administration and Murmansk Region Road Administration made a black spot analysis of Murmansk by-pass road concentrating on 7 most dangerous junctions. Some of the drawings in this memo have been taken from that work.

As for the data we chose all the accidents that caused injuries and fatalities as they are more thoroughly registered in statistics. From the preliminary analysed material we have chosen 9 black spots from all filling the following criteria:

- 3 or more injury or fatality accidents in 5 years in maximum 1000 m section
- 2 injury or fatality accidents in 5 years in maximum 400 m section

The overall picture of the data in black sections is the following:

Fatality and injury accidents in black spots and their impacts 1/2004-9/2008 (GIBDD data, 4,75 years) and 1/2006-12/2008 (Uprdor Kola data, 3 years)

No of the	Location: Start point – end	Length of the	Statistics period	Number of fatal and	Number of killed	Number of	Accident costs.

"black section"	point	section m		injury accidents	people	injured people	mln.RUR annually
12.	1+000 – 1+550	550	4,75	6	1	8	5.98
13.	1+750 – 2+700	950	4,75	16	1	22	13.06
14.	4+100 – 5+000	900	3	4	0	5	4.01
15.	5+000 – 5+600	600	4,75	10	3	13	12.44
16.	7+150 – 8+000	850	3	4	0	4	3.19
17.	8+000 – 8+502	502	4,75	4	0	5	2.52
18.	9+080 – 9+500	420	3	4	0	5	4.01
19.	11+100 – 11+855	755	3	5	0	8	6.41
20.	14+000 – 14+451	451	4,75	4	0	4	2.02
	Total	**5978**		**57**	**5**	**74**	**53.64**

2. Executive summary and recommendations

The Polar Traffic Safety project among other things studied the accident concentrations in Murmansk by-pass federal road (about 14,5 km). Firstly, the project made a short statistic and expert analysis, which was based on all fatal and injury accidents recorded by GIBDD (4.5 years and the road owner, Kola federal road administration (3 years). Secondly, a multinational Russian- Swedish-Finnish group made a site visit to he problematic road and photographed it. Thirdly, the project proposed measures, estimate their impacts and assessed costs and benefits of proposed measures for 9 black sections as well as for the whole road.

In the whole 14.5 km road there were 68 fatal or injury accidents between 1.1.2006 and 30.4.2009 causing 6 deaths (1.8 deaths annually) and 95 injuries (28.5 injured annually). Bout 71% of the accidents were head-on-collisions (see table below).

1.1.2006 – 30.4. 2009 (3 years and 1/3 years)

Road accident type	Number of road accidents	Number of killed	Number of injured	Killed per year	Injured per year
Collision	**48**	**6**	**73**	**1.8**	**21.9**
Driving off the road	**9**		**11**		**3.3**
Driving on a parked/stopped vehicle					
Driving on an obstacle	**4**		**4**		**1.2**
Driving on pedestrian	**4**		**4**		**1.2**
Driving on a bicycle rider	**1**		**1**		**0.3**
Driving on an animal-drawn transport					
Falling of the passenger					
Other	**2**		**2**		**0.6**
Total	**68**	**6**	**95**	**1.8**	**28.5**

In 9 black sections representing about 6 km of he lengths of the road there occur 1.05 deaths annually and about 18 injured annually. The black sections represent about 63% of fatal and injury accidents in the whole 14.5 km road. (see table below).

No of the "black	Location: Start point – end point	Length of the sectio	Statistics period	Number of fatal and	Number of killed people	Number of injured	No of killed annually	No of injured annually

section”		n m		injury accidents		people		
1.	1+000 – 1+550	550	4,75	6	1	8	0.21	1.68
2.	1+750 – 2+700	950	4,75	16	1	22	0.21	4.63
3.	4+100 – 5+000	900	3	4	0	5		1.67
4.	5+000 – 5+600	600	4,75	10	3	13	0.63	2.74
5.	7+150 – 8+000	850	3	4	0	4		1.33
6.	8+000 – 8+502	502	4,75	4	0	5		1.05
7.	9+080 – 9+500	420	3	4	0	5		1.67
8.	**11+100–11+855**	755	3	5	0	8		2.67
9.	**14+000–14+451**	451	4,75	4	0	4		0.84
	Total	**5978**		**57**	**5**	**74**	**1.05**	**18.28**

The project assessed several levels of traffic safety measures to those spots and as well for the whole length of the road road. The impacts were taken mainly from the analogical measures implemented in Scandinavian countries as there are no long term study results of the measures in Russia. The accident costs were taken from the Russian “Methodology of assessment of normative socio-economic accident costs R-03112199-0502-00” developed by the Scientific Research Institute of Motor transport (NIIAT) for the Russian Ministry of Transport. As for the accident cost to society, was used 9.3 Million RUR for a lost life and 2.4 Million RUR for an injury.

The analyzed measures and prognosis of them to 9 black sections are the following:

- Small physical improvement (e.g. road markings, warning signs, rumble strips, speed limits) in 9 black spots with about 5 km of road would cost 2 million rubles and would save annually 0.3 lives and 5 injuries. The economic impact of the measures is rather high as the paying back period of investment is about 5 months. The measures are recommended.

- Road lights to all 9 black sections and roundabouts to some most dangerous junctions would cost 20 million rubles and would save annually 0.8 lives and 15 injuries. The economic impact of the measure is as well rather high as the paying back period of investment is about 8 months. The measures are recommended.

- If to construct crash barrier and additional lane to 9 black sections, it would cost 112 million rubles and would save annually 0.7 lives and 13 injuries. The economic impact of the measure is satisfactory as the paying back period of investment is about 8 years. The measures are not recommended to all black section. However, it is recommend to those 4 sections, where paying pack period is between 1.4 and 5 years.

The analyzed measures and prognosis of them to the whole 14.5 km road are the following:

- The speed limits of 60 km/h would cost 0.4 million rubles and would save annually 0.5 lives and 7 injuries. The economic impact of the measures is very high as the paying back period of investment is about 2.5 months. As the time cost losses are rather numerous, this measure is recommended to use targeted to few black sections together with other small supporting measures like renewing the road markings and installing of cross-sectional rumble strips and warning signs.

- Installing of (rumbling) audio marking parallel to centre line and both edge lines marked on the asphalt would cost 1.4 million rubles and would save annually 0.4 lives and 7 injuries. The economic impact of the measures is very high as the paying back period of investment is about 1 month. This measure is recommended as it is economically very feasible.

- Installing of the road lights to whole 14.5 km road would cost 14.5 million rubles and would save annually 0.7 lives and 10 injuries. The economic impact of the measures is high as the paying back period of investment is about 6 months. This measure is recommended as it is economically very feasible.

- Installing of the mid crash-barrier and additional lane to whole 14.5 km road would cost 200 million rubles and would save annually 2 lives and 22 injuries. The economic impact of the measures is rather high as the paying back period of investment is about 33 months. This measure is recommended in case the construction of 4-lane road or motorway would take another 5…10 years.

3. Analysis, proposals of measures, impacts and economic evaluation of 9 black sections

1 MURMANSK FEDERAL BY-PASS road 1+000 – 1+550

Detailed analysis on the "black section"

Fatal and injury accidents 1/2004-9/2008	6
In these:	
Persons killed	1 (0,21 annually)
Persons injured	8 (1.68 annually)
Accidents costs to the society [1], mln. RUR	5.98 annually
In darkness (or bad visibility)	67 %
In Winter period:	67% (1.10-30.4.)
Special characteristics of accidents:	17% driving on pedestrian 83% head-on collisions
Safety rule violation:	05,07,28
Road factor during the accidents:	Access to Kopytova St., right turn, horizontal section, bad visibility of traffic signs, insufficient road lighting

[1] The accident unit costs are counted based on the Russian method based on "Methodology of assessment of normative socio-economic accident costs R-03112199-0502-00" is developed by Scientific Research Institute of Motor transport (NIIAT) for the Russian Ministry of Transport (annex 1). The average costs used in this calculations are: 9.3 MRUR for fatalities and 2.4 MRUR for injuries. Russian Rosavtodor is in process of issuing the traffic safety guidelines for the federal roads. They propose 8.7 MRUR fatality cost and 0.3 MRUR injury cost. The latter is definitely too low and this is why in this study we decided to use the "older" values.

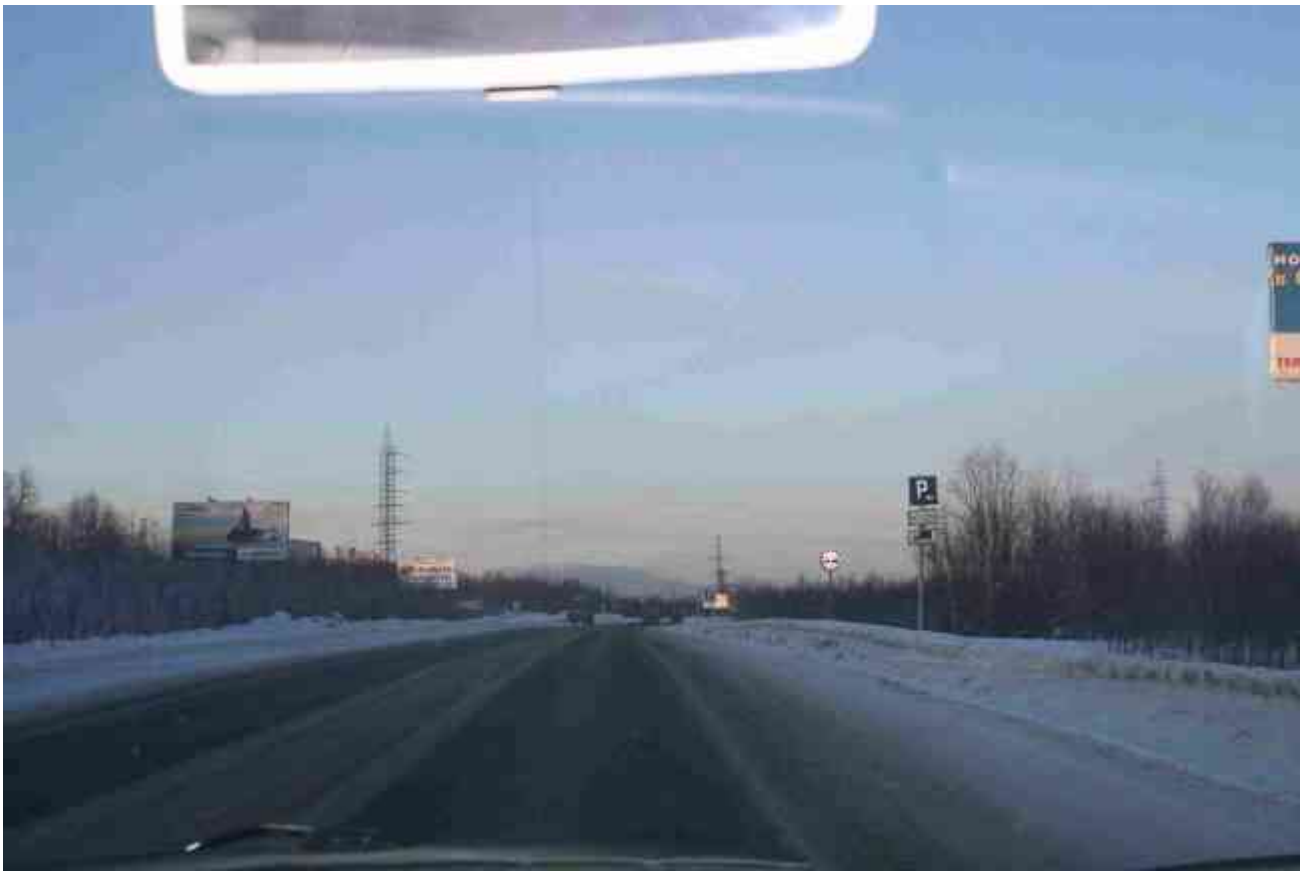


Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	7700	vpd
Percentage of heavy vehicles (roughly)	30	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	2.5 x 2	m
Pedestrian path	no	m
Pavement	Asphalt	
Horizontal and vertical alignment	Horizontal long curve	
Pedestrians	yes	
Bicyclists	yes	
Traffic lights	no	
Road lighting	no	
Road signing	+	
Other	Section includes a new X-junction to residential area on the city side and carrage area behind the by-pass road	

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of **60 km/h speed limit**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** in entries of the junctions, L
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt, L

Constructing a long traffic separation **islands** to enable safely left turning in two junctions and pedestrian crossings over by-pass road, M

Constructing a **roundabouts** in two junctions**,** M

Improving of **road lighting** for whole km length, M

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.22 MRUR

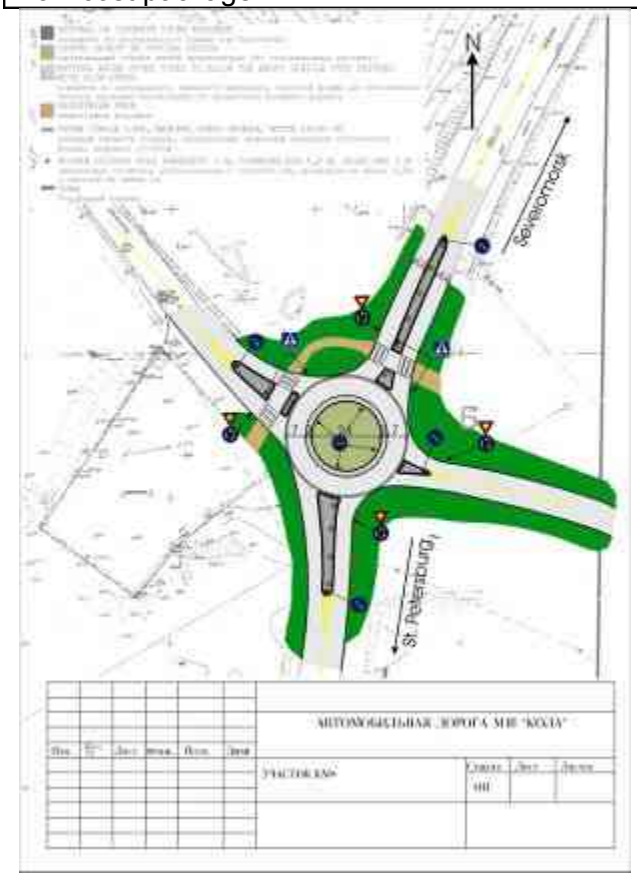
Measure	**RUR**
Renewing all horizontal and vertical road **markings**	55.000
Installment of **60 km/h speed limit** –signs, 2	25.000
Installment of a **"dangerous road section"** –signs, 2	25.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	25.000

Mid cost measure package 1, about 4.5 MRUR

Measure	**MRUR**
Constructing of a long traffic separation **islands** to enable safely left turning and small islands on the accessing roads to two intersections	4.25
Low cost package	0.22

Mid cost measure package 2, about 4.5 MRUR

Measure	MRUR
Constructing a **roundabout** to the Shabalina street junction and island a long traffic separation **islands** to enable safely left turning and small islands on the accessing roads to junction 300 m south from that.	4.25
Low cost package	0.22



Proposed measure in the black section Shabalina street junction, mid package 2.

Mid cost measure package 3, about 0.9 MRUR

Measure	MRUR
Installing of **road lighting** for 0,6 km length (made by wooden poles and air cable decreasing the costs down to 1 MRUR per km, 12 poles a 54.000 RUR	0,7
Low cost package	0.22

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.22 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0.21 killed
	1.68 injured
Forecasted annual impact with the measure, less	**0.06 killed** (0.6 RUR)
	0,5 injured (1.2 MRUR)
Annual economic savings of the society	**1,8 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 6 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,8 MRUR**
Paying-pack period	(0,22/1,8-0,8)x12 = **3 months**

Package 1 of mid-cost measures (mid-islands)	**4,5 MRUR**

Rough estimate of impacts, decrease of injury accidents	**- 45%**
Impact without the measure, annually	0.21 killed
	1.68 injured
Forecasted annual impact with the measure, less	**0.09 killed** (0.9 MRUR)
	0,76 injured (1.8 MRUR)
Annual economic savings of the society	**2,7 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 6 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,8 MRUR**
Paying-pack period	(4,5/2,7-0.8)x12 months = **2.4 years**

Package 2 of mid-cost measures (roundabout)	**4,5 MRUR**
Rough estimate of impacts, decrease of injury accidents	**- 70%**
Impact without the measure, annually	0.21 killed
	1.68 injured
Forecasted annual impact with the measure, less	**0.15 killed** (1.4 MRUR)
	1,18 injured (2.9 MRUR)
Annual economic savings of the society	**4,3 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 6 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,8 MRUR**
Paying-pack period	(4,5/4,3-0.8)x12 months = **15 months**

Package 3 of mid-cost measures (road lights)	**0.8 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-70%** (30% for low package and 40% for road lights)
Impact without the measure, annually	0.21 killed
	1.68 injured
Forecasted annual impact with the measure, less	**0.15 killed** (1.4 MRUR)
	1,18 injured (2.9 MRUR)
Annual economic savings of the society	**4.3 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 6 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,8 MRUR**
Paying-pack period	(0.8/4.3-0.8)x12 months = **3 months**

2 MURMANSK FEDERAL BY-PASS road 1+750 – 2+700

Detailed analysis on the "black section"

Fatal and injury accidents 1/2004-9/2008	16
In these:	
Persons killed	1 (0.21 annually)
Persons injured	22 (4.63 annually)
Accidents costs to the society, mln.RUR	13.06 annually
In darkness (or bad visibility)	57 %
In Winter period:	57% (1.10-30.4.)
Special characteristics of accidents:	50% head-on collisions 25% driving off the road 13% driving on pedestrian 6% other accident 6% passenger falling
Safety rule violation:	05,06,07,14,28,31,42
Road factor during the accidents:	Obstacle on the shoulder, no road marking, ascending section, right turn, poor shoulder condition, road lighting

	out of order, low skid resistance, snow walls limiting visibility

Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location
18.02.2009

AADT on the main road (roughly)	7700	vpd
Percentage of heavy vehicles (roughly)	30	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	2.5 x 2	m
Pedestrian path	no	m
Pavement	asphalt	
Horizontal and vertical alignment	both curvy	
Pedestrians	yes	
Bicyclists	yes	
Traffic lights	no	
Road lighting	no	
Road signing	+	
Other		

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of **60 km/h speed limit**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** in entries of the junctions, L
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt, L

Improving of **road lighting** for whole km length, M

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.22 MRUR

Measure	RUR
Renewing all horizontal and vertical road **markings**	55.000
Installment of **60 km/h speed limit** –signs, 2	25.000
Installment of a **"dangerous road section"** –signs, 2	25.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	25.000

Mid cost measure package, about 1.3 MRUR

Measure	MRUR
Installing of **road lighting** for 1,0 km length (made by wooden poles and air cable decreasing the costs down to 1 MRUR per km, 20 poles a 54.000 RUR	1.1
Low cost package	0.2

High cost measure package, 14 MRUR

Measure	RUR
Install **mid crash-barrier** and additional lane to about 1 km length	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.22 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0.21 killed
	4.63 injured
Forecasted annual impact with the measure, less	**0.06 killed** (0.6 RUR)
	1.4 injured (3.4 MRUR)
Annual economic savings of the society	**4,0 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 9 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**1,2 MRUR**
Paying-pack period	(0,22/4,0-1,2)x12 = **1 month**

Package of mid-cost measures (road lights)	**1.3 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-70%** (30% for low package and 40% for road lights)
Impact without the measure, annually	0.21 killed
	4.63 injured
Forecasted annual impact with the measure, less	**0.15 killed** (1.4 MRUR)
	3.2 injured (7.9 MRUR)
Annual economic savings of the society	**9.3 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 9 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**1,2 MRUR**
Paying-pack period	(1.3/9.3-1.2)x12 months = **2 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0.21 killed
	4.63 injured

Forecasted annual impact with the measure, less	**0.17 killed** (1.9 MRUR) **3.7 injured** (9.0 MRUR)
Annual economic savings of the society	**10.9 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 9 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**1,2 MRUR**
Paying-pack period	(14/10.9 – 1.2)x12 months = **21 months**

3 MURMANSK FEDERAL BY-PASS road 4+000 – 4+700

Detailed analysis on the "black section"

Fatal and injury accidents 1/2006-12/2008	4
In these:	
Persons killed	0 (0 annually)
Persons injured	5 (1.67 annually)
Accidents costs to the society, mln.RUR	4.01 annually
In darkness (or bad visibility)	75 %
In Winter period:	50 % (1.10-30.4.)
Special characteristics of accidents:	100% head-on collisions
Safety rule violation:	03,06
Road factor during the accidents:	Left turn, poor shoulder condition, wrong sign installed

Photo from the black section

Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	7700	vpd
Percentage of heavy vehicles (roughly)	30	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	2.5 x 2	m
Pedestrian path	no	m
Pavement	asphalt	
Horizontal and vertical alignment	both directions and a lot	
Pedestrians	no	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	+	
Other	High traffic volume, settlement around	

Infrastructure development for the next 3 years on the spot

- Road signs with high-reflective properties were installed in 2008.
- The section was repaired.
- Road marking is planned to be done.

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of **60 km/h speed limit**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** in entries of the junctions, L
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt, L

Improving of **road lighting** for whole km length, M

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.22 MRUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	55.000
Installment of **60 km/h speed limit**	25.000
Installment of a **"dangerous road section"** –signs, 2	25.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	25.000

Mid cost measure package, about 1.3 MRUR

Measure	**MRUR**
Installing of **road lighting** for 1.0 km length (made by wooden poles and air cable decreasing the costs down to 1 MRUR per km, 20 poles a 54.000 RUR	1.1
Low cost package	0.2

High cost measure package, 14 MRUR

Measure	**RUR**

Install **mid crash-barrier** and additional lane to about 1 km length	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.22 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0 killed
	1.67 injured
Forecasted annual impact with the measure, less	**0 killed** (RUR)
	0,5 injured (1.2 MRUR)
Annual economic savings of the society	**1,2 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 7 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,9 MRUR**
Paying-pack period	(0,22/1.2-0,9)x12 = **8 months**

Package of mid-cost measures (road lights)	**1.3 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-75%** (30% for low package and 45% for road lights)
Impact without the measure, annually	0 killed
	1.67 injured
Forecasted annual impact with the measure, less	**0 killed** (MRUR)
	1.25 injured (3.0 MRUR)
Annual economic savings of the society	**3.0 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 7 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,9 MRUR**
Paying-pack period	(1.3/3.0-0.9)x12 months = **7 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0 killed
	1.67 injured
Forecasted annual impact with the measure, less	**0. killed** (2.5 MRUR)
	1.3 injured (3.2 MRUR)
Annual economic savings of the society	**3.2 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 7 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,9 MRUR**
Paying-pack period	(14/3.2 – 0.9)x12 months = **11 years**

4 A MURMANSK FEDERAL BY-PASS road 5+000 – 5+600

Detailed analysis on the "black section"

Fatal and injury accidents 1/2004-9/2008	10
In these:	
Persons killed	3 (0,63 annually)
Persons injured	13 (2.74 annually)
Accidents costs to the society, руб.:	12.44 annually
In darkness (or bad visibility)	40 %
In Winter period:	30% (1.10-30.4.)
Special characteristics of accidents:	70% head-on collisions

	20% driving off the road 10% driving on a bicycle rider
Safety rule violation:	03,05,06,07,10,28
Road factor during the accidents:	Wrong sign installed, steep ascent, no road marking, the shoulder is lower than the pavement, ascending section, left and right turns

Photo from the black section

Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	7700	vpd
Percentage of heavy vehicles (roughly)	30	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	2.5 x 2	m
Pedestrian path	no	m
Pavement	asphalt	
Horizontal and vertical alignment	both and sharp	
Pedestrians	yes	
Bicyclists	yes	
Traffic lights	no	
Road lighting	no	
Road signing	+	
Other		

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of **60 km/h speed limit**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** in entries of the junctions, L
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt, L

Improving of **road lighting** for whole km length, M

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.22 MRUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	55.000
Installment of **60 km/h speed limit**	25.000
Installment of a **"dangerous road section"** –signs, 2	25.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	25.000

Mid cost measure package, about 0.8 MRUR

Measure	**MRUR**
Installing of **road lighting** for 0.6 km length (made by wooden poles and air cable decreasing the costs down to 1 MRUR per km, 12 poles a 54.000 RUR	0.6
Low cost package	0.2

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane to about 1 km length	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.22 MRUR**

Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0.63 killed
	2.74 injured
Forecasted annual impact with the measure, less	**0.19 killed** (1.8 MRUR)
	0,8 injured (2.0 MRUR)
Annual economic savings of the society	**3,8 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 6 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,8 MRUR**
Paying-pack period	(0,22/3.8-0,8)x12 = **1 month**

Package of mid-cost measures (road lights)	**0.8 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-55%** (30% for low package and 25% for road lights)
Impact without the measure, annually	0.63 killed
	2.74 injured
Forecasted annual impact with the measure, less	**0,35 killed** (3.3 MRUR)
	1.5 injured (3.7 MRUR)
Annual economic savings of the society	**7.0 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 6 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,8 MRUR**
Paying-pack period	(0.8/7.0-0.8)x12 months = **1,5 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0.63 killed
	2.74 injured
Forecasted annual impact with the measure, less	**0. 5killed** (4.8 MRUR)
	2.2 injured (5.3 MRUR)
Annual economic savings of the society	**10.1 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 6 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,8 MRUR**
Paying-pack period	(14/10.1 – 0.8)x12 months = **22 months**

5 MURMANSK FEDERAL BY-PASS road 7+150 – 8+000

Detailed analysis on the "black section"

Fatal and injury accidents 1/2006-12/2008	4
In these:	
Persons killed	0 (0.00 annually)
Persons injured	4 (1.33 annually)
Accidents costs to the society, mln.RUR	3.19 annually
In darkness (or bad visibility)	0%
In Winter period:	25% (1.10-30.4.)
Special characteristics of accidents:	75% head-on collisions 25% driving on pedestrian
Safety rule violation:	03,04,05,06,28,42
Road factor during the accidents:	

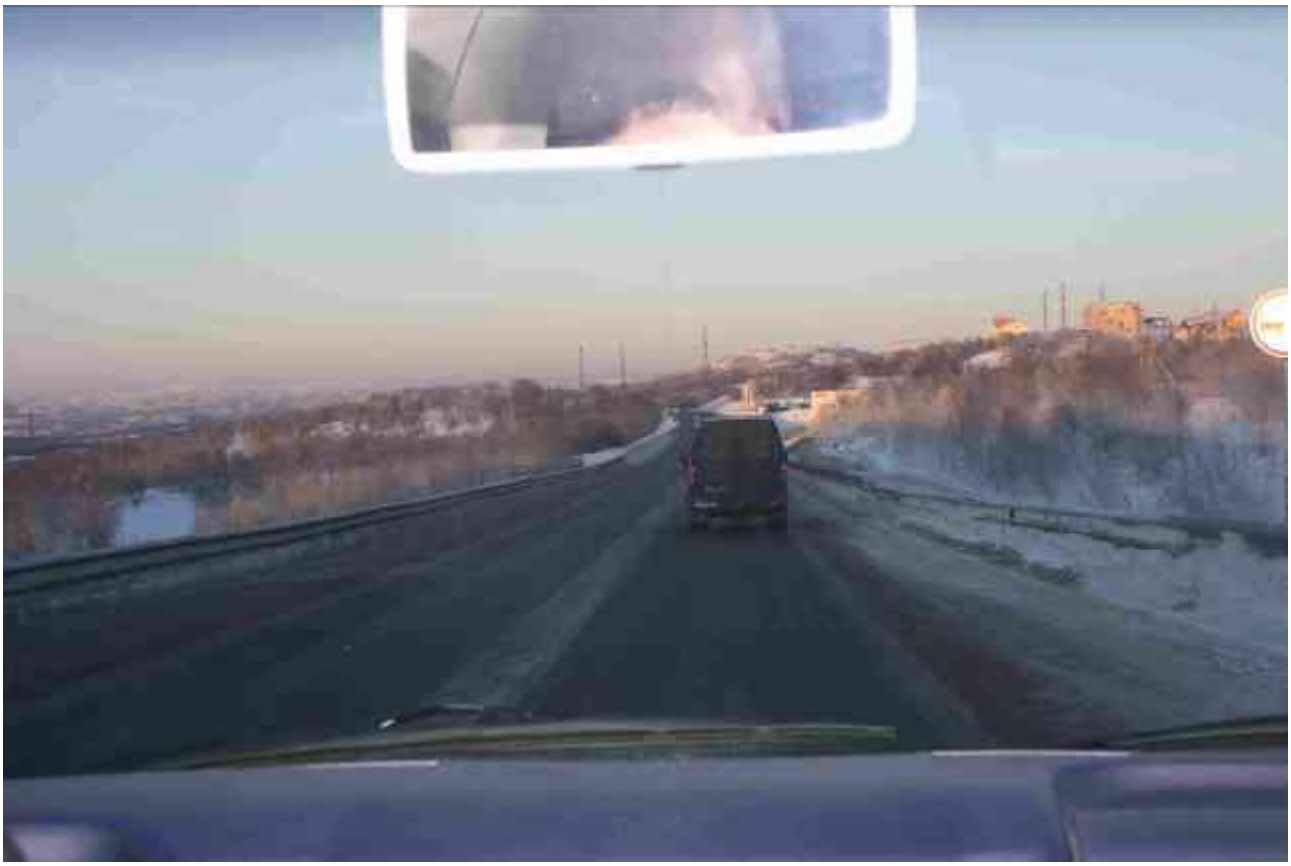
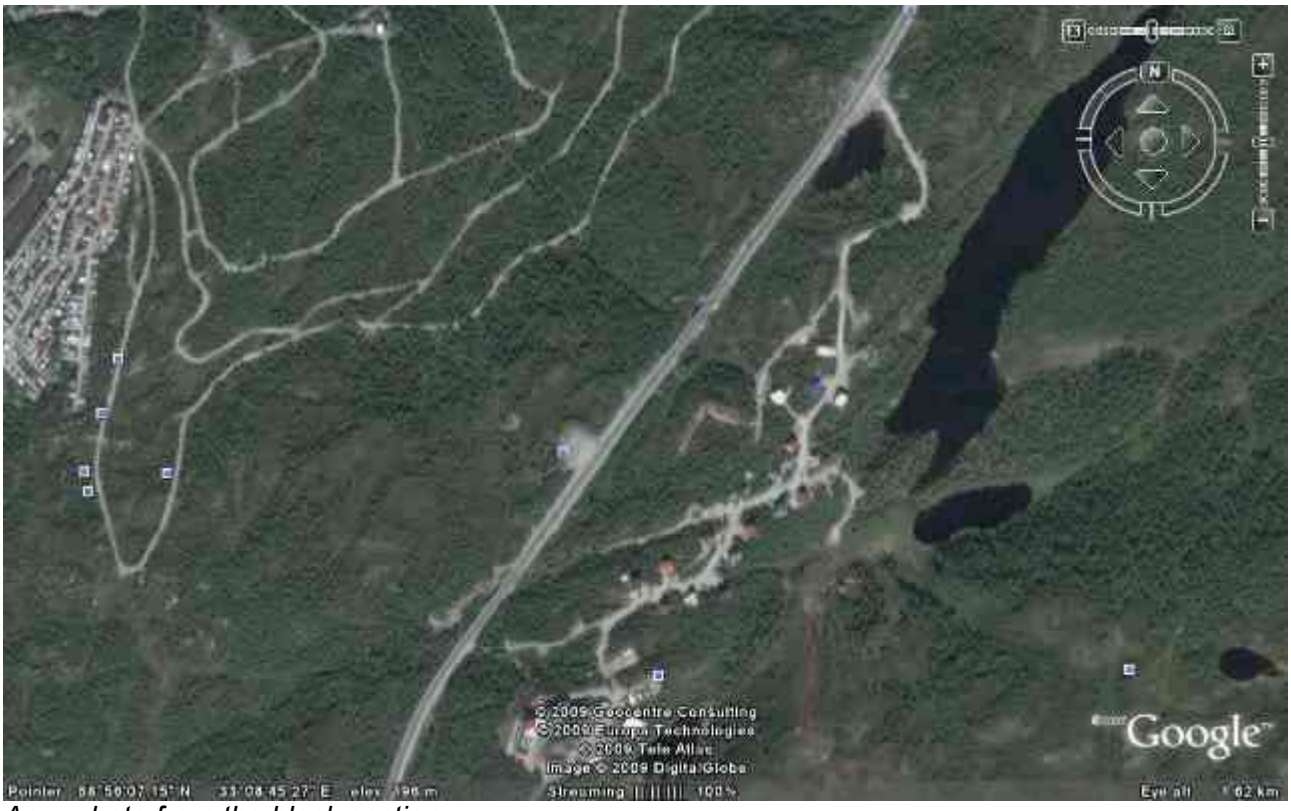


Photo from the black section



Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	7700	vpd
Percentage of heavy vehicles (roughly)	30	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	2.5 x 2	m
Pedestrian path	no	m
Pavement	asphalt	
Horizontal and vertical alignment	vertical steep	
Pedestrians	yes (among victims)	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	ok.	
Other	High traffic volume, settlement.	

Infrastructure development during the last 3 years on the spot

- In 2008 road signs with high reflective properties were installed.
- The section was repaired.
- Road marking is to be done.

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of **60 km/h speed limit**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** in entries of the junctions, L
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt, L

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.22 MRUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	55.000
Installment of **60 km/h speed limit**	25.000
Installment of a **"dangerous road section"** –signs, 2	25.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	25.000

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane to about 1 km length	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.22 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0.00 killed
	1.33 injured
Forecasted annual impact with the measure, less	**0.0 killed** (0 MRUR)

	0,4 injured (1.0 MRUR)
Annual economic savings of the society	**1,0 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 6 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,8 MRUR**
Paying-pack period	(0,22/1.0-0,8)x12 = **12 month**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0 killed
	1.33 injured
Forecasted annual impact with the measure, less	**0.killed** (MRUR)
	1.1 injured (2.6 MRUR)
Annual economic savings of the society	**2.6 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 6 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,8 MRUR**
Paying-pack period	(14/2.6 – 0.8)x12 months = **9 years**

6 MURMANSK FEDERAL BY-PASS road 8+000 – 8+502

Detailed analysis on the "black section"

Fatal and injury accidents 1/2004-9/2008	4
In these:	
Persons killed	0 (0 annually)
Persons injured	5 (1.05 annually)
Accidents costs to the society, mln. RUR	2.52 annually
In darkness (or bad visibility)	50 %
In Winter period:	50% (1.10-30.4.)
Special characteristics of accidents:	50% head-on collisions 25% driving off the road 25% driving on an obstacle
Safety rule violation:	02,07,10,28,55
Road factor during the accidents:	Descending section, no road marking, turn

Photo from the black section

Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	7700	vpd
Percentage of heavy vehicles (roughly)	30	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	2.5 x 2	m
Pedestrian path	no	m
Pavement	asphalt	
Horizontal and vertical alignment	steep vertical and horizontal	
Pedestrians	no (among victims)	
Bicyclists	no	
Traffic lights	no	
Road lighting	yes, but not sufficient	
Road signing	ok.	
Other	High traffic volume, settlement.	

Infrastructure development during the last 3 years on the spot

- non

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of **60 km/h speed limit**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** in entries of the junctions, L

Install **rumble strips** parallel to centre line and both edge lines sink into asphalt, L

Improving of **road lighting** for whole km length, M

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.22 MRUR

Measure	RUR
Renewing all horizontal and vertical road **markings**	55.000
Installment of **60 km/h speed limit**	25.000
Installment of a **"dangerous road section"** –signs, 2	25.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	25.000

Mid cost measure package, about 0.8 MRUR

Measure	MRUR
Installing of **road lighting** for 0.5 km length (made by wooden poles and air cable decreasing the costs down to 1,0 MRUR per km, 12 poles a 54.000 RUR	0.6
Low cost package	0.2

High cost measure package, 14 MRUR

Measure	RUR
Install **mid crash-barrier** and additional lane to about 1 km length	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.22 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0.00 killed
	1.05 injured
Forecasted annual impact with the measure, less	**0.0 killed** (0 MRUR)
	0,3 injured (0.8 MRUR)
Annual economic savings of the society	**0,8 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,66 MRUR**
Paying-pack period	(0,22/0.8-0,66)x12 = **17 month**

Package of mid-cost measures (road lights)	**0.8 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-62%** (30% for low package and 32% for road lights)
Impact without the measure, annually	0. killed
	1.05 injured
Forecasted annual impact with the measure, less	**0,killed** (MRUR)
	0.65 injured (1.6 MRUR)
Annual economic savings of the society	**1.6 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,65 MRUR**
Paying-pack period	(0.8/1.6-0.66)x12 months = **10 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0 killed
	1.05 injured

Forecasted annual impact with the measure, less	**0.killed** (MRUR) **0.8 injured** (2.0 MRUR)
Annual economic savings of the society	**2.0 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,66 MRUR**
Paying-pack period	(14/2.0 – 0.66)x12 months = **10 years**

7 MURMANSK FEDERAL BY-PASS road 9+080 – 9+500

Detailed analysis on the "black section"

Fatal and injury accidents 1/2006-12/2008	4
In these:	
Persons killed	0 (0 annually)
Persons injured	5 (1.67 annually)
Accidents costs to the society, mln. RUR	4.01 annually
In darkness (or bad visibility)	75%
In Winter period:	100% (1.10-30.4.)
Special characteristics of accidents:	100% head-on collisions
Safety rule violation:	03,06,28
Road factor during the accidents:	No road marking, descending section, pavement defects, left turn, insufficient road lighting

Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	7700	vpd
Percentage of heavy vehicles (roughly)	30	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	2.5 x 2	m
Pedestrian path	no	m
Pavement	asphalt	
Horizontal and vertical alignment	steep vertical and horizontal	
Pedestrians	no (among victims)	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	ok.	
Other	After repair works and installation of road signs but the number of accident stayed the same	

Infrastructure developments on the section:

- In 2008 road signs with high reflective properties were installed.
- The section was repaired.

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of **60 km/h speed limit**, L

Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** in entries of the junctions, L
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt, L

Improving of **road lighting** for whole km length, M

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.22 MRUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	55.000
Installment of **60 km/h speed limit**	25.000
Installment of a **"dangerous road section"** –signs, 2	25.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	25.000

Mid cost measure package, about 0.8 MRUR

Measure	**MRUR**
Installing of **road lighting** for 0.5 km length (made by wooden poles and air cable decreasing the costs down to 1,0 MRUR per km, 12 poles a 54.000 RUR	0.6
Low cost package	0.2

High cost measure package, 14 MRUR

Measure	**RUR**
Install **mid crash-barrier** and additional lane to about 1 km length	13,7 M
Low cost package	250.000

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.22 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0.00 killed
	1.67 injured
Forecasted annual impact with the measure, less	**0.0 killed** (0 MRUR)
	0,5 injured (1.2 MRUR)
Annual economic savings of the society	**1,2 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,66 MRUR**
Paying-pack period	(0,22/1.2-0,66)x12 = **4 month**

Package of mid-cost measures (road lights)	**0.8 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-78%** (30% for low package and 48% for road lights)
Impact without the measure, annually	0. killed
	1.67 injured
Forecasted annual impact with the measure, less	**0,killed** (MRUR)
	1.3 injured (3.1 MRUR)
Annual economic savings of the society	**3.1 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,65 MRUR**
Paying-pack period	(0.8/3.1-0.65)x12 months = **4 months**

Package of high - cost measures (mid barrier)	**14 MRUR**

Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0 killed
	1.67 injured
Forecasted annual impact with the measure, less	**0.killed** (MRUR)
	1.3 injured (3.2 MRUR)
Annual economic savings of the society	**3.2 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,66 MRUR**
Paying-pack period	(14/3.2 – 0.66) x12 months = **5years**

8 MURMANSK FEDERAL BY-PASS road 11+100 – 11+855

Detailed analysis on the "black spot"

Fatal and injury accidents 1/2006-12/2008	5
In these:	
Persons killed	0 (0.00 annually)
Persons injured	8 (2.67 annually)
Accidents costs to the society, mln. RUR	6.41 annually
In darkness (or bad visibility)	20%
In Winter period:	60% (1.10-30.4.)
Special characteristics of accidents:	40% head-on collisions 20% driving off the road 20% driving on bicyclist 20% other accident
Safety rule violation:	05,06,28,55
Road factor during the accidents:	Steep descent, low skid resistance, poor shoulder condition, straight section

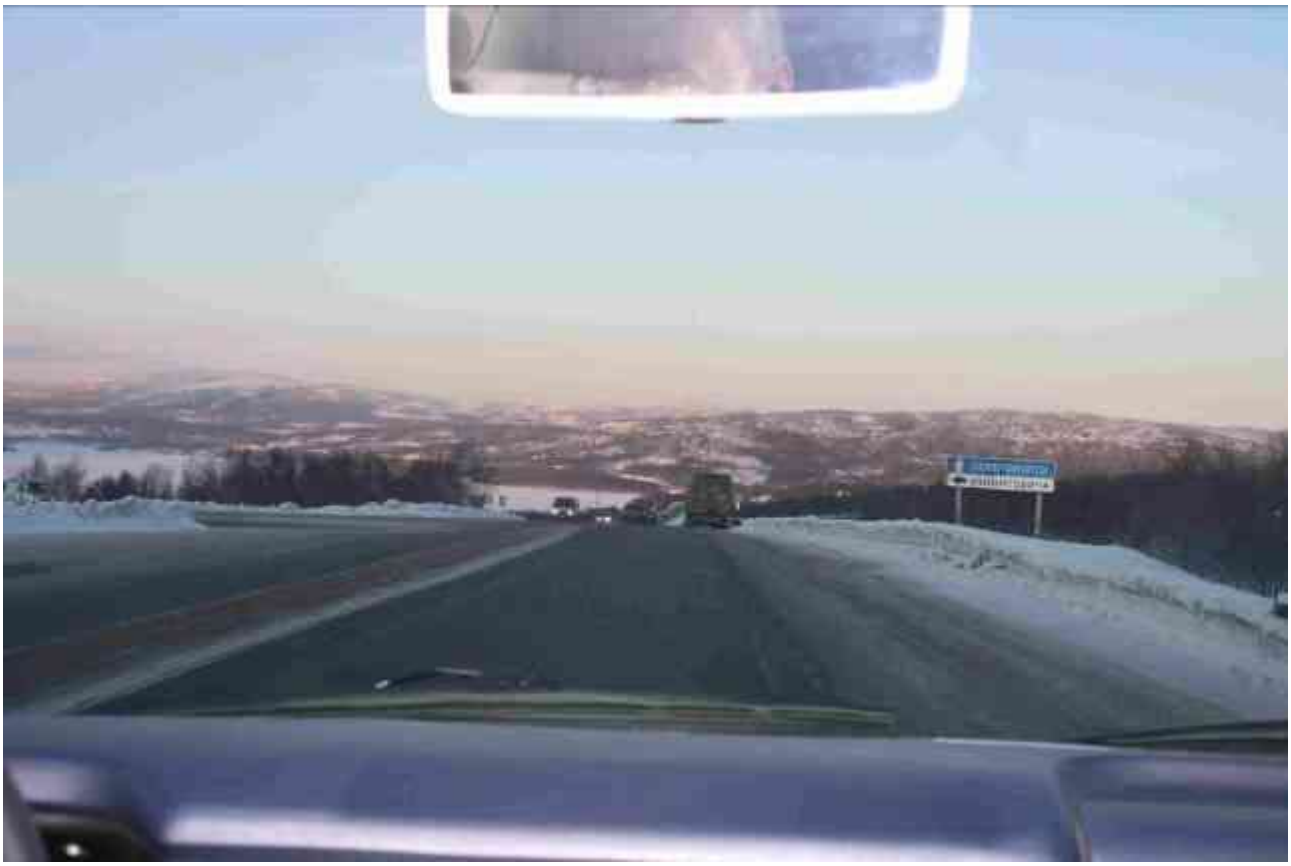


Photo from the black section

Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	7700	vpd
Percentage of heavy vehicles (roughly)	30	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	2.5 x 2	m
Pedestrian path	no	m
Pavement	asphalt	
Horizontal and vertical alignment	steep vertical and horizontal	
Pedestrians	no (among victims)	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	ok.	
Other	High traffic volume, settlement. Intersection. After repair works the number of accidents hasn't changed.	

Infrastructure development during the last 5 years on the spot

- In 2008 road signs with high reflective properties were installed.
- The section was repaired.
- Road marking is planned to be done.

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of **60 km/h speed limit**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** in entries of the junctions, L
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt, L

Constructing a long traffic separation **islands** to enable safely left turning in two junctions and pedestrian crossings over by-pass road, M

Constructing a **roundabouts** in the main T-junctions**,** M

Improving of **road lighting** for whole km length, M

Install **mid crash-barrier** and additional lane, H

Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.22 MRUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	55.000
Installment of **60 km/h speed limit**	25.000
Installment of a **"dangerous road section"** –signs, 2	25.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	25.000

Mid cost measure package 1, about 2.2 MRUR

Measure	**MRUR**
Constructing of a long traffic separation **islands** to enable safely left turning and small islands on the accessing roads to main T-intersection (Planernaja)	2.0
Low cost package	0.2

Proposed measure in the black section Planernaja Street junction, mid package 1.

Mid cost measure package 2, about 2.4 MRUR

Measure	**RUR**
Constructing a **roundabout** to the Planernaja Street junction.	2.2
Low cost package	0.2

Mid cost measure package 3, about 1.2 MRUR

Measure	**MRUR**
Installing of **road lighting** for 1 km length (made by wooden poles and air cable decreasing the costs down to 1 MRUR per km, 12 poles a 54.000 RUR	1,0
Low cost package	0.2

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.22 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0 killed
	2.67 injured
Forecasted annual impact with the measure, less	**0 killed** (RUR)
	0,8 injured (1.9 MRUR)
Annual economic savings of the society	**1,9 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,7 MRUR**
Paying-pack period	(0,22/1,8-0,7)x12 = **2 months**

Package 1 of mid-cost measures (mid-islands)	**2,2 MRUR**
Rough estimate of impacts, decrease of injury accidents	**- 45%** (30% due to speed limit, 15 due

	to island)
Impact without the measure, annually	0 killed
	2.67 injured
Forecasted annual impact with the measure, less	**0. killed** (MRUR)
	1,2 injured (2.9MRUR)
Annual economic savings of the society	**2,9 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,7 MRUR**
Paying-pack period	(2.2/2,9-0.7)x12 months = **12 months**

Package 2 of mid-cost measures (roundabout)	**2,4 MRUR**
Rough estimate of impacts, decrease of injury accidents	**- 70%**
Impact without the measure, annually	0 killed
	2.67 injured
Forecasted annual impact with the measure, less	**0. killed** (MRUR)
	1,9injured (4.5 MRUR)
Annual economic savings of the society	**4,5 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,7 MRUR**
Paying-pack period	(2,4/4,5-0.7)x12 months = **8 months**

Package 3 of mid-cost measures (road lights)	**1.2 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-43%** (30% for low package and 13% for road lights)
Impact without the measure, annually	0 killed
	2.67 injured
Forecasted annual impact with the measure, less	**0. killed** (MRUR)
	1.1 injured (2.4 MRUR)
Annual economic savings of the society	**2.4 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,7 MRUR**
Paying-pack period	(1.2/2.4-0.7)x12 months = **8 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0 killed
	2.67 injured
Forecasted annual impact with the measure, less	**0.killed** (MRUR)
	2.1 injured (5 MRUR)
Annual economic savings of the society	**5 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 5 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,7 MRUR**
Paying-pack period	(14/5 – 0.7)x12 months = **4 years**

9 MURMANSK FEDERAL BY-PASS road 14+000 – 14+451

Detailed analysis on the "black section"

Fatal and injury accidents 1/2004-9/2008	4

In these:	
Persons killed	0 (0 annually)
Persons injured	4 (0.84 annually)
Accidents costs to the society, mln. RUR	2.02 annually
In darkness (or bad visibility)	75%
In Winter period:	75% (1.10-30.4.)
Special characteristics of accidents:	25% driving on pedestrian 75% head-on collisions
Safety rule violation:	02,05,06
Road factor during the accidents:	Horizontal section, ascending section, left turn, low skid resistance

Photo from the black section

Photo from the black section

Aero photo from the black section

Observations of a multinational (Russian-Swedish-Finnish) expert team visiting the location 18.02.2009

AADT on the main road (roughly)	7700	vpd

Percentage of heavy vehicles (roughly)	30	%
Speed limit	90	km/h
Carriageway width (roughly)	3.5 x 2	m
Shoulder width (roughly)	2.5 x 2	m
Pedestrian path	no	m
Pavement	asphalt	
Horizontal and vertical alignment	steep vertical and horizontal	
Pedestrians	no (among victims)	
Bicyclists	no	
Traffic lights	no	
Road lighting	no	
Road signing	ok.	
Other	A dangerous intersection on the hill.	

Infrastructure development during the last 5 years on the spot

- non

Initial proposed measures (L=Low cost measure 0…300.000 RUR, M= medium cost measure 300.000…1.500.000 RUR, H= high cost measure, over 1.5 MRUR)

Renewing all horizontal and vertical road **markings**, L
Installment of **60 km/h speed limit**, L
Installment of a **"dangerous road section"** –sign, L
Install a unit of three cross sectional **rumble strips** in entries of the junctions, L
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt, L

Constructing a long traffic separation **islands** to enable safely left turning in two junctions and pedestrian crossings over by-pass road, M

Constructing a **roundabouts** in the main T-junctions**,** M

Improving of **road lighting** for whole km length, M

Install **mid crash-barrier** and additional lane, H

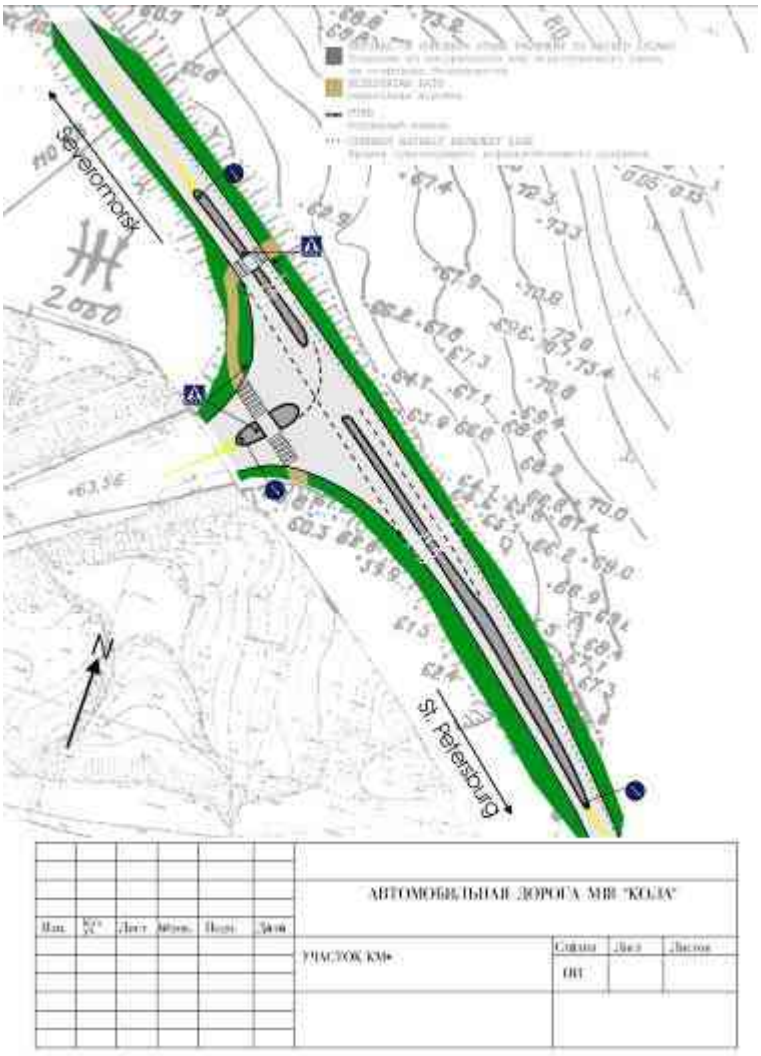
Assessed improvement packages and their economic evaluation:

Low cost measure package, 0.22 MRUR

Measure	**RUR**
Renewing all horizontal and vertical road **markings**	55.000
Installment of **60 km/h speed limit**	25.000
Installment of a **"dangerous road section"** –signs, 2	25.000
Install **rumble strips** parallel to centre line and both edge lines sink into asphalt	90.000
Install a unit of three cross sectional **rumble strips** in entries of the junction	25.000

Mid cost measure package 1, about 2.2 MRUR

Measure	**MRUR**
Constructing of a long traffic separation **islands** to enable safely left turning and small islands on the accessing roads to main T-intersection (Vekhneroshenskaya)	2.0
Low cost package	0.2



Proposed measure in the black section Vekhnerostinskoye schosse *junction, mid package 1.*

Mid cost measure package 2, about 2.4 MRUR

Measure	**RUR**
Constructing a **roundabout** to the Vekhneroshenskaya Street junction.	2.2
Low cost package	0.2

Mid cost measure package 3, about 1.2 MRUR

Measure	**MRUR**
Installing of **road lighting** for 1 km length (made by wooden poles and air cable decreasing the costs down to 1 MRUR per km, 12 poles a 54.000 RUR	1,0
Low cost package	0.2

Forecasted impacts and economic effectiveness of the proposed measures:

Package of low-cost measures	**0.22 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-30%** (mostly from speed reduction)
Impact without the measure, annually	0 killed
	0.84 injured
Forecasted annual impact with the measure, less	**0 killed** (RUR)
	0,24 injured (0.6 MRUR)
Annual economic savings of the society	**0,6 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 4 (100	**0,5 MRUR**

м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	
Paying-pack period	(0,22/0,6-0,5)x12 = **24 months**

Package 1 of mid-cost measures (mid-islands)	**2,2 MRUR**
Rough estimate of impacts, decrease of injury accidents	**- 45%** (30% due to speed limit, 15% due to island)
Impact without the measure, annually	0 killed
	0.84 injured
Forecasted annual impact with the measure, less	**0. killed** (MRUR)
	0,4 injured (0.9MRUR)
Annual economic savings of the society	**0,9 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 4 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,6 MRUR**
Paying-pack period	(2.2/0,9-0.4)x12 months = **4 years**

Package 2 of mid-cost measures (roundabout)	**2,4 MRUR**
Rough estimate of impacts, decrease of injury accidents	**- 70%**
Impact without the measure, annually	0 killed
	0.84 injured
Forecasted annual impact with the measure, less	**0. killed** (MRUR)
	0,6injured (1.4 MRUR)
Annual economic savings of the society	**1,4 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 4 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,5 MRUR**
Paying-pack period	(2,4/1,4-0.5)x12 months = **32 months**

Package 3 of mid-cost measures (road lights)	**1.2 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-78%** (30% for low package and 48% for road lights)
Impact without the measure, annually	0 killed
	0.84 injured
Forecasted annual impact with the measure, less	**0. killed** (MRUR)
	0.7 injured (1.6 MRUR)
Annual economic savings of the society	**1.6 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 4 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,5 MRUR**
Paying-pack period	(1.2/1.6-0.5)x12 months = **13 months**

Package of high - cost measures (mid barrier)	**14 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-80%**
Impact without the measure, annually	0 killed
	0.84 injured
Forecasted annual impact with the measure, less	**0.killed** (MRUR)
	0.7 injured (1.3 MRUR)
Annual economic savings of the society	**1.3 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 4 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**0,5 MRUR**
Paying-pack period	(14/1.3 – 0.5)x12 months = **19 years**

Summary of costs and expected impacts of proposed black spot measures

Low cost measures (0…300.000 RUR) on BLACK SECTIONS
(Road markings, signs, rumble strips, in all spots the speed limit 60km/h)

Black Spot Address KM	Implementation cost (Million RUR)	Forecasted amount of fatalities less annually*)	Forecasted amount of Injuries less annually*)	Saving for the society annually (MRUR)**)	Paying back period (Months)
1. 1+000 – 1+550	0.22 (incl 60km/h)	0.06	0.5	1.0	3
2. 1+750 – 2+700	0.22 (incl 60km/h)	0.06	1.4	2.8	1
3. 4+000 – 4+700	0.22 (incl 60km/h)	0	0.5	0.3	8
4. 5+000 – 5+600	0.22 (incl 60km/h)	0.19	0.8	3.0	1
5. 7+150 – 8+000	0.22 (incl 60km/h)	0	0.4	0.2	12
6. 8+000 – 8+502	0.22 (incl 60km/h)	0	0.3	0.14	17
7. 9+080 – 9+500	0.22 (incl 60km/h)	0	0.5	0.5	4
8. 11+100 – 11+855	0.22 (incl 60km/h)	0	0.8	1.1	2
9. 14+000 – 14+451	0.22 (incl 60km/h)	0	0,24	0.1	1
Total	2.0 million RUR	0.31	5,44	9.14	5 Month

*) based on the before-after studies in similar climate conditions at Nordic Countries.

**)
The Russian method is based on unit costs adapted from the “Methodology of assessment of normative socio-economic accident costs R-03112199-0502-00”, which is developed by Scientific Research Institute of Motor transport (NIIAT) for the Russian Ministry of Transport.

Medium cost measure 300.000…1.500.000 RUR on BLACK SECTIONS

(Road lights, roundabouts in the main junctions, plus low cost package)

Black Spot Address KM	Implementation cost (Million RUR)	Forecasted amount of fatalities less annually*)	Forecasted amount of Injuries less annually*)	Saving for the society annually (MRUR)**)	Paying back period (Months)
1. 1+000 – 1+550	4.5 roundabout to junction	0.15	1.18	3.5	15
1. 1+000 – 1+550	0.8 road lights	0.15	1.18	3.5	3
2. 1+750 – 2+700	1.3 road lights	0.15	3.2	8.1	2
3. 4+000 – 4+700	1.3 road lights	0	1.25	2.1	7
4. 5+000 – 5+600	0.8 road lights	0.35	1.5	6.2	1.5
5. 7+150 – 8+000					
6. 8+000 – 8+502	0.8 road lights	0	0.65	0.9	10
7. 9+080 – 9+500	0.8 road lights	0	1.3	2.5	4
8. 11+100 – 11+855	4.5 roundabout to junction	0	2.4	1.9	8
8. 11+100 – 11+855	1.2 road lights	0	1.1	1.7	8
9. 14+000 – 14+451	2.4 roundabout to junction	0	0.6	0.9	32
9. 14+000 – 14+451	1.2 road lights	0	0.7	0.9	13
Total	19.6 million RUR	0.8	15.06	32.2	8 Months

High cost measure, over 1.5 MRUR on BLACK SECTIONS

(Mid crash-barrier and additional lane plus low cost package)

Black Spot Address KM	Implementation cost (Million RUR)	Forecasted amount of fatalities less annually*)	Forecasted amount of Injuries less annually*)	Saving for the society annually (MRUR)**)	Paying back period (Years)
1. 1+000 – 1+550					
2. 1+750 – 2+700	14 Crash-barrier, add. lane	0.17	3.7	9.7	1.4
3. 4+000 – 4+700	14 Crash-barrier, add. lane	0	1.3	2.3	11
4. 5+000 – 5+600	14 Crash-barrier, add. lane	0.5	2.2	9.3	1.8
5. 7+150 – 8+000	14 Crash-barrier, add. lane	0	1.1	1.8	9

6. 8+000 – 8+502	14 Crash-barrier, add. lane	0	0.8	1.3	10
7. 9+080 – 9+500	14 Crash-barrier, add. lane	0	1.3	2.5	5
8. 11+100 – 11+855	14 Crash-barrier, add. lane	0	2.1	4.3	4
9. 14+000 – 14+451	14 Crash-barrier, add. lane	0	0.7	0.8	19
Total	112 million RUR	0.67	13.2	32.2	8 Years

4. Analysis of some measures concerning the whole 14.5 km section

The length of the Murmansk federal by-pass road is 14.451 km.

Road accident statistics on Murmansk by- pass federal road between 2006 – 2009 is the following:

2006

Road accident type	Number of road accidents	Number of killed	Number of injured
Collision	15	3	20
Driving off the road	2		3
Driving on a parked/stopped vehicle			
Driving on an obstacle	2		2
Driving on pedestrian	2		2
Driving on a bicycle rider			
Driving on an animal-drawn transport			
Falling of the passenger			
Other	1		1
Total	**22**	**3**	**28**

2007

Road accident type	Number of road accidents	Number of killed	Number of injured
Collision	12	3	20
Driving off the road	5		5
Driving on a parked/stopped vehicle			
Driving on an obstacle	1		1
Driving on pedestrian	1		1
Driving on a bicycle rider	1		1
Driving on an animal-drawn transport			
Falling of the passenger			
Other			
Total	**20**	**3**	**28**

2008

Road accident type	Number of road accidents	Number of killed	Number of injured
Collision	17		26
Driving off the road	2		3
Driving on a parked/stopped vehicle			
Driving on an obstacle	1		1
Driving on pedestrian	1		1
Driving on a bicycle rider			
Driving on an animal-drawn transport			
Falling of the passenger			
Other			
Total	**21**	**0**	**31**

2009 01.01.2009-30.04.2009

Road accident type	Number of road accidents	Number of killed	Number of injured
Collision	4		7
Driving off the road			
Driving on a parked/stopped vehicle			
Driving on an obstacle			

Driving on pedestrian			
Driving on a bicycle rider			
Driving on an animal-drawn transport			
Falling of the passenger			
Other	1		1
Total	**5**	**0**	**8**

1.1.2006 – 30.4. 2009 (3 years and 1/3 years)

Road accident type	Number of road accidents	Number of killed	Number of injured	Killed per year	Injured per year
Collision	**48**	**6**	**73**	**1.8**	**21.9**
Driving off the road	**9**		**11**		**3.3**
Driving on a parked/stopped vehicle					
Driving on an obstacle	**4**		**4**		**1.2**
Driving on pedestrian	**4**		**4**		**1.2**
Driving on a bicycle rider	**1**		**1**		**0.3**
Driving on an animal-drawn transport					
Falling of the passenger					
Other	**2**		**2**		**0.6**
Total	**68**	**6**	**95**	**1.8**	**28.5**

Assessed measures, their initial implementation costs, impacts and economic evaluation

1. Installing of 60 km/h speed limit to whole 14.5 km section

60 km/h speed limit	**0.4 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-25 %**
Impact without the measure, annually	1.8 killed
	28.5 injured
Forecasted annual impact with the measure, less	**0.45 killed** (4.2 MRUR)
	7,1 injured (16.9 MRUR)
Annual economic savings of the society	**21,1 MRUR**
Annual loss of time 7.700 veh./24h. x 365 days x 145 (100 м) x 2 sec./veh. x 1,93 euro/veh.-hour/3600 sec/hour	**19.2 MRUR**
Paying-pack period	(0,4/21.1-19.2)x12 = **2.5 months**

2. Installing (rumbling) audio marking parallel to centre line and both edge lines marked on the asphalt to whole 14.5 km section

Current Russian norm recognize audio marking made on top of asphalt but not (yet) a marking dug some 10 mm inside (under) the pavement

Audio marking (rumbling)	**1.4 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-24 %**
Impact without the measure, annually	1.8 killed
	28.5 injured
Forecasted annual impact with the measure, less	**0.43 killed** (4.0 MRUR)
	6,9 injured (16.3 MRUR)
Annual economic savings of the society	**20,3 MRUR**

Annual loss of time	**non**
Paying-pack period	(1,4/20.3) x 12 = **1 month**

3. Installing road lights to whole 14.5 km section

If installing of **road lighting** made by wooden poles and air cable decreasing the costs are some 1 MRUR per km. This is many times inexpensive than Russian standard variant with concrete poles and cable under the ground. Road lighting decreases 64% dark time or bad visibility accidents.

Road lights	**14.5 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-36 % (64% x 57%)**
Impact without the measure, annually	1.8 killed
	28.5 injured
Forecasted annual impact with the measure, less	**0.65 killed** (6.0 MRUR)
	10,.3 injured (24.4 MRUR)
Annual economic savings of the society	**30.4 MRUR**
Annual loss of time	**non**
Paying-pack period	(14.5/30.4) x 12 = **6 months**

4. Installing mid crash-barrier and additional lane to whole 14.5 km section

Current Russian standards allow installing of **centre crash barrier and additional lane** only in case of long steep slope. To use his solution in Russia as a by-passing lane in high volume one-carriageway road has still problems. In case of new construction or reconstruction the Russian State Expertise does not approve this solution as it is not mentioned in the current norms. The solution takes away head-on collisions.

Centre crash barrier and additional lane	**200 MRUR**
Rough estimate of impacts, decrease of injury accidents	**-100 %** (in head-on collisions)
Impact without the measure, annually	1.8 killed (in head-on collisions)
	21.9 injured (in head-on collisions)
Forecasted annual impact with the measure, less	**1.8 killed** (17 MRUR)
	21.9 injured (52 MRUR)
Annual economic savings of the society	**71 MRUR**
Annual loss of time	**non**
Paying-pack period	(200/71) x 12 = **33 months**

Some explanations of method used in economic evaluation
ANNEX 1

The Russian method is based on “Methodology of assessment of normative socio-economic accident costs R-03112199-0502-00” is
developed by Scientific Research Institute of Motor transport (NIIAT) for the Russian Ministry of Transport, It is based on the following cost formation:

Fatality with a man having a family	7,329 MRUR	250,990 EUR
Fatality with a man having no family	6,930	237,330
Injure with disablement status (no possibilities for further work)	3,622	124,040
Injure with disablement status (with possibility for further work)	2,090	71,575
Injure without disablement status	0,039	1,335
Fatality with a child	8,411 MRUR	288,050 EUR

As there is no percentage of accident by above types we propose the following average normative costs

for fatalities **258,790 $, 212,000 EUR,** for the EUR –RUR rate 44,0 - **9.3 MRUR**
for injuries **65,650 $, 54,000 EUR,** for the EUR –RUR rate 44,0 - **2.4 MRUR**

Russian Rosavtodor is in process of issuing the traffic safety guidelines for the federal roads with **8.7 MRUR** fatality cost and **0.3 MRUR** injury cost. The latter is definitely too low and is recommended to be altered.

Some explanations of chosen economic assessment method

Time value

Because some of the measures, namely speed limits, decrease directly the trip time, we have decreased the effectiveness of that measure by assessing time losses. The values were counted for Scandinavia road E18 (Leningrad Region, 2004) and should be up-dated if used in detailed economy calculations:

Speed limits decrease from 90 km/h to 60 km/h lower the speed and add the trip time through those black spots, which 60 km/h limit has been proposed. We have counted that, when every vehicle will slow down the speed about 30 km/h in the length of the particular section, this makes a loss of 2 seconds for every vehicle per 100 metres. The annual loss depends on traffic volume in each section in concern. As there are no current Russian values of travel time available, we propose to use the values:

- 1,23 euros/hour for light vehicle and
- 2,97 euros/hour for buses and heavy vehicles

The values have been estimated by dividing the analogical values used in Finland by factor, when dividing Russian GDP to Finnish GDP. The Finnish time costs by vehicle hour are 11,1 Euros for light vehicles and 26,7 Euros for heavy vehicles. As the share between light vehicles and heavy vehicles are 60 % - 40 % this make the time value losses equal to 1,23E x 60 % plus 2,97E x 40 %, which makes **1,93 Euro per vehicle hour**, We have used this value in calculations in this memo to assess time losses when proposing speed limit reductions.

Ignored things

In proposed method have been ignored some factors, which are typical for Western methods, like:

- Accidents with only material damage, because of small economic effect and vague statistics
- Vehicle costs (petrol, lubricant, tires etc,) do not differ between proposed variants

- Maintenance costs, which may be slightly increased, because some measure may increase manual work in street maintenance (e,g, snow removing near traffic islands)
- Pollution costs, which will be lower with lower speeds,
- Residual value, because of the short paying back periods
- Discounting, because of very short paying back periods (some months)
- Traffic growth, because is very short paying back periods

These ignoring make the proposed method rather simple to use. At the same time it gives quite good indication for assessing the effectiveness of the investment compared to other investments in the society and very good indication to compare traffic and transport investments among themselves