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FEASIBILITY STUDY FOR THE REHABILITATION AND EXTENSION OF THE ROAD M3 CHISINAU – GIURGIULESTI/ROMANIAN BORDER

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1 GEOTECHNICAL INVESTIGATION

1.1 General

For the preparation of the Feasibility study and preliminary design of the M3 Chisinau-Giurgiulesti Road Rehabilitation geotechnical and materials investigation had to be carried out to provide the design team with the required reliable geotechnical and material information. The M3 road from Chisinau to Giurgiulesti with a total length of about 215km is mainly a two lane road with the exception of the first 34km which have four lanes.

This report details the characteristics of the terrain and foreseen difficulties during the rehabilitation works for the M3 Chisinau-Giurgiulesti road. It describes the general methodology that was used to conduct the geological and geotechnical studies and investigations and studies undertaken to assess the geomorphologic and geotechnical characteristics along the project road, identify potential critical areas and determine the requirements of appropriate slope stabilization and erosion protection.

To establish the feasibility to incorporate parts of the existing pavement into the rehabilitated road the bearing capacity of the existing pavement had to be assessed. A limited amount of investigations and test were carried out to substantiate visual inspection for feasibility purposes.

Data and information from previous studies relevant to the present project concerning subgrade and construction materials as well as available information about history of the existing road and road pavement respectively were reviewed. During the Consultant’s field reconnaissance these data were verified and consequently the program of required geotechnical investigations, sampling and laboratory testing was determined.

Information obtained from geological maps and available reports was used to set up the geological outline of the project area and determine the geomorphologic and geotechnical characteristics along the project road.

The preliminary road design follows mainly the existing road alignment. The investigations and tests have therefore been carried out on the existing road and the immediate vicinity. In addition along where bypass sections have been designed investigations have been done on the proposed new alignment.

The scope of the geotechnical study relates primarily to the assessment of the subgrade strength, the type and structure of the existing pavement, the location of suitable construction material and provision of parameter for elaboration of rehabilitation measures and a preliminary pavement design.

1.2 Desktop studies

Data and information from previous studies relevant to the present project concerning subgrade and construction materials as well as available information about history of the existing road and road pavement respectively were reviewed including the following:

- *Chisinau-Reni Road Construction, Rezeni-Mihailovca Section, km32 -40 anti sliding, IPDA Institute for Road Design, 1991*
- *Cimislia Bypass Construction Project, Mihailovca-Basarabeasca sector, IPDA Institute for Road Design, 1991.*

- *Comrat Bypass Construction Project I, IPDA Institute for Road Design, 1988*
- *Working Design of Comrat Bypass Construction, II StageI, IPDA Institute for Road Design, 1988.*
- *Detailed Design of Ciumai-Burlaceni-Vulcanesti M3 Road, IPDA Institute for Road Design, 1997.*
- *Vulcanesti Bypass Construction, IPDA Institute for Road Design, 1998.*
- *Feasibility Study of Slobozia Mare-Giurgiulesti Road Construction, IPDA Institute for Road Design, 1992.*

1.3 Geological overview of the project area

In the geological structure of Republic of Moldova the Neogene, Quaternary and contemporary deposits are prevalent.

The Neogene deposits are developed all over the Republic and are represented by sands and loams, limestone and marls. In south – west the thickness of Neogene deposits reaches 400 m.

The Quaternary deposits are developed almost overall in Moldova. In the river valleys their depth reaches 30 m. The thickness of deposits is increasing from north to the south. The loess-type loamy soils, sands, loams, silts and pebbles of the river valleys are prevalent.

The contemporary deposits are represented by deposits of gullies, waterway channels, various embankments, including the motor way embankments, dams, channels, and contemporary landslide deposits. Most underground waterbearing stratums are related to the depths of Neogene deposits.

The project area is located within the limits of the central part of Moldova. The relief of this area is considerably cut with ravines and has high seismicity magnitude. The area is formed of middle Sarmate, upper Sarmate and Quaternary age soils. The middle Sarmate is exposed in the valleys of rivers Isnovat, Botna, Botnisoara and is represented by loams, sands and limestone.

The clays are grey, greenish-grey, green and blue and have solid and semi-solid consistency with thin layer of dust sand, tightly and not –tightly adhered to them, with clusters and crystals of gypsum. They can be a reliable basis for piles when building the foundations of artificial structures as viaducts and bridges over roads and rivers.

Calcareous sand, loose limestone is exposed in the valley of river Isnovat. They are represented by silty sands with limestone fragments and broken seashell; they are water-saturated and occur in the limestone of middle rigidity (the limestone residual soil). The limestone is grey, light-grey, organogenic, oolitic, porous. The exposed thickness is up to 3.4m and can be a basis for piles of the bridge over the river Isnovats and for piles of the viaduct over the motorway Singera – Bacioi – Cutuzov.

The upper Sarmate loams and sands occur on sections of deep excavations and high embankments The clays are greenish-grey, green, have solid and semi–solid consistence; these clays are also rich, with thin layer of sand tightly and not–tightly adhered to them, often having the thin-layer structure and gypsum clusters insertions. The opened thickness reaches 19.0 m. If the excavation method has been used for opening so the weathering processes rapidly impairing their bearing capacity. The sands are silty, yellowish-grey, with loamy sand interlayers, with scattered crushed sand stone; they have the various humidity and their thickness reaches 7-8 m.

The Quaternary deposits genetically (originally) are represented by the alluvial, eluvial – dealluvial, dealluvial deposits and anthropogenic formations. The alluvial deposits are exposed (opened) on the flood plains of Isnovat, Botna and Botnisoara rivers.

Seismic activity, geo-hazards, natural disasters

The Republic of Moldova is situated in a seismic zone where the earthquakes can reach the magnitude of 8-9. During the last 200 years Moldova has been affected by 18 earthquakes of magnitude 7-9.

There are about 16,000 areas affected by landslides in the Republic of Moldova. The highest intensity thereof is registered in the central region of the country and the Tigheci plateau, where over 1500 areas at risk are located within the settlements. The situation is so serious that 48 villages have to be moved to new locations to avoid the danger for human lives and material property.

The landslide activity is influenced by the landscape, the geological structure, the quantity and dynamics of precipitation. Human activities (e.g. the way the settlements are placed and built) can exacerbate the landslide processes. In February-March, 1998 the intensity of landslides in the central part of Moldova, including Chisinau, considerably increased.

Within the project area direct affecting the existing alignment and new designed bypass sections at this stage only the potential landslide near Porumbrei village has been detected.

On the slope of the valley beyond Porumbrei village on the existing road the engineering-geological conditions of the deep excavation pit are characterized by availability of a massive thick layer of sand soils, overlaid by a layer of loam, with Neogene clay underneath. The layer of sand is characterized by great abundance of water, and when the excavation is opened the sand may turn into a flowing liquid state. In connection with this the following measures are required:

- construction of drainage systems on the slopes of the excavation pit;
- protection of slopes by means of geo-textile membranes;
- depending on the results of the detailed engineering-geological survey it may be necessary the construction of supporting structures.

The most frequent natural phenomena in 2002 were the torrential rains with hail and floods caused by intensive rains. As a result of these phenomena emergency situations arose at the national, regional and local levels.

1.4 Climate

The climate of the Republic of Moldova is moderately continental. It is characterized by a lengthy frost-free period, short mild winters, lengthy hot summers, modest precipitation, and long dry periods in the south. The average annual temperature increases southward from around 8-9℃ in the north to around 10-11℃ in the south. The average annual precipitation varies between 600-650 mm in the north and the center and 500-550 mm in the south and the southeast.

The M3 corridor is located in the Climatic Zone with temperate continental climate. The Table 1-1 provides an overview of climatic variables in the study area.

Table1-1. Climatic Variables

District	Frost Penetration Max.	Frost Penetration Avg.	Snow Cover* Max.	Annual Precipitation
Ialoveni	60-65 cm	35-40 cm	31 cm	485 mm
Cimislia	65 – 70 cm	35-40 cm	18 cm	435 mm
Comrat	65 – 70 cm	35-40 cm	18 cm	420 mm
Cahul	55 – 60 cm	30-35 cm	33 cm	475 mm
Vulcanesti	55 – 60 cm	25-30 cm	33 cm	420 mm

Source: The Consultant * 10 year average

1.5 Geotechnical field Investigation and laboratory testing

1.5.1 Methods of investigation and testing

Following a review and evaluation of existing information regarding soil, pavement and material conditions for the project road sections an investigation and testing program has been developed and implemented.

Field testing, sampling and laboratory testing has been designed to provide information as follows:

Trial Pits
Trial pits were sunk at approximate nominal intervals of around 6.0km with each pit attaining a target depth of 1.0 m. The pitting operations were carried out with an excavator. The test pits were located on alternate edges of the road. To minimize traffic interruption, excavation of trial pits was done only at the road edges. The aim of the excavation of trial pits was to determine the structure of existing pavement, the type of soil in the subgrade including extraction of material samples. In-situ density tests to determine the actual density of the subgrade where executed at selected locations

Bulk samples have been taken; pavement and subgrade layers have been recorded and are shown in detail in Annex GEO, Table 1. The stratigraphy revealed by each pit was carefully logged with special note taken to the thicknesses and conditions of the various pavement layers. Bulk samples were recovered from the unbound pavement layers and subgrade for laboratory testing. In addition samples of the existing asphalt were taken for testing.

Asphalt cores
Asphalt cores from the existing pavement were taken at intervals of about 2km alternating between right and left lane in order to determine the number and thickness of the existing bituminous layers.

Dynamic Cone Penetration Test (DCP)
Dynamic Cone Penetrometer (DCP) tests were conducted through the pavement layers below the bituminous surfacing to provide an estimate of the in-situ CBR-value of the granular layers, the subgrade and the top of the embankment. On road sections without or with extremely deteriorated asphalt pavement DCP test were executed from the existing surface be it a gravel layer or a subgrade material. DCP tests at this stage were performed along the road in intervals of 2.0km, alternating between right and left lanes. For the acquisition of additional relevant field

data as in-situ CBR values, a program of dynamic cone penetrometer testing was carried out, using the TRL model cone penetrometer with the following characteristics:

Weight of hammer	8 kg
Height of drop of hammer	575 mm
Cone diameter	20 mm
Cone Angle	60 degrees

The TRL DCP is an instrument designed for the rapid in-situ measurement of the structural properties of existing road pavements constructed with unbound materials. Correlations have been established between measurements with the DCP and CBR (California Bearing Ratio) so that results can be interpreted and compared with CBR specifications for pavement design.

Prior to the performance of a series of tests on the road, the zero reading of the penetrometer was determined. The dynamic penetrometer tests were then performed along the road, alternating between the right and left lanes, by taking readings of cone penetration after a number of blows depending on the consistency of the layer being penetrated.

The bituminous surface was penetrated prior to testing by core drilling. The test was then carried out directly on the unbound base/subgrade layer. The tests were terminated at maximum depths of 1000mm wherever possible. At some test points where it was suspected that the test was conducted on isolated bigger stones the test was repeated at a new location close by.

A total number of 71 DCP Test were carried during the actual investigation. The exact locations of all DCP tests carried out are listed in Annex GEO, Table 6.

Locating and sampling of road construction materials
Sources of suitable construction materials for the road and structures had to be located within economic hauling distances. Existing borrow areas and quarries as well as available laboratory test results of borrow material have been reviewed. A detailed description of the results of the construction material investigation is presented in a separate chapter of the report.

The Republic of Moldova has only few natural resources containing high quality aggregates suitable for construction of bound and unbound pavement layers, asphalt and cement concrete. A number of locations with suitable material are no longer accessible as they are located in environmental protected areas.

There is no local bitumen production in the Republic of Moldova. All bitumen and bitumen based product have to be imported.

At the time of compiling this report the only cement factory in Moldova producing cement for the local market is the “Ciment” plant in Rezina.

Laboratory testing
Samples from each type of subgrade soil encountered, existing base and sub-base course and from potential construction material sources were collected from site and brought to the Soils- and Materials Laboratory “State Organization Institute INGEOCAD” in Chisinau for testing.

Analyses of samples from existing asphalt were done by the Testing Laboratory of the “State Road Administration” of the Republic of Moldova in Chisinau.

The laboratory tests of soils are done according the requirements of State Soils Test Standards (GOST). Also, data on soils characteristics are according SNiP - performance requirements in construction, especially SNiP 2.02.01-83, SNiP 2,05,02-85, SNiP 2.05.03-84.

1.5.2 Field Investigation

Geotechnical field work for the feasibility study and preliminary design commenced in November 2008 and was completed during December 2008. The field surveys were carried out by the Consultant's Geotechnical Engineer assisted by a team from Universinj Ltd in Chisinau.

For the design, surveys and investigations the project road has been subdivided into twelve (12) distinctive road sections. In the following investigations, tests and results for each of the road section will be listed separately. For the preparation of the preliminary design the field studies for the material and site investigations include the following:

Section 1: Chisinau-Razeni (km0.0 to km34.5)

Sub-section 1A: km0.0 to km32.0
This section is a four lane road with a cement concrete pavement. The pavement is general in a fair condition. Investigation and testing has therefore at this stage of the project been limited to visual inspection and assessment. No destructive testing has been scheduled or executed.

Sub-section 1B: km32.0 to km34.5)
This short road section is designed as a continuation of the four lane road, but the cement concrete pavement of the two right lanes have not been completed across the bridge around km32.3. Therefore the two lanes at the right side are not in use and the traffic is diverted on the two left lanes.

Investigation and testing has also on this subsection been limited to visual inspection and assessment. No destructive testing has been scheduled or executed.

Section 2: Porumbrei-Junction with R3 (km34.5 to km48.1)

Figure 1-1. Trial pit excavation

- 3 nos. trial pits excavations along the existing road, alternating between right and left lanes have been executed,
- 7 nos. of core drillings have been executed at 2.0km intervals and asphalt cores taken,
- 7 nos. DCP (TRL) Tests have been carried out at 2.0km intervals at the same locations as the core samples,
- Benkelman tests have been carried out along this road section.

No testing had been scheduled at this stage of the project along the about 500m long stretch with a cement concrete pavement thru the village Porumbrei.

Section 3: Junction R3-Cimislia (km48.1 to km57.3)
For this road section it was reported that rehabilitation measures have been scheduled to be executed in 2009. As the extend and volume of these works have already been determined within a separate project it is assumed not necessary to carry out additional investigations along this section during this phase of the project. No investigation and testing has been scheduled or executed.

Section 4: Cimislia town passage (km57.3 to km61.3)
Pavement rehabilitation works are planned for 2009. No investigation and testing has been scheduled or executed.

Bypass M3 extension and bypass Cimislia
The proposed bypass section is designed to branch of to the left of existing road alignment prior to the village Porumbrei at road chainage km34.05 (bypass km0.0) and joining the existing road south of Cimislia at km63.25 (bypass km33.6). The total length of the bypass is 33.6km.
Soil investigations have been carried out previously during the time of the Soviet Union in this section during the design phase for the bypass. At the beginning of the bypass a geo hazard in form of an ancient landslide exists, where the actual slope has not yet reached a state of final stability.

During the investigations for the design of the bypass about 80 boreholes have been drilled to maximal depth of 18.0m and 50 core samples taken and tested in the laboratory.

The detailed description of the geological and geotechnical Investigations executed are presented in *“Chisinau-Reni Road Construction, Rezeni-Mihailovca Section, km32 -40 anti sliding”, IPDA Institute for Road Design, 1991* and *“Cimislia Bypass Construction Project, Mihailovca-Basarabeasca sector” IPDA Institute for Road Design, 1991.*

Section 5: Cimislia-Comrat (km61.3 to km88.4)
The asphalt pavement in this road section has been reconstructed during 2008. The rehabilitation works were almost complete at the time of the field investigations in November 2008. No investigation and testing has therefore been scheduled or executed in this section.

Section 6: Comrat town passage (km88.4 to km95.3)

- 4 nos. of core drillings have been executed at 2.0km intervals and asphalt cores taken,
- 4 nos. DCP (TRL) Tests have been carried out at 2.0km intervals at the same locations as the core samples,

- Benkelman tests have been carried out along this road section.

Bypass M3 extension and bypass Comrat
The proposed M3 extension to bypass the town of Comrat leaves the existing alignment according the preliminary design to the left at road km76.3 (bypass km0.0) and joins the existing road south of Comrat at km96.7 (bypass km17.75). The total length of the proposed bypass has a total length of 17.75km.

Soil investigations have been carried out previously during the time of the former Soviet Union (FSU) in this section during the design phase for the bypass. During the investigations for the design of the bypass several boreholes have been drilled as follows:

1988: 57 boreholes with total length 540m drilled

1992: 33 boreholes, with total length 257 m drilled

During the drilling works about 190 core samples have been taken and delivered to the laboratory for testing.

The detailed description of the geological and geotechnical investigations executed is presented in the *"Comrat Bypass Construction Project I", IPDA Institute for Road Design, 1988* and *"Working Design of Comrat Bypass Construction, II StageI", IPDA Institute for Road Design, 1988.*

Section 7: Comrat-Junction R38 (km59.3 to km135.4)

- 5 nos. trial pits excavations along the existing road alternating between right and left lanes have been executed,

Figure 1-2.

Drilling and Extraction of Asphalt Cores

- 20 nos. of core drillings have been executed at 2.0km intervals and asphalt cores taken,
- 20 nos. DCP (TRL) Tests have been carried out at 2.0km intervals at the same locations as the core samples,

- Benkelman tests have been carried out along this road section.

Bypass Chirsova, Bypass Congaz, Bypass Svetlii
Along these three short, in a previous study proposed bypass sections, no soil investigations have been carried out. Investigation results from earlier studies were also not available. At this stage of the project the economic evaluation does not indicate feasibility of these bypasses. Therefore field investigations for these sections have not been scheduled at this stage of the project.

Section 8: Junction R38-Ciumai (km135.4 to km151.2)

- 2 nos. trial pits excavations along the existing road alternating between right and left lanes have been executed,
- 8 nos. of core drillings have been executed at 2.0km intervals and asphalt cores taken,
- 8 nos. DCP (TRL) Tests have been carried out at 2.0km intervals at the same locations as the core samples,
- Benkelman tests have been carried out along this road section.

Section 9: Ciumai-Vulcanesti (km151.2 to 172.7)

- 3 nos. trial pits excavations along the existing road alternating between right and left lanes have been executed,
- 10 nos. of core drillings have been executed at 2.0km intervals and asphalt cores taken,

Figure 1-3.

Execution of Dynamic Cone Penetration (DCP) tests

- 10 nos. DCP (TRL) Tests have been carried out at 2.0km intervals at the same locations as the core samples,
- Benkelman tests have been carried along this road section.

New Alignment and Bypass Ciumai-Burlaceni
Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU). During the investigations for the design of the bypass several boreholes have been drilled and samples taken and tested in the laboratory.

The new realignment and bypass section has a total length of about 15.3km which shortens the existing alignment of 21.4km by about 6.1km.

The detailed description of the geological and geotechnical investigations executed is presented in the "*Detailed Design of Ciumai-Burlaceni-Vulcanesti M3 Road", IPDA Institute for Road Design, 1997.*

Section 10: Vulcanesti town passage (km172.7 to km176.2)

- 1 nos. trial pits excavations along the existing road alternating between right and left lanes have been executed,
- 2 nos. of core drillings have been executed at 2.0km intervals and asphalt cores taken,
- 2 nos. DCP (TRL) Tests have been carried out at 2.0km intervals at the same locations as the core samples,
- Benkelman tests have been carried out.

Bypass Vulcanesti
The proposed road alignment to bypass the town of Vulcanesti has a total length of about 8.9km according the preliminary design. Soil investigations have been carried out previously during the time of the former Soviet Union (FSU) in this section during the design phase for the bypass. During the investigations for the design of the bypass for the first section 9 boreholes have been drilled, and for the second section 69 boreholes, samples taken and delivered to the laboratory for testing.

The detailed description of the geological and geotechnical investigations executed is presented in the project *"Vulcanesti Bypass Construction", IPDA Institute for Road Design, 1998.*

Section 11: Vulcanesti-Slobozia Mare (km176.2 to km201.9)

- 4 nos. trial pits excavations along the existing road alternating between right and left lanes have been executed,
- 13 nos. of core drillings have been executed at 2.0km intervals and asphalt cores taken,
- 13 nos. DCP (TRL) Tests have been carried out at 2.0km intervals at the same locations as the core samples,
- Benkelman tests have been carried out along this road section.

Section 12: Slobozia Mare-Giurguilesti (km201.9 to km215.8)

- 2 nos. trial pits excavations along the existing road alternating between right and left lanes have been executed,
- 7 nos. of core drillings have been executed at 2.0km intervals and asphalt cores taken,
- 7 nos. DCP (TRL) Tests have been carried out at 2.0km intervals at the same locations as the core samples,
- Benkelman tests have been carried along this road section.

New alignment and bypasses of Slobozia Mare, Cislita-Prut, Giurguilesti
Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU). During the investigations for the design of the bypass several boreholes have been drilled and samples taken and tested in the laboratory.

The detailed description of the geological and geotechnical investigations executed is presented in the *“Feasibility Study of Slobozia Mare-Giurgiulesti Road Construction”, IPDA Institute for Road Design, 1992.*

1.5.3 Laboratory testing

Laboratory tests were performed by the Soils and Materials Testing Laboratory “State Organization Institute INGEOCAD” in Chisinau. Routine laboratory testing to obtain the relevant material properties required for pavement rehabilitation measures and design was carried out on soil samples of the base/sub-base and subgrade material recovered from the trial pits and smaller percussion borings.

The following laboratory testing has been executed for the preliminary design:

- determination of grain size distribution
- determination of natural moisture content
- determination of Atterberg limits
- execution of Proctor tests (moisture density relation, MDD/OMC)
- determination of salinity

Laboratory tests as this stage of investigation were mostly carried out according Russian Standards as the available and existing laboratory equipment complies with GOST and other Russian Standards.

On samples from the existing asphalt pavement, consisting of the top asphalt layer and the second asphalt layer, the following laboratory tests have been performed:

- determination of bitumen content
- determination of aggregate grading

Samples from located borrow areas will be tested in the Materials Laboratory to determine the main material properties for soils and for aggregates, in addition historical information and test results will be reviewed and incorporated in the assessment of borrow areas. The above testing and soil classification was carried out as follows:

- The visual classification of soils was carried out according to AASHTO and ASTM, Standard Practice for Classification of Soils for Engineering Purposes. The pavement stratigraphy and soil profiles recorded in trial pits have been compiled and are attached to this report in Annex GEO, Table 1.

- The moisture density relations of soils were determined according Russian Standard (modified Proctor) providing the modified maximum dry density (MDD) and the related optimum moisture content (OMC).

1.6 Results of Field Investigations and Laboratory Testing

1.6.1 Field Investigation Results

Following the commencement of the field works in November 2008 all available results from site investigations and laboratory tests have been compiled to assess the existing pavement structure and subgrade condition with the following results:

Section 1: Chisinau-Razeni (km0.0 to km34.5)

Sub-section 1A: km0.0 to km32.0
Based on design information the cement concrete pavement has the following structure:

- 240mm cement concrete, no reinforcement
- 180mm cement stabilised granular base course
- compacted subgrade

The about 20year old existing cement concrete pavement of the four lane road is general in a fair condition. Few surface defects, cracks and edge deteriorations have been recorded on the first 22.0km. Signs of distresses of the concrete become more frequent from km22.0 towards the end of the section including a few depressions and a slightly uneven surface which result in a more rough riding condition.

It has been observed that all joints in the concrete pavement are not filled with a joint sealant and remain open or partly filled with soil. Obviously the joint filling material has vanished over the years or the joints have not been closed at all in some sections.

Sub-section 1B: km32.0 to km34.5)
Based on design information the cement concrete pavement has the following structure:

- 240mm cement concrete, no reinforcement
- 180mm cement stabilised granular base course
- compacted subgrade

In this section the two right lanes of the four lane road have not been completed at the approaches to the bridge. The traffic is therefore diverted to the two left lanes until the end of the concrete pavement at the entrance to Porumbrei village.

The pavement of the not used two right lanes has several locations where distorted concrete slabs have been observed.

The left lanes now used for the bidirectional traffic show some surface defect, cracks and depression and a general rough surface. Joints of the concrete pavement are empty as the joint filling material has vanished over the years

Section 2: Porumbrei-Junction with R3 (km34.5 to km48.1)
This section is a two lane road with an asphalt surface, except for a stretch of about 400m in the Porumbrei village which has a cement concrete pavement.

The short 400m long section of cement concrete pavement shows excessive cracking as the concrete slabs are extending over the full width of the carriage way without a joint. Joints exist only in transverse direction not longitudinal.

It was reported that the asphalt pavement of the road section from Porumbrei to junction with R3 has undergone rehabilitation and reconstruction measures only 2 years ago. However especially the first road stretch after Porumbrei until about km40.0 shows already severe deformation of the road. Deep depressions and severe road bed deformations at road edges together with rutting are signs of a weak pavement and soft subgrade.

A lot of patching has been observed and shorter stretches with completely new surface layer. From about km40.0 to the junction with the R3 the pavement is in a fair to locally poor condition.

The existing pavement from Porumbrei to the junction with the R3 consists generally of two bituminous layers over a granular road base. Underlying the road base is directly the subgrade or fill material. A distinct sub-base layer does not exist.

Trial pits
Based on field investigation results the pavement can be described as follows:

- surface layer with fine graded asphalt with varying thickness's from 50 mm to 150mm, at many location the original surface has been repaired, the thicker asphalt pavement has been recorded along the road stretch towards the junction with the R3,

- underlying the bituminous layers is a granular base material with a thickness varying from 100mm to 230mm. The existing base course material is a crushed limestone with varying contents of sand and fines,

- the embankment fill below the base course representing the subgrade is mainly a low to medium plastic clay, locally containing top soil. The road embankment is obviously constructed mainly with cohesive material excavated adjacent to the road. It seems that at some locations the road embankment has been build direct on the original surface without removing top soil completely.

The thickness of asphalt pavement, subbase and subgrade layers has been recorded and details are shown in Annex GEO, Table 1 and Table 2.

Core sampling
Core drillings have been executed at intervals of 2.0km alternating between right and left lane to extract core samples and determine the thickness of the asphalt layers. The combined asphalt thickness of the mainly two layers measured at the cores ranges from 85mm to 120mm. Detailed asphalt thickness on this section is shown on in Annex GEO, Table 2.

DCP Tests
To determine the in-situ strength of unbound pavement layers and subgrade material, dynamic cone penetrometer (TRL DCP) tests have been executed in a nominal distance of 2.0km.

The evaluation of these DCP tests has been done utilizing the software UK DCP, Version 3.1 provided by TRL.

The DCP test results show for the cohesive material in-situ CBR values as low a 7%, indicating a material which is considered the subgrade.

An overview presenting the subgrade in-situ CBR values according the DCP tests in graphic form is given in Annex GEO, Figure 1 and a summary of the DCP test results are presented in Annex GEO, Table 6 of this report.

Benkelman Tests
Tests with the Benkelman have been carried out. Test results and evaluations were not available at the time of compiling the report.

Section 3: Junction R3-Cimislia (km48.1 to km57.3)
Rehabilitation measures already designed and execution of works scheduled for 2009 therefore no investigation or testing carried out.

Section 4: Cimislia town passage (km57.3 to km61.3)
Rehabilitation measures already designed and execution of works scheduled for 2009 therefore no investigation or testing carried out.

Bypass M3 extension and bypass Cimislia
The highest point of the proposed bypass section is situated at the suburbs of village Porumbrei. The geological structure of this district is characterized by inconsistent lithology of soil, by separate layers wedging out on short distances and by facial replacement of sediments. The upper part of the soil sediments is mainly represented by clay and clayey soil, loess and loam.

Previous investigations have shown that at around km34.5 to km34.9 the designed bypass road crosses the top part of an ancient sliding sector. The previous investigation report states that the boundaries of the ancient landslide are very faintly expressed, and the typical relief forms of the sliding body (skeleton) are smooth. It also indicates that there are some other relief sections which are significantly deformed by ancient sliding processes. The steepness of the sliding slope in the central part is about 8^0, and at the RHS (km 35.0) about 9^0
It has been recommended to implement stabilizing measures in the critical sliding sector.

Groundwater at different level and locally water containing soil lenses have been recorded during the investigations.

Detailed description of investigation results in this section with regard to the potential geo-hazard (landslide) is presented in *“Chisinau-Reni Road Construction, Rezeni-Mihailovca Section, km32 -40 anti sliding”, IPDA Institute for Road Design, 1991.*

Cimislia town bypass
The southern end of the proposed alignment bypasses Cimislia township in the east und runs mainly through arable lands. According previous investigations the subsoil structure of this bypass section can be described as follows:

- Topsoil, thickness 0,3-1,0
- Loam, silty, brown, thickness 1,7-9,8м
- Clay, grey-brown. thickness 3,4-6,3м
- Clay, fat gray-brown, thickness 1,0-10,5м

The detailed results of previous geological and geotechnical field investigations are presented in the *"Cimislia Bypass Construction Project, Mihailovca-Basarabeasca sector" IPDA Institute for Road Design, 1991.*

Section 5: Cimislia-Comrat (km61.3 to km88.4)
The asphalt pavement in this road section has been rehabilitated during 2008. The rehabilitation works were almost complete at the time of the field investigations in November 2008. Therefore no investigation or testing has been carried out.

Section 6 to Section 12: Comrat to Giurgiulesti
At this stage of investigation the seven road sections from Comrat to Giurgiulesti are combined with regard to pavement structure and soil profiles.

On the road section from Comrat to Giugiulesti the asphalt pavement is visually in fair, locally poor condition. The pavement condition within the towns is generally poor to very poor, this may be a result of not functioning or missing drainage.

The existing pavement from Comrat to the junction with the R38 consists generally of two bituminous layers over a granular road base. Underlying the road base is directly the subgrade or fill material. A distinct sub-base layer does not exist.

Trial pits
Based on field investigation results the pavement can be described as follows:

- surface layer with fine graded asphalt with varying recorded thickness's from 30 mm to 80mm, often the original surface has been repaired
- second asphalt layer with varying thickness's from 40 to 90mm
- third asphalt layer has been found only locally with a thickness from 40 to 90mm, there have been more layers distinguished at some locations which are at this stage summarized with in the third layer
- Underlying the bituminous layers is a granular base material with a thickness varying from 120mm to 350mm. The existing base course material consists of crushed limestone with varying contents of sand and fines.
- The subgrade material below the base course varies from low to medium plastic clay with a stiff to firm consistency

The thickness of asphalt pavement, subbase and subgrade layers has been recorded and details are shown in Annex GEO, Table 1 and Table 2.

Core sampling
Core drillings have been executed at intervals of 2.0km alternating between right and left lane to extract core samples and determine the thickness of the asphalt layers. The asphalt thickness measured at the cores ranges from 60mm to 280mm. Detailed asphalt thickness on this section is shown on the in Annex GEO, Table 2.

Dynamic Cone Penetration (DCP) Tests
The DCP tests reached to a maximum depth of 1.8m below existing road surface. The results of the DCP Test were analyzed and evaluated according Road Note 8 by means of the computer program (UK DCP 3.1) developed by TRL. After entering the field measurements the program returns for zones (these vertical zones will be further on called "layers") of nearly constant penetration rates the in-situ CBR values and the relevant thickness. Calculated values for in-situ CBR > 150% are reduced to 150% for base course layers and values >50% for subgrade material are limited to 50% according recommendations in Road Note 8. At this stage of

investigation the road from Comrat to Giurgiulesti has been divided into seven sections for the evaluation of the DCP tests. The in-situ CBR value for the subgrade material has been calculated according the penetration resistance with the following results presented in Table 1-2:

Table 1-2. In-situ Subgrade CBR

Road section	Chainage		in-situ subgrade CBR
	from (km)	to (km)	%
Comrat - Junction R38	88.4	135.4	7 to 26
Junction R39 - Ciumai	135.4	151.2	7 to 15
Ciumai – Vulcanesti	151.2	172.2	11 to 21
Vulcanesti – Slobozia Mare	172.2	201.9	5 to 50
Slobozia Mare – Giurgiulesti	201.9	115.8	5 to 26

Source: The Consultant

An overview presenting the subgrade in-situ CBR values according the DCP tests in graphic form is given in Annex GEO, Figure 1 and a summary of the DCP test results are presented in Annex GEO, Table 6 of this report.

Benkelman Tests

Tests with the Benkelman beam are currently carried out. Test results and evaluations were not available at the time of compiling the report.

Bypass M3 extension and bypass Comrat

Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU). During the investigations for the design of the bypass several boreholes have been drilled and samples taken and tested in the laboratory.

The investigation results show a cohesive subgrade below a top soil layer of 0.2 to 1.0m. The subsoil ranges from silty sand and silty loam to fat clay. A detailed description and classification is presented in *"Comrat Bypass Construction Project I", IPDA Institute for Road Design, 1988* and *"Detailed Design of Comrat Bypass Construction, II StageI", IPDA Institute for Road Design, 1988.*

New alignment and bypass Ciumai-Burlaceni

Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU). During the investigations for the design of the bypass several boreholes have been drilled and samples taken and tested in the laboratory.

The investigation results show a cohesive subgrade material. A detailed description and classification of the subsoil strata is presented in the "*Detailed Design of Ciumai-Burlaceni-Vulcanesti M3 Road", IPDA Institute for Road Design, 1997.*

Bypass Vulcanesti

The first section of the proposed Vulcanesti bypass with a length of about 2.6km has already been constructed.

According previous investigations the geological structure for the second section can be described as follows:

- The geological structure of the road area is composed of sediments of Quaternary and Neogene systems.
- The Quaternary sediments are represented by backfill soil of the existing earthworks and topsoil. The area of flood-lands contains alluvial clay and loam with organic inclusions and fine sand intercepted by thin gravel layers.
- The slope area is composed of alluvial-diluvia loam and clay, as well as Neogene clay, loam and sand.

Detailed results and descriptions of the previous investigations for both bypass sections are presented in the relevant report *“Vulcanesti Bypass Construction”, IPDA Institute for Road Design, 1998.*

New alignment and bypasses of Slobozia Mare, Cislita-Prut, Giurguilesti
Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU). During the investigations for the design of the bypass several boreholes have been drilled and samples taken and tested in the laboratory.

Details on the performed investigation and results are presented in the *“Feasibility Study of Slobozia Mare-Giurgiulesti Road Construction”, IPDA Institute for Road Design, 1992*

1.6.2 Laboratory test results

Along the road alignment shallow trial pits were excavated in the carriageway down to the subgrade and disturbed and undisturbed samples taken. Laboratory tests on this material samples taken during field investigations were carried out to determine the main material properties with the following results:

Section 1: Chisinau-Razeni (km0.0 to km34.5)

Sub-section 1A: km0.0 to km32.0
No samples have been taken and no laboratory tests performed.

Sub-section 1B: km32.0 to km34.5)
No samples have been taken and no laboratory tests performed.

Section 2: Porumbrei-Junction with R3 (km34.5 to km48.1)

Existing bituminous layers
Samples of the existing asphalt pavement were taken by core drilling along the road and delivered to the laboratory for testing. The top and second/third asphalt layer were separated in the laboratory and analyzed to determine the bitumen content and grain size distribution of aggregates. Samples for each section were combined to accumulate sufficient material for laboratory testing.

The bitumen content of samples from the top layer (Surface Course) was determined in the laboratory at an average of 5.6 %. The fine content <0,071mm at an average of 8.0% is within the usual upper and lower limits for asphalt surface courses. Tested asphalt samples contain up to 31% aggregates larger than 15mm and up to 10% aggregates greater than 20mm. Aggregates of the existing asphalt are only partly crushed. Results are summarized in Annex GEO, Table 4.1

Samples of the second and third asphalt layer (Binder Course and base course), have been taken and analyzed. The bitumen content was determined at an average of 4.4% of the total mix. The fine content determined at an average of 7.0% for this section is within the normal range for an asphalt binder and base course. The analyzed asphalt samples contained up to 36% aggregates larger than 20mm. The detailed results are shown in Annex GEO, Table 4.2.

Existing base course
The term “existing base” or “base course” is restricted in this report for the purpose of identifying the existing pavement structure, for the uppermost granular layer adjacent to the surfacing containing mainly suitable granular material.
Samples from the existing base course material have been tested in the laboratory with the following results:

The grain size distribution of the tested samples shows gravel with small contents of sand and little fines. The sand content in the samples was determined around 4 % with a low fines (<0.063mm) content around 1.0 %. This base material is a crushed limestone from local quarries. The material has been classified as well graded sandy gravel (GW). Laboratory test results of granular material are summarized in Annex GEO, Table 5.

Subgrade
Laboratory tests on the samples of subgrade material from the existing ground below the road pavement were performed to determined material properties and the subgrade strength.

Based on the laboratory tests the subgrade material can be described as clay with varying fine-sand and silt content. The plasticity of the fine material ranges for the Liquid Limit from 30% to 45%. With a Plasticity Index from 11% to 20% the material has been classified as clay with medium plasticity.

The maximum dry densities (MDD) for the subgrade in this section range from 15.2 to 16.6kN/m^3 with optimum moisture contents (OMC) of 19% to 26%.

Determination of the in-situ density for the road section from Porumbrei to the junction with R3 returned dry densities for the clayey material between 17.0 and 19.5kN/m^3 with natural moisture contents ranging from 16.0 to 22.0%. The natural dry density of the cohesive material ranges between 112% and 120% MDD.
A summary of laboratory test results of subgrade material is presented in Annex GEO, Table 3.

Chemical laboratory tests to determine the salinity in the subgrade material have resulted in 160 to 220mg/kg sulphate (SO_4) content which is considered low aggressive to cement concrete according Russian standard GOST. Chloride content determined as Cl has resulted in 107 to 840mg/kg. This amount is considered low to medium aggressive against cement concrete according Russian standard GOST.

Section 3: Junction R3-Cimislia (km48.1 to km57.3)
Rehabilitation measures scheduled for 2009, no samples have been taken and no laboratory tests performed.

Section 4: Cimislia town passage (km57.3 to km61.3)
Rehabilitation measures scheduled for 2009, no samples have been taken and no laboratory tests performed.

Bypass M3 extension and bypass Cimislia
Laboratory tests have been performed on soil samples taken during the previous investigations for the bypass design. Testing at that time has been performed according Russian standards and procedures. Assessment and evaluation of laboratory tests results has also been done based on Russian specifications
Detailed laboratory results are presented in the previous soil investigation in *"Cimislia Bypass Construction Project, Mihailovca-Basarabeasca sector" IPDA Institute for Road Design, 1991* and *"Chisinau-Reni Road Construction, Rezeni-Mihailovca Section, km32 -40 anti sliding", IPDA Institute for Road Design, 1991*.

Section 5: Cimislia-Comrat (km61.3 to km88.4)
Pavement reconstructed and rehabilitate during 2008, no samples have been taken and no laboratory tests performed.

Section 6: Comrat town passage (km88.4 to km95.3)

Section 7: Comrat-Junction R38 (km95.3 to km135.4)

Existing bituminous layers
Samples of the existing asphalt pavement were taken by core drilling along the road and delivered to the laboratory for testing. The top and second/third asphalt layer were separated in the laboratory and analyzed to determine the bitumen content and grain size distribution of aggregates. Samples for each section were combined to accumulate sufficient material for laboratory testing.

The bitumen content of samples from the top layer (Surface Course) was determined in the laboratory at an average of 4.5% which is below the usual range for asphalt surface course. The fine content <0,071mm at an average of 7.0% is within the usual upper and lower limits for asphalt surface courses. Tested asphalt samples contain up to 6% aggregates larger than 15mm and no aggregates greater than 20mm. Aggregates of the existing asphalt are only partly crushed. Results are summarized in Annex GEO, Table 5.

Samples of the second and third asphalt layer (Binder Course and base course), have been taken and analyzed. The bitumen content was determined at an average of 4.5% of the total mix. The fine content determined at an average of 5.0% for this section is within the normal range for an asphalt binder and base course. The analyzed asphalt samples contained up to 20% aggregates larger than 20mm. The detailed results are shown in Annex GEO, Table 4.2.

Existing base course
The term "existing base" or "base course" is restricted in this report for the purpose of identifying the existing pavement structure, for the uppermost granular layer adjacent to the surfacing containing mainly suitable granular material.
Samples from the existing base course material have been tested in the laboratory with the following results:

The grain size distribution of the tested samples shows gravel with varying contents of sand and little fines. The sand content in the samples ranges from around 4% to 11 %, the fines

(<0.05mm) content was determined between 2.0 and 10%. This base material is a crushed limestone from local quarries.

The material has been classified as well graded sandy locally silty gravel (GW-GM). Laboratory test results of the grading of granular material are shown in Annex GEO, Table 5.

Subgrade
Laboratory tests on the samples of subgrade material from the existing ground below the road pavement were performed to determined material properties and the subgrade strength.

Based on the laboratory tests the subgrade material can be described as clay with varying fine-sand and silt content. The plasticity of the material ranges for the Liquid Limit between 24% and 34%. With a Plasticity Index from 8% to 13% the material has been classified as clay with low to medium plasticity.

The maximum dry densities (MDD) for the subgrade in this section range from 16.4 to 17.0kN/m³ with optimum moisture contents (OMC) of 18% to 21%.

Determination of the in-situ density for the road section from Comrat to the intersection with the R38 road returned dry densities for the clayey material between 13.1 and 19.2kN/m^3 with natural moisture contents ranging from 10 to 19%. The natural dry density of the cohesive material ranges between 79% and 116% MDD.

A summary of laboratory test results of subgrade material is presented in Annex GEO, Table 3.

Chemical laboratory tests to determine the salinity in the subgrade material have resulted in up to 2455mg/kg sulphate (SO_4) and a maximum of 734mg/kg chloride (Cl). The soil is therefore considered high aggressive to cement concrete according Russian standard.

Bypass M3 extension and bypass Comrat
At the beginning of this section a geo-hazard in form of a landslide has been observed. This area has been investigated in detail in the framework of previous design projects during the time of former Soviet Union.

A number of boreholes have been sunk und samples taken for laboratory testing. Detailed test results are available for the whole length of the bypass section and are presented in *“Comrat Bypass Construction Project I”, IPDA Institute for Road Design, 1988* and *“Detailed Design of Comrat Bypass Construction, II StageI”, IPDA Institute for Road Design, 1988.*

Section 8: Junction R38-Ciumai (km135.4 to km151.2)

Existing bituminous layers
Samples of the existing asphalt pavement were taken by core drilling along the road and delivered to the laboratory for testing. The top and second/third asphalt layer were separated in the laboratory and analyzed to determine the bitumen content and grain size distribution of aggregates. Samples for each section were combined to accumulate sufficient material for laboratory testing.
The bitumen content of samples from the top layer (Surface Course) was determined in the laboratory at an average of 4.8% which is below the usual range for asphalt surface course. The fine content <0,071mm at an average of 7.0% is within the usual upper and lower limits for asphalt surface courses. Tested asphalt samples contain up to 9% aggregates larger than 15mm and 7% aggregates greater than 20mm. Aggregates of the existing asphalt are only partly crushed. Results are summarized in Annex GEO, Table 4.1

Samples of the second and third asphalt layer (Binder Course and base course), have been taken and analyzed. The bitumen content was determined at an average of 4.8% of the total mix. The fine content determined at an average of 4.0% for this section is within the normal range for an asphalt binder and base course. The analyzed asphalt samples contained up to 31% aggregates larger than 20mm, detailed results are shown in Annex GEO, Table 4.2.

Existing base course
The term "existing base" or "base course" is restricted in this report for the purpose of identifying the existing pavement structure, for the uppermost granular layer adjacent to the surfacing containing mainly suitable granular material.

Samples from the existing base course material have been tested in the laboratory with the following results:

The grain size distribution of the tested samples shows gravel with extreme varying contents of sand and fines. The sand content in the samples ranges from around 1.0 % to 30%, the fines (<0.05mm) content from 1.0 to 12.0%. The base material consists of crushed limestone from local quarries. The material has been classified as gravel to sandy, silty gravel (GM-GW).Grain size distribution of granular material is shown in Annex GEO, Table 5.

Subgrade
Laboratory tests on the samples of subgrade material from the existing ground below the road pavement were performed to determined material properties and the subgrade strength.

Based on the laboratory tests the subgrade material can be described as clay with varying fine sand and silt content. The plasticity of the material ranges from values for the Liquid Limit between 33% and 35%. With a Plasticity Index from 13.0% to 14.0% the material is clay with low plasticity. The material has been classified as low plastic clay (CL).

The maximum dry density (MDD) for the subgrade in this section was determined at 16.4kN/m^3 with optimum moisture contents (OMC) between 20% and 21%.

Determination of the in-situ density for the section from km135.4 to km151.2 returned dry densities for the clayey material between 14.4 and 18.1kN/m^3 with natural moisture contents ranging from 12 to 15%. The natural dry density of the cohesive material ranges between 87% and 110% MDD.

A summary of laboratory test results of subgrade material is presented in Annex GEO, Table 3.
Determination of sulphate and chloride content in the subgrade material has shown maximum values of 5818mg/kg sulphate (SO_4) and up to 520mg/kg chloride (Cl). According Russian standards this soil is considered high aggressive to cement concrete.

Section 9: Ciumai-Vulcanesti (km151.2 to 172.7)

Existing bituminous layers
Samples of the existing asphalt pavement were taken by core drilling along the road and delivered to the laboratory for testing. The top and second/third asphalt layer were separated in the laboratory and analyzed to determine the bitumen content and grain size distribution of aggregates. Samples for each section were combined to accumulate sufficient material for laboratory testing.

The bitumen content of samples from the top layer (Surface Course) was determined in the laboratory at an average of 5% which is below the usual range for asphalt surface course. The fine content <0,071mm at an average of 8.0% is within the usual upper and lower limits for asphalt surface courses. Tested asphalt samples contain up to 8% aggregates larger than 15mm and 4% aggregates greater than 20mm. Aggregates of the existing asphalt are only partly crushed. Results are summarized in Annex GEO, Table 4.1

Samples of the second and third asphalt layer (Binder Course and base course), have been taken and analyzed. The bitumen content was determined at an average of 5.0% of the total mix. The fine content determined at an average of 5.0% for this section is within the normal range for an asphalt binder and base course. The analyzed asphalt samples contained up to 29% aggregates larger than 20mm, detailed results are shown in Annex GEO, Table 4.2.

Existing base course
The term “existing base” or “base course” is restricted in this report for the purpose of identifying the existing pavement structure, for the uppermost granular layer adjacent to the surfacing containing mainly suitable granular material.

Samples from the existing base course material have been tested in the laboratory with the following results:

The grain size distribution of the tested samples shows gravel with varying contents of sand and fines. The sand content in the samples ranges from around 2.0 % to 14 %, the fines (<0.05mm) content from around 4.0 to 8.0%. The base material consists of crushed limestone from local quarries. The material has been classified as gravel to sandy, silty gravel (GW).Laboratory test results of granular material are presented in Annex GEO, Table 5.

Subgrade
Laboratory tests on the samples of subgrade material from the existing ground below the road pavement were performed to determined material properties and the subgrade strength.

Based on the laboratory tests the subgrade material varies from silty fine-sand to clay. The plasticity of the fine material ranges for the Liquid Limit between 20% and 32%. With a Plasticity Index from 3% to 11% the material varies from sand-silt mixture to sand-clay mixture. The maximum dry densities (MDD) for the subgrade in this section range from 16.2 to 18kN/m^3 with optimum moisture contents (OMC) of 14% to 21%.

Determination of the in-situ density for this section returned dry densities for the clayey material between 15.4 and 17.3kN/m^3 with natural moisture contents ranging from 12 to 15%. The natural dry density of the cohesive material ranges between 90% and 107% MDD. For the more granular material in this section in-situ dry density was determined at 16.4kN/m^3 with a moisture content of 14%.A summary of laboratory test results of subgrade material is presented in Annex GEO, Table 3.

Chemical laboratory tests to determine the salinity in the subgrade material have resulted in sulphate (SO_4) content ranging from 1035 to 1591mg/kg SO_4 and a maximum of 460mg/kg chloride (Cl). The soil is therefore considered medium aggressive to cement concrete according Russian standard.

New alignment and bypass Ciumai-Burlaceni
Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU). During the investigations for the design of the bypass several boreholes have been drilled and samples taken and tested in the laboratory.

Laboratory test results show a cohesive subgrade material. Detailed test results and classification of the soil is presented in “*Detailed Design of Ciumai-Burlaceni-Vulcanesti M3 Road”, IPDA Institute for Road Design, 1997.*

Section 10: Vulcanesti town passage (km151.2 to km176.2)

Section 11: Vulcanesti-Slobozia Mare (km176.2 to km201.9)

Existing bituminous layers
Samples of the existing asphalt pavement were taken by core drilling along the road and delivered to the laboratory for testing. The top and second/third asphalt layer were separated in the laboratory and analyzed to determine the bitumen content and grain size distribution of aggregates. Samples for each section were combined to accumulate sufficient material for laboratory testing.

The bitumen content of samples from the top layer (Surface Course) was determined in the laboratory at an average of 6.3% which is within the usual range for asphalt surface course. The fine content <0,071mm at an average of 7.0% is within the usual upper and lower limits for asphalt surface courses. Tested asphalt samples contain up to 19% aggregates larger than 15mm and 9% aggregates greater than 20mm. Aggregates of the existing asphalt are only partly crushed. Results are summarized in Annex GEO, Table 4.1

Samples of the second and third asphalt layer (Binder Course and base course), have been taken and analyzed. The bitumen content was determined at an average of 6.3% of the total mix which is above the usual limit for binder course. The fine content determined at an average of 6.0% for this section is within the normal range for an asphalt binder and base course. The analyzed asphalt samples contained up to 29% aggregates larger than 20mm, detailed results are shown in Annex GEO, Table 4.2.

Existing base course
The term “existing base” or “base course” is restricted in this report for the purpose of identifying the existing pavement structure, for the uppermost granular layer adjacent to the surfacing containing mainly suitable granular material.

Samples from the existing base course material have been tested in the laboratory with the following results:

The grain size distribution of the tested samples shows gravel with varying contents of sand and little fines. The sand content in the samples ranges from around 5% to 25%, the fines (<0.05mm) content is very low with 3 to 5%. The base material consists mainly of crushed limestone from local quarries. The material has been classified as gravel to sandy gravel (GW-GM). Grain size distribution of existing granular material is shown in Annex GEO, Table 5.

Subgrade
Laboratory tests on the samples of subgrade material from the existing ground below the road pavement were performed to determined material properties and the subgrade strength.

Based on the laboratory tests the subgrade material can be described as sandy silty clay with varying sand and silt content. The plasticity of the tested material ranges for the Liquid Limit between 19% and 29%. With a Plasticity Index from 6% to 10% the material is a clay with low plasticity. The material has been classified as low plastic clay (CL).

The maximum dry densities (MDD) for the subgrade in this section range from 16.9 to 19kN/m³ with optimum moisture contents (OMC) of 13% to 19%.

Determination of the in-situ dry density for the section from km151.2 to km201.9 returned dry densities for the clayey material between 13.2 and 17kN/m^3 with natural moisture contents ranging from 10 to 19%. The natural dry density of the cohesive material ranges between 76% and 109% MDD. A summary of laboratory test results of subgrade material is presented in Annex GEO, Table 3.

Chemical laboratory tests to determine the salinity in the subgrade material have resulted in sulphate (SO_4) content ranging from 1343 to 6109mg/kg SO_4 and a maximum of 820mg/kg chloride (Cl). The soil is therefore considered high aggressive to cement concrete according Russian standard.

Bypass Vulcanesti

Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU). During the investigations for the design of the bypass several boreholes have been drilled and samples taken and tested in the laboratory.

The subsoil consists of clay, loam and silt and often a mixture a mixture of this two of the soils have been encountered. Samples of soil material extracted from the boreholes in different depth have been tested. According the historical laboratory test results the soil parameter have been determined within the following ranges:

Type of soil: loam, silt, clay

Liquid Limit:	23 to 43%
Plasticity Index:	5 to 26
Natural moisture content:	10 to 30%
In-situ density:	17.1 to 19.7 kg/m^3
Natural dry density	14.2 to 16.2 kg/m^3

The above values have been extracted from the relevant previous investigation report *“Vulcanesti Bypass Construction”, IPDA Institute for Road Design, 1998.*

Section 12: Slobozia Mare-Giurguilesti (km201.9 to km215.8)

Existing bituminous layers

Samples of the existing asphalt pavement were taken by core drilling along the road and delivered to the laboratory for testing. The top and second/third asphalt layer were separated in the laboratory and analyzed to determine the bitumen content and grain size distribution of aggregates. Samples for each section were combined to accumulate sufficient material for laboratory testing.

The bitumen content of samples from the top layer (Surface Course) was determined in the laboratory at an average of 5.6% which is within the usual range for asphalt surface course. The fine content <0,071mm at an average of 7.0% is within the usual upper and lower limits for asphalt surface courses. Tested asphalt samples contain up to 7% aggregates larger than 15mm and 2% aggregates greater than 20mm. Aggregates of the existing asphalt are only partly crushed. Results are summarized in Annex GEO, Table 4.1

Samples of the second and third asphalt layer (Binder Course and base course), have been taken and analyzed. The bitumen content was determined at an average of 5.6% of the total mix which is above the usual limit for binder course. The fine content determined at an average of 6.0% for this section is within the normal range for an asphalt binder and base course. The analyzed asphalt samples contained up to 21% aggregates larger than 20mm, detailed results are shown in Annex GEO, Table 4.2.

Existing base course

The term “existing base” or “base course” is restricted in this report for the purpose of identifying the existing pavement structure, for the uppermost granular layer adjacent to the surfacing containing mainly suitable granular material.

Samples from the existing base course material have been tested in the laboratory with the following results:
The grain size distribution of the tested samples shows gravel with varying contents of sand and little fines. The sand content in the samples was determined at around 8%, the fines (<0.05mm) content at around 3%. The base material consists mainly of crushed limestone from local quarries.

The material has been classified as well graded sandy gravel (GW). Laboratory test results of granular material are shown in Annex GEO, Table 5.

Subgrade

Laboratory tests on the samples of subgrade material from the existing ground below the road pavement were performed to determined material properties and the subgrade strength.
Based on the laboratory tests the subgrade material can be described as clay and silt. The plasticity of the tested material ranges for the Liquid Limit between 21 and 23%. With a Plasticity Index from 4 to 6% the material is a silt-sand and clay sand mixture. The material has been classified as clay (CL) at km209 and silt (ML) at km213.

The maximum dry densities (MDD) for the subgrade in this section range from 17.7 to 18.9kN/m³ with optimum moisture contents (OMC) of 12 to 15%.

Determination of the in-situ density for the section from km201.9 to km215.8 returned dry densities for the clayey material between 14.1 and 18.3kN/m^3 with natural moisture contents ranging from 8 to 16%. The natural dry density of the cohesive material ranges between 80% and 103% MDD. A summary of laboratory test results of subgrade material is presented in Annex GEO, Table 3.

Chemical laboratory tests to determine the salinity in the subgrade material have resulted in sulphate (SO_4) content ranging from 1155 to 1600mg/kg SO_4 and a maximum of 220mg/kg chloride (Cl). The soil is therefore considered high aggressive to cement concrete according Russian standard.

New alignment and bypasses of Slobozia Mare, Cislita-Prut, Giurguilesti

Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU). During the investigations for the design of the bypass several boreholes have been drilled and samples taken and tested in the laboratory.

The subsoil consists mainly of loam and silt and often mixture of this two soils have been encountered. Samples of soil material extracted from the boreholes in different depth have been tested. According the historical laboratory test results the soil parameter have been determined within the following ranges:

Type of soil: loam, silt

Liquid Limit:	23 to 29%
Plasticity Index:	5 to 10
Natural moisture content:	11 to 16%
In-situ density:	17.7 to 20.6 kg/m^3
Natural dry density	15.9 to 18.3 kg/m^3

The above values have been extracted from the previous investigation report and may not be complete. Details of the laboratory tests are presented in the *"Feasibility Study of Slobozia Mare-Giurgiulesti Road Construction", IPDA Institute for Road Design, 1992*

1.7 Evaluation of investigations and test results

The existing pavement of the M3 road sections Chisinau-Giurgiulesti has for the major length an asphalt surfacing consisting of two, locally only one layer. Exceptions are the first 35km with a cement concrete pavement. The road is over greater length constructed on an embankment of varying height. Remaining sections are at or near natural ground level. Road sections within a cut of shorter length are located mainly at the north and south end of the road.

Most the existing roads sections are in fair to poor only locally very poor condition. However the existing bituminous road surface on some road sections is widely in a condition which needs major maintenance and repair where rutting, depressions, alligator cracking and frequent transverse cracks have been recorded

Evaluation of each road section has been done based on all available information and results for the existing bituminous layer (actual condition, re-use), existing base course (grading, bearing capacity) and subgrade condition (determination of design subgrade strength).

The layer direct below the asphalt (granular base layer) has been obviously constructed from crushed limestone with varying grading and fine content. The base material has therefore along the road the same characteristics. This granular layer is underlain by a cohesive material, mostly clay, with varying content of silt, sand and gravel

Little or no useful drainage remains on some of the sections thru the towns and villages resulting in severe damage to the road pavement.

TRL-DCP test have shown in most sections low bearing capacity of the subgrade. It is therefore recommended to remove the existing asphalt layers to allow the construction of new unbound pavement layer to improve the strength of the road foundation. Material of the existing bituminous layers should be re-used and in-cooperated into the new pavement. A detailed proposal for the optimal and most economical way of reuse of the existing asphalt pavement will be prepared during design phase.
The existing base course layer is varying in thickness and quality over the length of the project road. The material does not comply with international specifications for granular base or subbase material. This granular material below the asphalt should be left in place if permitted by the vertical design. Following repair of wet sections with soil replacement, levelling, shaping and compaction this layer is providing an acceptable base at formation level for the new pavement construction. In some sections this material may act as a capping layer and should therefore wherever possible be left in place.

In the following the subgrade design CBR has been determined for the natural subsoil which is overlain in most sections by a granular layer. Also in most cases the granular material has a

higher CBR value this has not been considered as design CBR at this stage for the following reasons. This granular layer has in most sections an extremely varying thickness. During the design process it might become necessary in some sections to excavate this layer due to the design of the vertical alignment. Following the removal of the existing asphalt pavement levelling and shaping will be required which might also affect the usable thickness of this granular layer.
The maximum frost penetration depth during the winter period according historical records ranges from 600mm in the Cahul and Vulcanesti district to 700mm in Cimislia and Comrat district. Detailed information is provided in the chapter Climate of this report.

Section 1: Chisinau-Razeni (km0.0 to km34.5)

Sub-section 1A: km0.0 to km32.0
The existing cement concrete pavement of the four lane road is general in a fair condition. Few surface defects, cracks and edge deteriorations and open joints have been recorded on the first 22.0km. Signs of distresses of the concrete become more frequent from km22.0 towards the end of the section including a few depressions, open joints and a slightly uneven surface which result in a more rough riding condition.

Based on the inspection of the actual pavement condition in this section no indication of structural failures of the pavement has been detected.

To improve riding conditions and to limit further deterioration of the pavement the following repair and rehabilitation measures are proposed:

- crack repair
- edge repair, where spalling has occurred
- surface repair, where scaling and disintegration has occurred
- cleaning and filling of joints with appropriate sealant

In addition regular maintenance is required to keep the pavement condition at an acceptable service level. Maintenance activities shall include regular checks if road drainage installations are functional.

Sub-section 1B: km32.0 to km34.5)
For this short two lane road section with cement concrete pavement similar distresses as for sub-section 1A have been recorded.

The same rehabilitation and repair measures as for section 1A as well as maintenance activities shall be applied to this section:

- crack repair
- edge repair, where spalling has occurred
- surface repair, where scaling and disintegration has occurred
- cleaning and filling of joints with appropriate sealant

In addition regular maintenance is required to keep the pavement condition at an acceptable service level. Maintenance activities shall include regular checks if road drainage installations are functional.

Section 2: Porumbrei-Junction with R3 (km34.5 to km48.1)
This section is a two lane road with an asphalt surface, except for a stretch of about 400m in the Porumbrei village which has a cement concrete pavement.The existing pavement from

Porumbrei to the junction with the R3 consists generally of two bituminous layers over a granular road base. Underlying the road base is directly the subgrade or fill material. A distinct sub-base layer does not exist.

The short 400m long section of cement concrete pavement shows excessive cracking and require repair.

The road stretch from Porumbrei village until about km40.0 shows severe deformation of the road. Deep depressions and severe road bed deformations at road edges together with rutting are signs of structural failures of the pavement. In addition a lot of patching has been observed and shorter stretches with completely new surface layer.

From about km40.0 to the junction with the R3 the pavement is in a fair to locally poor condition.

Existing asphalt courses
On this road section the existing asphalt pavement has a thickness varying from 85mm to 120mm. The bituminous pavement along the road section from Porumbrei to junction with R3 consists mainly of two, locally only one layer. The asphalt pavement contains in the surface layer in average 5.6% bitumen, in the second layer 4.4%. This percentage of bitumen is within the requirements of international recognised standards for asphalt wearing course (> 5.2%) and binder course (>4.0%). Severe deformations and settlements of the road surface have been recorded from Porumbrei village to about km40.0.

Taking into consideration the general condition of the road surface from Porumbrei village to about km40.0 the existing asphalt pavement has to be removed and the pavement reconstructed following the preparation of a stable road foundation.

The existing asphalt should be removed, processed and reused. Possible options for processing, recycling and reuse are currently analyzed to determine the optimal technical and most economical solution. At this stage of the project cold recycling of the existing pavement is proposed.

Existing base course
The existing layer of material direct below the asphalt is considered as base course. This layer has varying thickness ranging from 140mm to 230mm.The existing mostly granular material can be described as crushed limestone with varying fine content. Laboratory test results show that the existing material does not fully comply with requirements for base course material.

Evaluation of DCP tests results show for this layer direct below the bituminous pavement a general high penetration resistance leading to in-situ CBR values ranging from 63 to 129%. High in-situ CBR values are a result of larger stones contained in the base material

Following the removal of the existing asphalt, local repairs including excavation and soil replacement at locations of settlements/depression and the removal of wet material and replacement with new material should take place. The existing base material should be reused as subbase material if a CBR >30% at 95% compaction can be always reached. Where the vertical alignment permits the material may left in place and used as capping and or leveling layer which might require the import of additional material.

Subgrade
A subbase layer does not exist and the base or top layer has been placed directly on the subgrade.

The subgrade in this section ranges from a clayey to a gravelly clay, locally with traces of topsoil and organic material. It is assumed that at the time of construction the existing topsoil has not been completely removed and the road embankment just placed on top of existing surface. Evaluation of DCP tests results show for the subgrade material in-situ CBR values ranging from 7% to 15%.

Using the lower 10 percentile of the in-situ CBR of the TRL DCP tests a subgrade in-situ design CBR of 7% has been determined for the road section. An overview presenting the subgrade strength in graphic form according the DCP tests performed is shown in Annex GEO, Figure 3.1

Taking into consideration all available tests results the design CBR has been assessed for this road section: subgrade design CBR = 7%.

Taking into consideration the severe climatic conditions along the project road special care is taken for the frost protection. The recorded long-term maximum frost penetration depth has been determined as 600 to 700mm in the Ialoveni and Cimisilia region. The whole length of this road section is situated in seismic zone 7.

Section 3: Junction R3-Cimislia (km48.1 to km57.3)
Rehabilitation measures scheduled for 2009 no investigations or testing performed.

Section 4: Cimislia town passage (km57.3 to km61.3)
Rehabilitation measures scheduled for 2009 no investigations or testing performed.

Bypass M3 extension and bypass Cimislia
The analysis of the engineering-geological information, obtained from investigations and surveys of previous years, serves as base for proposing a number of measures to provide stability to the designed road along the landslide section.

The previous proposal consists of placing a pattern of piles to prevent further sliding of the slope. A number of piles have already been constructed. There is no doubt that stabilisation measure have to be implemented along the potential slide are.

The determination of the measures to be implemented has to be done during the design phase and may incorporate the previous solution of piling as well as other methods.

The subsoil along this section consists of a cohesive material and it is assumed that a new pavement will depend on this material as road foundation either in-situ or as an embankment fill.

Taking into consideration the test results of the neighbouring sections with similar subsoil conditions a preliminary design CBR for this bypass section is proposed as follows: subgrade design CBR = 7%.
Taking into consideration the severe climatic conditions along the project road special care is taken for the frost protection. The recorded long-term maximum frost penetration depth has been determined as 600 to 700mm in the Ialoveni and Cimisilia region. The whole length of this road section is situated in seismic zone 7.

Section 5: Cimislia-Comrat (km61.3 to km88.4)
Pavement reconstructed and rehabilitated during 2008 no investigations or testing performed.

Section 6 and 7: Comrat town passage (km88.4 to km95.3)

Comrat-Junction R38 (km95.3 to km135.4)

Existing Asphalt courses
On this road sections the existing asphalt pavement has a thickness varying from 70mm to 280mm. The bituminous pavement consists mainly of two, locally three or more layer. The asphalt pavement contains in the surface layer in average 4.5% bitumen, in the second layer 4.5%. This percentage of bitumen is below the requirements of international recognised standards for asphalt wearing course (> 5.2%) but within the limit for binder course (>4.0%).

For the rehabilitation of this road sections of M3 Chisinau-Giurgiulesti road it is recommended that the existing asphalt pavement shall be removed, processed, reused and preferable in-cooperated into new pavement layers. The existing asphalt material has to be broken down to maximum particle sizes of 32.5mm or smaller depending on the intended use. Blended with granular material to comply with the relevant requirements it can be used as granular base or subbase. As the existing material properties are varying, frequent testing is required to verify compliance with the specifications.

Based on further investigation and testing it should be determined in which proportions a mixture of existing asphalt (broken down to sizes <32mm) with existing or new base material (limestone) can fulfil the requirements for base course material. The addition of cement to the mixture usually enhanced the strength of the mixture.

During the design phase it will also be determined along which road sections a direct or indirect in-place cold recycling of the existing asphalt pavement is feasible. The direct in-place recycling method normally requires road sections with sufficient subgrade strength and a horizontal and vertical alignment following closely the existing road alignment.

Existing base course
The granular material layer direct below the bituminous pavement is considered as base. This layer has varying thickness ranging from 120mm to 350mm. The existing mostly granular material can be described as crushed limestone with varying fine content.

Evaluation of DCP tests results show for this layer direct below the bituminous pavement a general high penetration resistance leading to in-situ CBR values ranging from 25% to >150 %. The extreme high in-situ CBR values are a result of larger stones contained in the base material

The sampled and tested material of the base layer does not comply with the requirements of recognized standards as neither the grading nor the CBR values do fully comply with the requirements for base material. Road sections with severe alligator cracking and rutting are indications of the locally poor base condition and weak subgrade.

For the reconstruction of the pavement the existing base material could be reused as material for a levelling or capping layer without additional treatment provided a CBR>15% can always be reached or if processed as supplementary subbase material if a CBR>30% at 95% compaction can always be reached. The import of new material may be required to reach the required layer thickness and strength.

If the new vertical alignment permits, the existing granular material can be in general left in place at road formation level, following the removal of the bituminous pavement. Local repairs including excavation and soil replacement at locations of settlements/depression and the removal of wet material and replacement with new material shall take place. Following levelling and shaping the material has to be compacted to at least 95% MDD (AASHTO T180) to a depth of 150mm.

Where the new design of the vertical alignment requires excavation to a certain depth the excavated granular material can be re-used for general fill or if processed, which will require at least screening, as material for subbase/capping. Compliance with the requirements for subbase/capping has to be verified prior and during placing of the material.

In sections where the design requires the vertical alignment to be raised the existing granular material may be left in place as part of a capping layer and levelled, shaped and compacted as required following the removal of the existing asphalt. Local replacement of unsuitable material shall be done prior to placing new layers of fill or capping/subbase material.

Subgrade
A subbase layer does not exist and the base or top layer has been placed directly on the subgrade.The subgrade in this section has been classified as clay. Evaluation of DCP tests results show for the subgrade material in-situ CBR values ranging from 7% to 26%. High in-situ CBR values are caused by single stones embedded in the subgrade.

Using the lower 10 percentile of the in-situ CBR of the TRL DCP tests a subgrade in-situ design CBR of 7% has been determined for the road section. An overview presenting the subgrade strength in graphic form according the DCP tests performed is shown in Annex GEO, Figure 2.

Taking into consideration all available tests results the design CBR has been assessed for this road section: subgrade design CBR = 7%.

Taking into consideration the severe climatic conditions along the project road special care is taken for the frost protection. The recorded long-term maximum frost penetration depth has been determined as 650 to 700mm in the Comrat region. This road sections are situated in seismic zone 7 and 8.

Bypass M3 extension and bypass Comrat
Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU).

The subsoil along this section consists of a cohesive material and it is assumed that a new pavement will depend on this material as road foundation either in-situ or as an embankment fill.

Taking into consideration the test results of the neighbouring sections with similar subsoil conditions a preliminary design CBR for this bypass section is proposed as follows: subgrade design CBR = 7%.

Taking into consideration the severe climatic conditions along the project road special care is taken for the frost protection. The recorded long-term maximum frost penetration depth has been determined as 550 to 700mm in the Comrat and Cahul region. This road section is situated in seismic zone 8.

A detailed description and evaluation of subsoil conditions is presented in *"Comrat Bypass Construction Project I", IPDA Institute for Road Design, 1988* and *"Detailed Design of Comrat Bypass Construction, II StageI", IPDA Institute for Road Design, 1988.*

Section 8: Junction R38-Ciumai (km135.4 to km151.2)

Existing Asphalt courses
On this road section the existing asphalt pavement has a thickness varying from 95mm to 140mm. The bituminous pavement along the road section from Junction R38 to Ciumai consists

mainly of two, locally three layer. The asphalt pavement contains in the surface layer in average 4.8% bitumen, in the second layer 4.8%. This percentage of bitumen is below the requirements of international recognised standards for asphalt wearing course (> 5.2%) and within limits for binder course (>4.0%).

For the rehabilitation of this road section of the M3 Chisinau-Giurgiulesti road it is recommended that the existing asphalt pavement shall be removed, processed, reused and preferable in-cooperated into the new pavement. The existing asphalt material has to be broken down to maximum particle sizes of 32.5mm or smaller depending on the intended use. Blended with granular material to comply with the relevant requirements it can be used as granular base, subbase or levelling/capping layer. As the existing material properties are varying, frequent testing is required to verify compliance with the specifications.

Based on further investigation and testing it should be determined in which proportions a mixture of existing asphalt (broken down to sizes <32mm) with existing or new base material (limestone) can fulfil the requirements for base course material. The addition of cement to the mixture usually enhanced the strength of the mixture.

During the design phase it will also be determined along which road sections a direct or indirect in-place cold recycling of the existing asphalt pavement is feasible. The direct in-place recycling method normally requires road sections with sufficient subgrade strength and a horizontal and vertical alignment following closely the existing road alignment.

Existing base course
The granular material layer direct below the bituminous pavement is considered as base. At km137.0 below the asphalt a 150mm thick layer of organic material visually classified as top soil has been recorded underlain by clay. The layer containing organic material has to be removed prior to any placing of new pavement layers. At this stage of investigation the exact extend of this layer could not be determined, but further investigations will be carried out during the following design phase.

The base course layer has varying thickness ranging from 150mm to 280mm. The existing mostly granular material can be described as crushed limestone with varying fine content.

Evaluation of DCP tests results show for this layer direct below the bituminous pavement a general high penetration resistance leading to in-situ CBR values ranging from 25% to >150 %. The extreme high in-situ CBR values are a result of larger stones contained in the base material

The sampled and tested material of the base layer does not comply with the requirements of recognized standards as neither the grading nor the CBR values do fully comply with the requirements for base material. Road sections with severe alligator cracking and rutting are indications of the locally poor base condition and weak subgrade.

For the reconstruction of the pavement the existing base material could be reused as material for a levelling or capping layer without additional treatment provided a CBR>15% can always be reached or if processed as supplementary subbase material if a CBR>30% at 95% compaction can always be reached. The import of new material may be required to reach the required layer thickness and strength.

If the new vertical alignment permits, the existing granular material can be in general left in place at road formation level, following the removal of the bituminous pavement. Local repairs including excavation and soil replacement at locations of settlements/depression and the removal of wet material and replacement with new material shall take place. Following levelling and shaping the material has to be compacted to at least 95% MDD (AASHTO T180) to a depth of 150mm.

Where the new design of the vertical alignment requires excavation to a certain depth the excavated granular material can be re-used for general fill or if processed, which will require at least screening, as material for subbase/capping. Compliance with the requirements for subbase/capping has to be verified prior and during placing of the material.
In sections where the design requires the vertical alignment to be raised the existing granular material may be left in place as part of a capping layer and levelled, shaped and compacted as required following the removal of the existing asphalt. Local replacement of unsuitable material shall be done prior to placing new layers of fill or capping/subase material.

Subgrade
A subbase layer does not exist and the base or top layer has been placed directly on the subgrade.

The subgrade in this section has during trial pit excavations visually assessed as clay with a firm consistence. Evaluation of DCP tests results show for the subgrade material in-situ CBR values ranging from 7% to 15%.

Using the lower 10 percentile of the in-situ CBR of the TRL DCP tests a subgrade in-situ design CBR of 6% has been determined for the road section. An overview presenting the subgrade strength in graphic form according the DCP tests performed is shown in Annex GEO, Figure 2.

Taking into consideration all available tests results the design CBR has been assessed for this road section: subgrade design CBR = 6%.

Taking into consideration the severe climatic conditions along the project road special care is taken for the frost protection. The recorded long-term maximum frost penetration depth has been determined as 550 to 700mm in the Comrat and Cahul region. This road section is situated in seismic zone 8.

New alignment and bypass Ciumai-Burlaceni
Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU).

The subsoil along this section consists of a cohesive material and it is assumed that a new pavement will depend on this material as road foundation either in-situ or as an embankment fill.Taking into consideration the test results of the neighbouring sections with similar subsoil conditions a preliminary design CBR for this bypass section is proposed as follows: subgrade design CBR = 6%.

Taking into consideration the severe climatic conditions along the project road special care is taken for the frost protection. The recorded long-term maximum frost penetration depth has been determined as 550 to 700mm in the Comrat and Cahul region. This road section is situated in seismic zone 8.

A detailed description and evaluation of the subsoil strata is presented in the “*Detailed Design of Ciumai-Burlaceni-Vulcanesti M3 Road”, IPDA Institute for Road Design, 1997.*

Section 9: Ciumai-Vulcanesti (km151.2 to 172.7)
In this road section a short stretch of concrete pavement around km167 exists. At this stage no investigations of the existing concrete pavement have been carried out.

Existing Asphalt courses

On this road section the existing asphalt pavement has a thickness varying from 45mm to 200mm. The bituminous pavement along the road section from Ciumai to Vulcanesti consists mainly of two, locally three layer.

The asphalt pavement contains in the surface layer in average 5% bitumen, in the second layer 5%. This percentage of bitumen is below the requirements of international recognised standards for asphalt wearing course (> 5.2%) and within limits for binder course (>4.0%).

For the rehabilitation of this road section of M3 Chisinau-Giurgiulesti road it is recommended that the existing asphalt pavement shall be removed, processed, reused and preferable in-cooperated into the new pavement. The existing asphalt material has to be broken down to maximum particle sizes of 32.5mm or smaller depending on the intended use. Blended with granular material to comply with the relevant requirements it can be used as granular base, subbase or levelling/capping layer. As the existing material properties are varying, frequent testing is required to verify compliance with the specifications.

Based on further investigation and testing it should be determined in which proportions a mixture of existing asphalt (broken down to sizes <32mm) with existing or new base material (limestone) can fulfil the requirements for base course material. The addition of cement to the mixture usually enhanced the strength of the mixture.

During the design phase it will also be determined along which road sections a direct or indirect in-place cold recycling of the existing asphalt pavement is feasible. The direct in-place recycling method normally requires road sections with sufficient subgrade strength and a horizontal and vertical alignment following closely the existing road alignment.

Existing base course

The granular material layer direct below the bituminous pavement is considered as base. This layer has varying thickness ranging from 240mm to 280mm. The existing mostly granular material can be described as crushed limestone with varying fine content.

Evaluation of DCP tests results show for this layer direct below the bituminous pavement a general high penetration resistance leading to in-situ CBR values ranging from 25% to >150 %. The extreme high in-situ CBR values are a result of larger stones contained in the base material

The sampled and tested material of the base layer does not comply with the requirements of recognized standards as neither the grading nor the CBR values do fully comply with the requirements for base material. Road sections with severe alligator cracking and rutting are indications of the locally poor base condition and weak subgrade.

For the reconstruction of the pavement the existing base material could be reused as material for a levelling or capping layer without additional treatment provided a CBR>15% can always be reached or if processed as supplementary subbase material if a CBR>30% at 95% compaction can always be reached. The import of new material may be required to reach the required layer thickness and strength.

If the new vertical alignment permits, the existing granular material can be in general left in place at road formation level, following the removal of the bituminous pavement. Local repairs including excavation and soil replacement at locations of settlements/depression and the removal of wet material and replacement with new material shall take place. Following levelling and shaping the material has to be compacted to at least 95% MDD (AASHTO T180) to a depth of 150mm.

Where the new design of the vertical alignment requires excavation to a certain depth the excavated granular material can be re-used for general fill or if processed, which will require at least screening, as material for subbase/capping. Compliance with the requirements for subbase/capping has to be verified prior and during placing of the material.
In sections where the design requires the vertical alignment to be raised the existing granular material may be left in place as part of a capping layer and levelled, shaped and compacted as required following the removal of the existing asphalt. Local replacement of unsuitable material shall be done prior to placing new layers of fill or capping/subbase material.

Subgrade
A subbase layer does not exist and the base or top layer has been placed directly on the subgrade.

The subgrade in this section ranges from a silty fine sand to clay. Evaluation of DCP tests results show for the subgrade material in-situ CBR values ranging from 11% to 18%.
Using the lower 10 percentile of the in-situ CBR of the TRL DCP tests a subgrade in-situ design CBR of 8% has been determined for the road section. An overview presenting the subgrade strength in graphic form according the DCP tests performed is shown in Annex GEO, Figure 2.

Taking into consideration all available tests results the design CBR has been assessed for this road section: subgrade design CBR = 8%.

Taking into consideration the severe climatic conditions along the project road special care has to be taken for the frost protection. The whole length of this road section is situated in seismic zone 8.

Section 10 and 11: Vulcanesti town passage (km172.7 to km176.2)

Vulcanesti-Slobozia Mare (km176.2 to km201.9)

Existing Asphalt courses
On this road section the existing asphalt pavement has a thickness varying from 55mm to 210mm. The bituminous pavement along the road from Vulcanesti to Slobozia Mare consists mainly of two, locally three or only one layer. The asphalt pavement contains in the surface layer in average 6.3% bitumen and in the second layer also 6.3%. This percentage of bitumen is within the requirements of international recognised standards for asphalt wearing course (> 5.2%) and for binder course (>4.0%).
For the rehabilitation of this road sections of M3 Chisinau-Giurgiulesti road it is recommended that the existing asphalt pavement shall be removed, processed, reused and preferable in-cooperated into the new pavement. The existing asphalt material has to be broken down to maximum particle sizes of 32.5mm or smaller depending on the intended use. Blended with granular material to comply with the relevant requirements it can be used as granular base, subbase or levelling/capping layer. As the existing material properties are varying, frequent testing is required to verify compliance with the specifications.

Based on further investigation and testing it should be determined in which proportions a mixture of existing asphalt (broken down to sizes <32mm) with existing or new base material (limestone) can fulfil the requirements for base course material. The addition of cement to the mixture usually enhanced the strength of the mixture.
During the design phase it will also be determined along which road sections a direct or indirect in-place cold recycling of the existing asphalt pavement is feasible. The direct in-place recycling method normally requires road sections with sufficient subgrade strength and a horizontal and vertical alignment following closely the existing road alignment.

Existing base course
The granular material layer direct below the bituminous pavement is considered as base. This layer has varying thickness ranging from 110mm to 130mm. The existing mostly granular material can be described as crushed limestone with varying fine content.

Evaluation of DCP tests results show for this layer direct below the bituminous pavement a general high penetration resistance leading to in-situ CBR values ranging from 25% to >150 %. The extreme high in-situ CBR values are a result of larger stones contained in the base material

The sampled and tested material of the base layer does not comply with the requirements of recognized standards as neither the grading nor the CBR values do fully comply with the requirements for base material. Road sections with severe alligator cracking and rutting are indications of the locally poor base condition and weak subgrade.

For the reconstruction of the pavement the existing base material could be reused as material for a levelling or capping layer without additional treatment provided a CBR>15% can always be reached or if processed as supplementary subbase material if a CBR>30% at 95% compaction can always be reached. The import of new material may be required to reach the required layer thickness and strength.

If the new vertical alignment permits, the existing granular material can be in general left in place at road formation level, following the removal of the bituminous pavement. Local repairs including excavation and soil replacement at locations of settlements/depression and the removal of wet material and replacement with new material shall take place. Following levelling and shaping the material has to be compacted to at least 95% MDD (AASHTO T180) to a depth of 150mm.

Where the new design of the vertical alignment requires excavation to a certain depth the excavated granular material can be re-used for general fill or if processed, which will require at least screening, as material for subbase/capping. Compliance with the requirements for subbase/capping has to be verified prior and during placing of the material.

In sections where the design requires the vertical alignment to be raised the existing granular material may be left in place as part of a capping layer and levelled, shaped and compacted as required following the removal of the existing asphalt. Local replacement of unsuitable material shall be done prior to placing new layers of fill or capping/subbase material.

Subgrade
A subbase layer does not exist and the base or top layer has been placed directly on the subgrade.

The subgrade in this section is generally low to medium plastic clay. Evaluation of DCP tests results show for the subgrade material in-situ CBR values ranging from 5% to 50%. High in-situ CBR values are caused by single stones embedded in the subgrade.

Using the lower 10 percentile of the in-situ CBR of the TRL DCP tests a subgrade in-situ design CBR of 5% has been determined for the road section. An overview presenting the subgrade strength in graphic form according the DCP tests performed is shown in Annex GEO, Figure 2.

Taking into consideration all available tests results the design CBR has been assessed for this road section: subgrade design CBR = 5%.

Taking into consideration the severe climatic conditions along the project road special care has to be taken for the frost protection. The whole length of this road section is situated in seismic zone 8.

Bypass Vulcanesti
The first about 2.6km long section of the design bypass has already been constructed. The second part of the bypass road alignment starting at km2+650 on the gentle slope of the Cogilnic river valley crosses the floodplains. The slope is dry, non-sliding. The flood-lands of the river are even, flat, without wetlands (swamped spots). During periods of abundant precipitations during the year the flood-lands are overflowed by waters of the Cahul River.

The unfavorable physical-geological processes and events are expressed by ravine erosion on the slopes and periodical overflow of Cahul River on the flood-lands. The designed alignment requires in one section an embankment of a height up to 13,5m. The stability and the settlement of the embankment shall be determined by calculations based on the proposed embankment material and existing subsoil conditions.

Following the high embankment the design requires the excavation of a deep cut section. The maximum depth of the cut is being designed as 19m and is located on the margin of the slope of Cahul river valley. The soil taken from the excavation of the cut can be used for construction of embankments. The stability of the high cut slopes have to be determined by calculations based on detailed investigations and laboratory tests during the design phase.

Taking into consideration the test results of the neighbouring sections with similar subsoil conditions and the frequent flooding of the area a preliminary design CBR for this bypass section is proposed as follows: subgrade design CBR = 5%.

The previously executed investigations and geological studies have not detected any geo-hazard along the designed bypass alignment. The whole length of this road section is situated in seismic zone 8.

Detailed description of the investigations and evaluation are presented in the report *“Vulcanesti Bypass Construction”, IPDA Institute for Road Design, 1998.*

New alignment and bypasses of Slobozia Mare, Cislita-Prut, Giurguilesti
Investigations for a new alignment and bypass have been previously carried out as part of a design prepared during times of the former Soviet Union (FSU). Details of investigations and evaluation are presented in the *“Feasibility Study of Slobozia Mare-Giurgiulesti Road Construction”, IPDA Institute for Road Design, 1992.*
The subsoil along this section consists of a cohesive material and it is assumed that a new pavement will depend on this material as road foundation either in-situ or as an embankment fill.

Taking into consideration the test results of the neighbouring sections with similar subsoil conditions a preliminary design CBR for this bypass section is proposed as follows: subgrade design CBR = 5%.

Taking into consideration the severe climatic conditions along the project road special care is taken for the frost protection. The recorded long-term maximum frost penetration depth has been determined as 600 to 700mm in the Ialoveni and Cimisilia region. The whole length of this road section is situated in seismic zone 8.

Section 12: Slobozia Mare-Giurguilesti (km201.9 to km215.8)
Existing Asphalt courses

On this road section the existing asphalt pavement has a thickness varying from 65mm to 240mm. The bituminous pavement from Slobozia Mare to Giurgiulesti consists mainly of two, locally three or only one layer. The asphalt pavement contains in the surface layer in average 5.6% bitumen, in the second layer also 5.6%. This percentage of bitumen is within the requirements of international recognised standards for asphalt wearing course (> 5.2%) and binder course (>4.0%).

For the rehabilitation of this road sections of M3 Chisinau-Giurgiulesti road it is recommended that the existing asphalt pavement shall be removed, processed, reused and preferable in-cooperated into the new pavement. The existing asphalt material has to be broken down to maximum particle sizes of 32.5mm or smaller depending on the intended use. Blended with granular material to comply with the relevant requirements it can be used as granular base, subbase or levelling/capping layer. As the existing material properties are varying, frequent testing is required to verify compliance with the specifications.

Based on further investigation and testing it should be determined in which proportions a mixture of existing asphalt (broken down to sizes <32mm) with existing or new base material (limestone) can fulfil the requirements for base course material. The addition of cement to the mixture usually enhanced the strength of the mixture.

During the design phase it will also be determined along which road sections a direct or indirect in-place cold recycling of the existing asphalt pavement is feasible. The direct in-place recycling method normally requires road sections with sufficient subgrade strength and a horizontal and vertical alignment following closely the existing road alignment.

Existing base course

The granular material layer direct below the bituminous pavement is considered as base. This layer has varying thickness ranging from 200mm to 500mm. The existing mostly granular material can be described as crushed limestone with varying fine content.

Evaluation of DCP tests results show for this layer direct below the bituminous pavement a general high penetration resistance leading to in-situ CBR values ranging from 25% to >150 %. The extreme high in-situ CBR values are a result of larger stones contained in the base material

The sampled and tested material of the base layer does not comply with the requirements of recognized standards as neither the grading nor the CBR values do fully comply with the requirements for base material. Road sections with severe alligator cracking and rutting are indications of the locally poor base condition and weak subgrade.

For the reconstruction of the pavement the existing base material could be reused as material for a levelling or capping layer without additional treatment provided a CBR>15% can always be reached or if processed as supplementary subbase material if a CBR>30% at 95% compaction can always be reached. The import of new material may be required to reach the required layer thickness and strength.

If the new vertical alignment permits, the existing granular material can be in general left in place at road formation level, following the removal of the bituminous pavement. Local repairs including excavation and soil replacement at locations of settlements/depression and the removal of wet material and replacement with new material shall take place. Following levelling and shaping the material has to be compacted to at least 95% MDD (AASHTO T180) to a depth of 150mm.

Where the new design of the vertical alignment requires excavation to a certain depth the excavated granular material can be re-used for general fill or if processed, which will require at least screening, as material for subbase/capping. Compliance with the requirements for subbase/capping has to be verified prior and during placing of the material.

In sections where the design requires the vertical alignment to be raised the existing granular material may be left in place as part of a capping layer and levelled, shaped and compacted as required following the removal of the existing asphalt. Local replacement of unsuitable material shall be done prior to placing new layers of fill or capping/subbase material.

Subgrade
A subbase layer does not exist and the base or top layer has been placed directly on the subgrade.The subgrade in this section ranges from sandy clay to silt. Evaluation of DCP tests results show for the subgrade material in-situ CBR values ranging from 5% to 26%.

Using the lower 10 percentile of the in-situ CBR of the TRL DCP tests a subgrade in-situ design CBR of 5% has been determined for the road section. An overview presenting the subgrade strength in graphic form according the DCP tests performed is shown in Annex GEO, Figure 2.

Taking into consideration all available tests results the design CBR has been assessed for this road section: subgrade design CBR = 5%.

Taking into consideration the severe climatic conditions along the project road special care has to be taken for the frost protection. The whole length of this road section is situated in seismic zone 8.The above determined preliminary subgrade design CBR values are summarized in the Table 1-3:

Table 1-3. Preliminary Subgrade Design CBR Values

Road section		subgrade CBR design values
from (km)	to (km)	%
Porumbrei 34.5	Junction with R3 48.1	7
Bypass M3 extension and bypass Cimislia		7
Comrat 88.4	Junction with R38 135.4	7
Bypass M3 extension and bypass Comrat		7
Junction with R3 135.4	Ciumai 151.2	6
Ciumai 151.2	Vulcanesti 172.7	8
New alignment and bypass Ciumai-Burlaceni		6
Vulcanesti 172.7	Slobozia Mare 201.9	5
Bypass Vulcanesti		5
New alignment and bypasses of Slobozia Mare, Cislita-Prut, Giurguilesti		5

Slobozia Mare 201.9	Giurguilesti 215.8	5

Source: Consultant

The subgrade material along all road sections contains material aggressive to cement concrete. Appropriate protective or other measures have to be taken for all concrete structures in contact with subgrade material to avoid damage to concrete structures due to the saline content of the subgrade.

At this stage of preliminary investigations it is the main aim to define a realistic subgrade CBR valid for most of the road length. Sections with weaker subgrade will be subject to a soil replacement or/and increased pavement thickness. Additional investigations and testing is required and scheduled to determine extend of areas with low subgrade strength. The whole length of this road is situated in seismic zone 7 and 8.

2 IDENTIFICATION OF CONSTRUCTION MATERIAL SOURCES FOR SUBBASE, BASE COURSE, BITUMINOUS MIXTURES AND CEMENT CONCRETE

2.1 General

For the preparation of the Feasibility Study for M3 Chisinau – Giurgiulesti road geotechnical and materials investigation had to be carried out to provide the design team with the required initial geotechnical and material information.

This section describes the investigations and studies undertaken to identify existing and potential sources of construction materials suitable for the construction of embankments, subbase, base, asphalt and cement concrete. Emphasis has been put on the investigation for suitable materials close to the project area and the most economic use of materials available during implementation of the project.

Data and information from previous studies relevant to the present project concerning construction materials have been evaluated. The information obtained from geological maps and available reports has been used to locate existing and potential quarries and borrow sites. Following the review of existing information the Consultant with the assistance of local experts carried out an investigation for suitable materials.

2.2 Identified Material Sources

Compilation and evaluation of investigations and all existing information indicate that naturally occurring granular material suitable for fill, capping, sub-base, base and asphalt does not exist or is not available in reasonable distance to the project area.

As a result of the geological condition the majority of the area of the Republic of Moldova is covered by fine grained cohesive soil. Granular deposits exist along rivers at the western and eastern border of the country. However most of these old borrow areas are closed and do no longer operate as they are located in environmental protected areas. Locations of main material sources in the republic of Moldova are shown on the attached map (Annex Geo Figure 3).

The only existing and operating rock quarry in the country near Soroca is located at the northern border to the Ukraine. This quarry, containing granite, is the main source of high quality crushed aggregates.

In the central and northern part of the Republic of Moldova there are several locations where limestone is extracted and processed. The limestone quarries closest to the project area are the quarries Micauti and Pietris near Chisinau. These quarries provide crushed limestone in the form of gravel and sand. At some locations the limestone is used to produce bricks.

It is reported that currently gravel and sand nearest to the project area is only extracted at the Viscauti borrow area in the eastern part of the country. Another borrow area near Chisinau near the village Cobusca Veche is producing only sand.

For the southern part of the project there are no recorded operating material sources containing granular material. It is therefore envisaged to import high quality aggregates for the construction of pavement layers from material sources in neighbouring countries, as Turcosia quarry in Romania.

Material suitable as general fill for embankment construction has been located during previous investigations in the vicinity of the project road.

A preliminary description of identified existing material sources deemed suitable for the M3 Chisinau-Giurguilesti road rehabilitation project together with a visual assessment, estimated quantities, locations and accessibility is listed below. The attached map provides an overview of the location of material sources in the Republic of Moldova.

2.2.1 Borrow pits and quarries

Based on the compiled information and evaluation of the availability of material suitable for road pavement construction purposes the following material sources are proposed to be used for the extraction of suitable material for the current project:

- Soroca, granite quarry
- Micauti, limestone quarry
- Piestris, limestone quarry
- Viscauti, gravel and sand borrow area
- Cobusca Veche, sand borrow pit

Material from the above quarries could be used for bound and unbound pavement layers but the distance to the project road and long haulage has to be considered.

Granite quarry Soroca
The only granite quarry in the Republic of Moldova is located at the northern border near the township of Soroca. The location is shown on the attached material sources location map in Annex GEO, Figure 3.

The quarry produces varies fractions of crushed material including sand and fines which can be used as filler for asphalt. A list with the actual type of materials produced according Russian specification including actual prices is attached.

Available test results of material samples from the quarry assumed to be representative for the quarry material show the following main material characteristics:
(Testing according Russian Standard and Specification)

Crushing resistance (similar ACV)	8.5 to 12.9%
Abrasion resistance (Similar LAA)	15.2 to 16.9%
Elongation/Flakiness	11 to 18%

The test results show that the material is in general suitable for the production of asphalt and cement concrete. However comprehensive testing has to be done to show compliance with the project specifications and requirements prior to use in the permanent works. The total usable material deposit is estimated at more than 4.0Mill. m^3

Acquisition of material from the Soroca quarry for the use in the project has to be negotiated and agreed with the operating enterprise and/or relevant authorities.

Limestone quarry Micauti
The limestone quarry Micauti is located near the village of Gornoe about 20km north of Chisinau. The location is shown on the attached material sources location map in Annex GEO, Figure 3.

The quarry produces varies fractions of crushed limestone material including sand and fines which can be used as filler for asphalt. A list with the actual type of materials produced according Russian specification including actual prices is attached.

Figure 2-1.
Micauti Limestone quarry

The material, a limestone, is in general relatively soft and might only be suitable for incorporation in a road base or subbase course but not for production of asphalt and cement concrete. However comprehensive testing has to be done to show compliance with the project specifications and requirements prior to use in the permanent works.

Crushed limestone is widely used for road construction purposes with the addition of cement to increase the strength. The total usable material deposit is estimated at more than 2.0Mill. m^3 Acquisition of material from the Soroca quarry for the use in the project has to be negotiated and agreed with the operating enterprise and/or relevant authorities.

Limestone quarry Pietris
This existing Limestone quarry is located north-west of Chisinau. The location is shown on the attached material sources location map in Annex GEO, Figure 3.

The material, a limestone, is in general relatively soft and might only be suitable for incorporation in a road base or subbase course but not for production of asphalt and cement concrete. However comprehensive testing has to be done to show compliance with the project specifications and requirements prior to use in the permanent works. Crushed limestone is widely used for road construction purposes with the addition of cement to increase the strength.

Permission and licences for the use of the borrow area and exploitation of material have to be obtained from the relevant authorities in agreement with the landowner.

Gravel and sand borrow area Viscauti
This existing borrow area is located about 60km north of Chisinau. Considering the great distance to the project area only high quality material for asphalt or cement concrete will be used due to the hauling distance and costs. The location is shown on the attached material sources location map in Annex GEO, Figure 3.

Information about quantity of remaining usable material as well as material test results will be provided within the next phase of the project. Comprehensive testing of the borrow material has to be done to show compliance with the project specifications and requirements prior to use in the permanent works.

Permission and licences for the use of the borrow area and exploitation of material have to be obtained from the relevant authorities in agreement with the landowner.

Sand borrow pit Cobusca Veche
This borrow area is located about 30km east of Chisinau and is therefore the nearest borrow area to the project road containing granular material. The location is shown on the attached material sources location map in Annex GEO, Figure 3.

Information about quantity of remaining usable material as well as material test results will be provided within the next phase of the project. Comprehensive testing of the borrow material has to be done to show compliance with the project specifications and requirements prior to use in the permanent works.

Permission and licences for the use of the borrow area and exploitation of material have to be obtained from the relevant authorities in agreement with the landowner.

Borrow areas for general fill material beside the road
In road sections where the design requires a widening, raising or construction of new embankments general fill material might be obtained from areas near the road alignment containing suitable fill material.

Borrow pit 1 near Comrat bypass
The proposed borrow area is located to the left of the proposed bypass alignment in a distance of about 0.5km. Access to the borrow area will be by dirt road. The location is shown on the attached material sources location map in Annex GEO, Figure 3.

From geomorphologic point of view the borrow pit represents a stretched hill. The slopes of this hill are steep, benched, non-sliding. The geological structure of the area has been explored to a depth of 21.0m during previous investigations. No unfavorable physical-geological processes and events or potential landslides have been found in the borrow area.

The proposed borrow area contains mainly a mixture of silt and clay. Depending on the time of the year, dry/wet season, the excavated material might require moistening for optimal compaction.
The available usable quantity within the borrow pit is estimated at 0.3 Mill. m^3 of general cohesive fill material for embankment construction.
Permission and licences for the use of the borrow area and exploitation of material have to be obtained from the relevant authorities in agreement with the landowner.

Borrow pit 2 near Comrat bypass
The proposed borrow area is located to the right of the proposed bypass alignment in a distance of about 1.0km. Access to the borrow area is provided be by dirt road which needs improvement. The proposed borrow pit area is mostly covered by private orchards. The location is shown on the attached material sources location map in Annex GEO, Figure 3.

The borrow pit area represents a slope of a medium steepness surrounded from both sides by ravines. The ravines are stabilized; there is turf on their sides and on their bottom. The slope is benched and stable, no wet spots in the area.

The geological structure of the area has been explored to a depth of 14.0m below existing ground level during previous investigations. The proposed borrow area contains below a topsoil layer of 0.3 to 1.0m thickness, loam material to about 4.0m depth. The loam is underlain by clay and silt intercepted by thin layers of sand. The available usable quantity within the borrow area is estimated at 0.4 Mill.m^3 of general cohesive fill material for embankment construction. Proposed borrow area is 100000m^2 (10ha).

It is not recommended to excavate the soil in the upper part of the borrow pit, where the watershed starts, also the water output is very low and it seems that the aquifer is localized.

Permission and licences for the use of the borrow area and exploitation of material have to be obtained from the relevant authorities in agreement with the landowner.

Borrow pit near Ciucur-Minjir bypass
The proposed borrow pit is located on the left side of the designed bypass alignment in a distance of about 1.5 km. The location is shown on the attached material sources location map in Annex GEO, Figure 3.

From geo-morphological point of view the borrow pit represents a stretched watershed slope of the gorge, edged by depressions (hollows) from the Northern and Southern part. The drop of height constitutes 6.0 m. The area is open from the Western part and is broken by shallow local small ravines.

The geological structure of the area has been explored to a depth of 12.0m below existing ground level during previous investigations. The available usable quantity within the borrow area is estimated at 0.15 Mill.m^3 of general cohesive fill material for embankment construction. Below a 0.3 to 0.5m thick topsoil layer the proposed borrow area contains loam and clay material with thin layers of sand.

No groundwater has been encountered during the previous investigations until a depth of 12m. Permission and licences for the use of the borrow area and exploitation of material have to be obtained from the relevant authorities in agreement with the landowner.

Borrow area 1 near Vulcanesti bypass
The borrow area is located in imediate proximity to the designed bypass road. From geomorphologic point of view the borrow pit area is dated back to the ancient sliding slope. The geological structure of the area has been explored to a depth of 18.0m below existing ground level during previous investigations.

The borrow pit contains sandy loam, sand and clay with thin layers of sand. On the surface the borrow pit is overlaid with topsoil with a thickness of about 0.2-0.7m. The available usable quantity within the borrow area is estimated at 0.05 Mill.m^3 of general cohesive fill material for embankment construction. The ground waters table has been encountered at the depth of 18.0m during previous investigations.

Soil samples from the proposed borrow area have been tested in the laboratory during previous investigations. These historic laboratory results of the borrow pit material as given in the old report are presented in the Table 2-1:

Table 2-1. Borrow Pit Material, Main Parameter

Characteristics of soils						
№	Description of soil	Natural moisture W	Optimal moisture W.o	Coeff. of moisture K_y	Density of dry soil g/см3	Maximum density max g/см3

1	Silt, sandy, loamy	0,05	0,16	0,31	1,42	1,77
2	Silt, sandy	0,08	0,15	0,53	-	1,83
3	Clay	0,10	0,15	0,73	1,72	1,83

Source: Consultant

Permission and licences for the use of the borrow area and exploitation of material have to be obtained from the relevant authorities in agreement with the landowner.

Borrow area 1 near Vulcanesti bypass
This existing borrow pit is located at the south-west suburb of Vulcanesti township near the railway station. The distance to the end of the designed alignment is about 0.8km. The geological structure of the area has been explored to a depth of 8.0m below existing ground level during previous investigations.

The borrow pit contains silty loam. Samples of the borrow material have been testing during the previous investigations. These historic laboratory results of the borrow pit material as given in the old report are presented below.

The remaining usable quantity within the borrow area is estimated at 0.05 Mill.m^3 of general cohesive fill material for embankment construction. No ground water has been encountered during previous investigations. The Table 2-2 shows the soil characteristics:

Table 2-2. Borrow Pit Material, Main Parameter

Characteristics of soils						
№	Description of soil	Natural moisture W	Optimal moisture W.o	Coeff. of moisture K_y	Density of dry soil g/cm^3	Maximum density max g/cm^3
1	Loam, silty	0,16	0,165	0,98	1,71	1,80

Source: Consultant

Permission and licences for the use of the borrow area and exploitation of material have to be obtained from the relevant authorities in agreement with the landowner.

2.2.2 Cement

Cement factories in Rezina and Ribnita are producing Portland cement. The production capacity of the Ribnita plant was reported as about 0.25million tons/year of which the majority is exported to the Russian Federation. The cement plant “Ciment” in Rezina, the only factory supplying the local market produces currently about 0.9milion t/year which is below the domestic demand of about 1.3 to 1.5million tons/year.

Demand for Portland cement exceeding the local production is satisfied by import from neighbouring countries.

2.2.3 Bitumen

Bitumen is currently not produced in the Republic of Moldova and all bitumen and bitumen based products have to be imported.

The Contractor shall be responsible for acquiring bituminous binder, bituminous emulsion and all other bituminous products for the project from dealer within the Republic of Moldova or from other countries and shall meet the required specifications. For cost calculation purpose all bituminous work shall include cost for acquiring bitumen from abroad.

3 EARTHWORKS

3.1 General

Where earthworks are required, these have been designed with full attention to the nature of the available materials and their strength and engineering properties. Where the existing profile is altered or the road widened, care has to be taken to adequately choose and place the material according requirements and that new fill is properly bonded to the existing work and that new fill material is suitable for use in the specific circumstances in which it is to be placed.

As far as practical the material resulting from cuts, widening of cuts or other excavations in the road reserve shall be utilised for construction of earthworks if suitable. Material which will not be used in earthworks due to quality or other reasons may be stockpiled for future use as topsoil or side fill.

During construction all earthworks shall be kept well drained and protected at all times. All windrows shall be cut away after construction to prevent the concentrated flow of water on completed earthworks layers, but, where necessary, flat berms shall be constructed to prevent the undue erosion of fill slopes. All permanent drains shall be constructed as soon as possible, together with sufficient additional temporary drains as may be necessary to protect the road prism, and shall be maintained in a good working order. Ruts, potholes, soft spots or any other damage developing in the earthworks after completion shall be repaired, and the damaged portions shall be reshaped and re-compacted. Side drains discharging water from cuts and all other drains shall be constructed in such a way that damage to the earthworks by erosion is avoided.

Proper precautions and temporary measures shall be taken in all cases to ensure that the method or procedure by which the fills are constructed will not impose loads on structures, especially on uncompleted structures, which may damage or overstress such structures.

All excavation shall be carried out to the required lengths, width, depths, inclinations and curvatures as required for the construction of the project. Wherever necessary for safety of the persons on site, adequate barricades and protective covers shall be provided around all excavations. The base of all excavations, after being trimmed and levelled, shall be well compacted to form a solid formation. To prevent damage to the prepared formation from weathering or construction activities adequate protection is required.

During construction, every effort should be made and measures taken to protect the subgrade before rain can soften it. Any subgrade material exposed during excavation works which will form part of the works should be protected from the ingress of water. Excavated material intended to be used or re-used should also be protected from water to avoid saturation and become unsuitable.
Embankments and other areas of fill shall be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct constructional plant and other vehicular traffic uniformly over them. Damage by constructional plant and other vehicular traffic shall be made good with material having the same characteristics and strength as the material had before it was damaged.

For the construction of a new pavement on the existing embankment it is important to start the new pavement construction on a formation that is shaped to allow adequate drainage and is sufficiently compacted. Compaction control tests and preferable plate load tests should be carried out to confirm the compliance of the formation with the design requirements.

3.2 Embankment construction

Materials for embankment construction shall be taken from the identified and recommended borrow areas or other material sources with similar or better material quality.

For construction of new embankments materials classified in the A-1, A-2-4, A-2-5, or A-3 groups according AASHTO M 145 shall be used if available and compacted to not less than 95% of the modified maximum dry density. Material of this character is not or only in greater distance available in the required quantity in the project corridor. If materials of the A-6 or A-7 groups will be used this has to be done with extreme care. Materials from these groups shall be compacted to not less than 95 % of the modified maximum dry density as determined in the laboratory and within two percentage points of the optimum moisture content. The material for the embankment construction has to be placed and compacted in layers not exceeding 250mm after compaction. The general fill material for embankments shall have a CBR equal or greater than the subgrade design CBR used in the pavement design.

Embankment construction or widening of embankments shall commence following the removal of vegetation and organic top soil where existing. Locally soft or muddy soil shall also be removed. Locally standing water on the surface may occur during times of higher rainfall. Prior to embankment construction this areas shall be drained to remove the surface water. Where a natural drain into near channels or ditches is not possible due to elevation difference the water has to be removed by pumping.

Construction of new embankments shall start at low point and material placed in layers approximately parallel to finished grade. The roadbed should be crowned or have other slopes to provide drainage at all times. Suitable equipment is required for spreading and to obtain uniform moisture content and layer thickness. The moisture content of the material placed should be at the time of compaction being within 2% of the optimum moisture content determined in the laboratory.

Material from recommended sources shall be placed in layers. The natural ground and the lowest layer of high embankments over soft ground shall be compacted to at least 92% of the modified maximum dry density (AASHTO T180) determined in the laboratory. The 500mm soil layer immediately beneath the subbase or capping layer should be compacted to at least 95% and shall have a CBR of equal or greater than the relevant subgrade design CBR (at 95%MDD) used in the pavement design. Compacted layer thickness shall not exceed 250mm. The embankment shall be constructed in such a way that at any time the surface is kept shaped and compacted so that surface water can run off quickly.

Where any additional material has to be imported to obtain the required level and layer thickness, and where the thickness of the layer of imported material would be less than the minimum layer thickness of at least 100mm after compaction, then the existing embankment material shall be scarified, the necessary imported material placed, and this combined material mixed and compacted to the full specified depth of the layer.

Where widening of the existing embankment is designed, it is essential to avoid different settlements of the road at the joint between the existing embankment and the new embankment which may result from the different stiffness and degrees of compaction of the existing and new fill. For widening of the existing embankment benching is an essential requirement for technically sound widening works. The following major steps for benching into an existing embankment slope should be followed:

- remove top soil and vegetation from the existing slope

- cut horizontal benches in the existing slope to a sufficient width to blend the new material with the existing embankment and to accommodate the placement, and compaction operations and equipment
- bench the slope as the embankment is placed, and compact into layers.
- begin each bench at the intersection of the existing slope and the vertical cut of the previous bench. Re-compact the cut materials along with the new widened embankment.

Recommended width of the base of each bench is ≥2.00m with height of the bench back slope ≤ 0.75m. This is to allow compaction and grading equipment to work on a level surface at any elevation from the bottom to the top of each bench.

Compaction of fill material placed upon an existing embankment slope, especially thin “sliver” fills of 1.0m or less thickness, is especially difficult. Conventional compaction equipment cannot be used on slopes as steep as a typical highway embankment, which means that fill placed directly on such a slope will generally be either poorly compacted or un-compacted, which leaves it highly susceptible to erosion or sliding failure. Even if compaction can be assured in such a fill, the sloping interface between the existing surface and the new fill provides a potentially weak continuous plane along which a shear failure may develop. This shall be avoided by using benching which creates a “stair-stepping” surface which improves stability by inhibiting the development of a contiguous shear plane along the interface.

The new pavement layers including capping layer where require and sub-base course shall be placed over the entire construction width.

Embankments shall be constructed according designed cross sections as shown on the relevant drawings and shall have side slopes as follows:1 : 3 (vertical : horizontal) for shallow embankments (height <3.0m); For higher embankments a slope of 1:2 to 1:1.5 should be used.

3.3 Construction of cut sections

The construction of new cuttings or widening of existing cut sections invariably disturbs the natural stability of the ground by the removal of lateral support and a change in the natural ground water conditions.

The preliminary design requires at several locations the construction of cut sections especially in new bypass sections by cutting into the hill or filling at the downhill side. Additional investigations will be required according the design.

New or widened cut slopes should be constructed according the design as shown on the relevant drawings with the following recommended slopes:

1: 1.5 (vertical: horizontal) for cut slopes ≤ 3.0m

1: 1.75 (vertical: horizontal) for cut slopes from 3.0 to < 6.0m

For cut slopes higher than 6.0m general benching is recommended and a slope of 1 : 2.

3.4 Capping layer/improved subgrade/soil replacement

Rehabilitation measures along the road include the removal of the existing pavement and replacement of wet muddy and soft soils. The minimum thickness of locally required soil replacement will be determined during the final investigation stage and will be shown in the pavement design as capping layer thickness. The capping layer (improved subgrade) thickness may vary depending on the local conditions along the road sections.

The soil replacement and construction of a capping layer is required to provide sufficient cover on weak subgrades. These measures are used in the lower pavement layers as a substitute for a thick sub-base to reduce costs. The requirements are less strict than for sub-bases.

A minimum CBR of 15 per cent is required for capping material at a density of 95%. The minimum required degree of compaction is 95 % MDD. Recommended grading or plasticity criteria are not given for these capping materials. However, it is desirable to select reasonably homogeneous materials since overall pavement behaviour is enhanced by this. The selection of materials which show the least change in bearing capacity from dry to wet is also beneficial. The capping layer or soil replacement material in cut sections shall have a low permeability to prevent ingress of water from the surface or granular pavement layers into the subgrade.

4 SUMMARY

4.1 General

For the preparation of the Feasibility study and preliminary design of the M3 Chisinau-Giurgiulesti Road Rehabilitation geotechnical and materials investigation had to be carried out to provide the design team with the required reliable geotechnical and material information. The M3 road from Chisinau to Giurgiulesti with a total length of about 215km is mainly a two lane road with the exception of the first 35km which have four lanes.

Within the M3 route there are two sections which are scheduled to be already rehabilitated in 2009 or have been resurfaced in 2008. These are the road sections from the junction of the M3 with R3 (km48.1) to Cimislia (61.3), including the town passage, where rehabilitation measures are scheduled for 2009, and the road section from Cimislia to Comrat. The asphalt pavement from Cimislia to Comrat has been rehabilitated during 2008. The rehabilitation works were almost complete at the time of the field investigations in November 2008.

This report details the characteristics of the terrain and foreseen difficulties during the rehabilitation works for the M3 Chisinau-Giurgiulesti road. It describes the general methodology that was used to conduct the geological and geotechnical studies and investigations and studies undertaken to assess the geomorphologic and geotechnical characteristics along the project road, identify potential critical areas and determine the requirements of appropriate slope stabilization and erosion protection.

Information obtained from geological maps and available reports was used to set up the geological outline of the project area and determine the geomorphologic and geotechnical characteristics along the project road.

4.2 Geological overview

In the geological structure of the Republic of Moldova the Neogene, Quaternary and contemporary deposits are prevalent. Most ground water bearing stratums are related to the depths of Neogene deposits.

The project area is located within the limits of the central part of Moldova. The relief of this area is considerably cut with ravines and has high seismicity magnitude. The area is formed of middle Sarmate, upper Sarmate and Quaternary age soils. The middle Sarmate is exposed in the valleys of rivers Isnovat, Botna, Botnisoara and is represented by loams, sands and limestone.

4.3 Seismic, Geo-hazards

The Republic of Moldova is situated in a seismic zone where the earthquakes can reach the magnitude of 8-9. During the last 200 years Moldova has been affected by 18 earthquakes of magnitude 7-9. It is reported that there are about 16,000 areas affected by landslides in the Republic of Moldova. The highest intensity thereof is registered in the central region of the country and the Tigheci plateau, where over 1500 areas at risk are located within the settlements. The whole length of the M3 road is situated in seismic zone 7 and 8.

The landslide activity is influenced by the landscape, the geological structure, the quantity and dynamics of precipitation. Within the project area direct affecting the existing alignment and new designed bypass sections at this stage only the potential landslide near Porumbrei village has been detected. This area has been surveyed and investigated previously during the time of former Soviet Union. From the historic investigation and tests results it has been concluded that in this section of the new bypass technical measures to stabilized the landslide are required.

4.4 Climate

The climate of the Republic of Moldova is moderately continental. It is characterized by a lengthy frost-free period, short mild winters, lengthy hot summers, modest precipitation, and long dry periods in the south.

Considering the cohesive subgrade and embankment fill along the project road attention has to be paid to the influence of freezing temperatures to the pavement layers and subgrade.

Based on long-term meteorological data the maximum depth of frost penetration has been recorded in the range from 600mm in the Cahul and Vulcanesti area to 700mm in the region around Cimislia and Comrat. The subgrade material is considered frost-susceptible.

4.5 Geotechnical field investigations

The scope of the geotechnical study at this stage relates primarily to the assessment of the subgrade strength, the type and structure of the existing pavement, the location of suitable construction material and provision of parameter for elaboration of rehabilitation measures and a preliminary pavement design.

Geotechnical field work for the feasibility study and preliminary design commenced in November 2008 and was completed during December 2008. The field surveys were carried out by the Consultant's Geotechnical Engineer assisted by a team from Universinj SRL in Chisinau.

For the preparation of the preliminary design the field studies for the material and site investigations included the following:

- Excavation of Trial pits along the existing road alternating between right and left lanes
- Execution of Dynamic Cone Penetration Tests (DCP) out at 2.0km intervals at the same locations as the core samples
- Drilling and extraction of Asphalt cores have been executed at 2.0km intervals
- Benkelman tests have been carried out along the road,

For the design, surveys and investigations the project road has been subdivided into twelf (12) distinctive road sections. In the following investigations, tests and results for each of the road section have been recorded and evaluated separately.

The proposed bypass sections had all been already been investigated during the during previous design phases at the time of former Soviet Union. At this stage of the project no additional investigation and testing had therefore been scheduled along the bypass and realignment sections.

4.6 Laboratory tests

Laboratory tests were performed on soil and asphalt samples extracted during the field investigations to determine the main parameter.

Samples from each type of subgrade soil encountered, existing base and sub-base course and from potential construction material sources were collected from site and brought to the Soils

and Materials Laboratory "State Organization Institute INGEOCAD" in Chisinau for testing. Analyses of samples from existing asphalt were done by the Testing Laboratory of the "State Road Administration" of the Republic of Moldova in Chisinau. The following laboratory testing has been executed on soil samples for the preliminary design:

- determination of grain size distribution
- determination of natural moisture content
- determination of Atterberg limits
- execution of Proctor tests (moisture density relation, MDD/OMC)
- determination of salinity

On samples from the existing asphalt pavement, consisting of the top asphalt layer and the second asphalt layer, the following laboratory tests have been performed:

- determination of bitumen content
- determination of aggregate grading

Laboratory tests as this stage of investigation were mostly carried out according Russian Standards as the available and existing laboratory equipment complies with GOST and other Russian Standards.

4.7 Evaluation and recommendation

The existing pavement of the M3 road sections Chisinau-Giurgiulesti has for the major length an asphalt surfacing consisting of two, locally only one layer. Exceptions are the first 35km with a cement concrete pavement. The road is over greater length constructed on an embankment of varying height. Remaining sections are at or near natural ground level. Road sections within a cut of shorter length are located mainly at the north and south end of the road.

Most the existing roads sections are in fair to poor only locally very poor condition. However the existing bituminous road surface on some road sections is widely in a condition which needs major maintenance and repair where rutting, depressions, alligator cracking and frequent transverse cracks have been recorded

Evaluation of each road section has been done based on all available information and results for the existing bituminous layer (actual condition, re-use), existing base course (grading, bearing capacity) and subgrade condition (determination of design subgrade strength).

The existing pavement consists mainly of two asphalt layers, locally one to three layers have been recorded. The asphalt is generally underlain by a layer of crushed limestone which is considered the base course. A subbase layer has not been detected during the investigations. The subgrade material either natural ground or embankment fill has a over the full length a cohesive characteristic, ranging from silty sand to fat clay.

The subgrade material along all road sections contains material aggressive to cement concrete. Appropriate protective or other measures have to be taken for all concrete structures in contact with subgrade material to avoid damage to concrete structures due to the saline content of the subgrade. At this stage for design purposes it is important that the strength of the subgrade is not seriously underestimated for large areas of pavement or overestimated to such an extent that there is a risk of local failures. Based on field and laboratory tests the preliminary subgrade design CBR has been determined in the range from 5 to 8% for the various road sections. This includes the bypass sections. In the Table 4-1 are shown the road sections and the CBR design values:

Table 4-1. Summary of Preliminary Subgrade Design CBR Values

Road section		subgrade CBR design values
from (km)	to (km)	%
Porumbrei 34.5	Junction with R3 48.1	7
Bypass M3 extension and bypass Cimislia		7
Comrat 88.4	Junction with R38 135.4	7
Bypass M3 extension and bypass Comrat		7
Junction with R3 135.4	Ciumai 151.2	6
Ciumai 151.2	Vulcanesti 172.7	8
New alignment and bypass Ciumai-Burlaceni		6
Vulcanesti 172.7	Slobozia Mare 201.9	5
Bypass Vulcanesti		5
New alignment and bypasses of Slobozia Mare, Cislita-Prut, Giurguilesti		5
Slobozia Mare 201.9	Giurguilesti 215.8	5

Source: The Consultant

In selecting the design CBR value for the subgrade, consideration has been given to the likely moisture conditions applying during construction, assuming that appropriate precautions are taken against excessive disturbance, as shall be demanded by the Specification. Also the likely long-term equilibrium moisture condition has been considered, making reasonable allowance for moisture ingress through the pavement, but assuming drainage is correctly installed as designed.

Most the existing roads sections are in fair to poor, only locally very poor condition. However the existing bituminous road surface on some road sections is widely in a condition which needs major maintenance and repair where rutting, depressions, alligator cracking and frequent transverse cracks have been recorded

For the rehabilitation of the M3 road from Chisinau to Giurgiulesti it is recommended to construct a new pavement over the entire length. This shall include the removal, reuse and recycling of the existing pavement layers. It is recommended to reuse the existing asphalt in a cold recycling process with or without the addition stabilising agents. The existing crushed limestone base may be left in place where the design permits as a capping, improved subgrade layer or part of subbase. In other sections with considerable change of the vertical or horizontal alignment the crushed material should be reused and incorporated as part of the new pavement structure where ever feasible

Considering the very limited availability of high quality aggregates for road construction, reuse and recycling of existing pavement material has to be a priority during any rehabilitation works.

4.8 Construction material sources

Natural sources for high quality aggregates for road construction and purposes are very rare in Moldova. The only existing and operating rock quarry in the country which is the main if not only source of high quality aggregates near Soroca is located at the northern border to the Ukraine.

Granular deposits exist along rivers at the western and eastern border of the country. However most of these old borrow areas are closed and do no longer operate as they are located in environmental protected areas. Locations of main material sources in the republic of Moldova are shown on the attached map (Annex Geo Figure 3). In the central and northern part of the Republic of Moldova there are several locations where limestone is extracted and processed. For the most southern section of the project road the import of high quality aggregates from neighbouring countries as Romania may be an option.

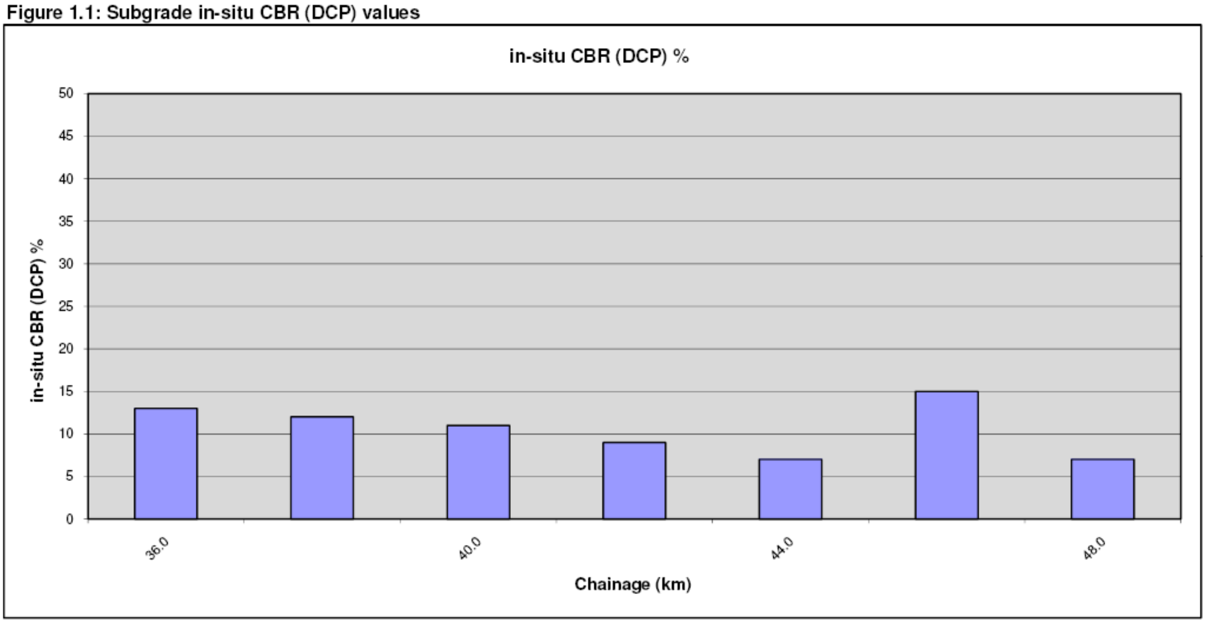
Other construction materials needed for the road pavement construction as bitumen and cement are also not or not in the required quantity available in Moldova. For the asphalt pavement construction besides aggregates, bitumen is required as the main component and binder. Bitumen products for road construction are not produced in Moldova and have to be imported. Cement is locally produced, but the demand exceeds presently the production. It has therefore to be expected that part or all of the cement for construction of structures and road works has to be imported.

ANNEX 1

In situ CBR M3 Comrat R38

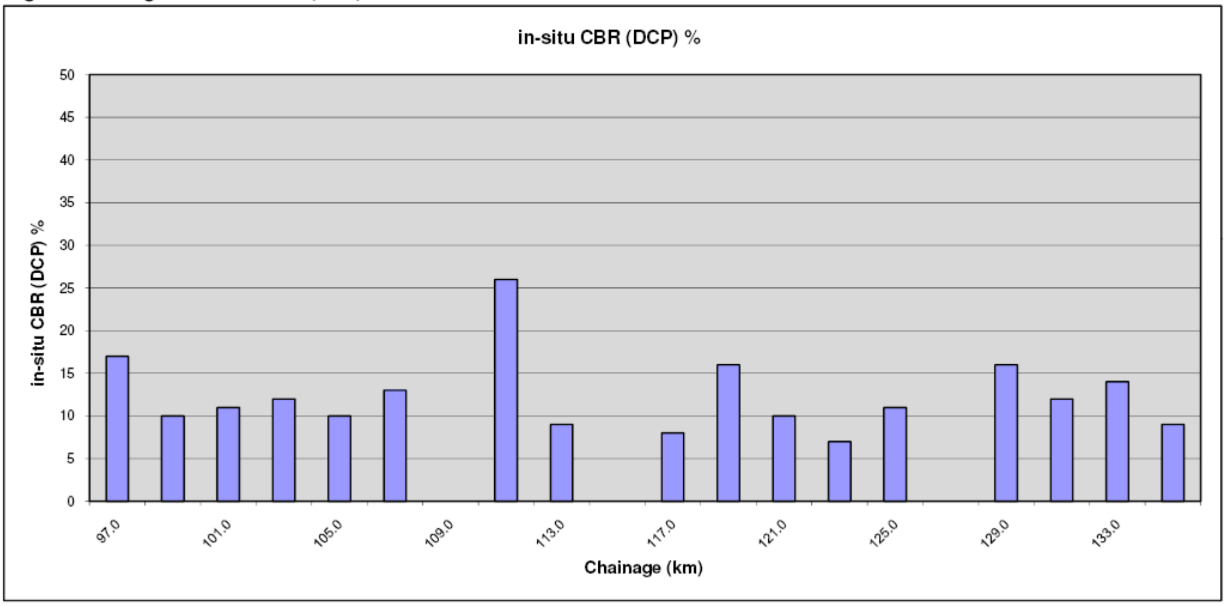
Road Section: M3 Porumbrei - Junction R3

Figure 1.1: Subgrade in-situ CBR (DCP) values



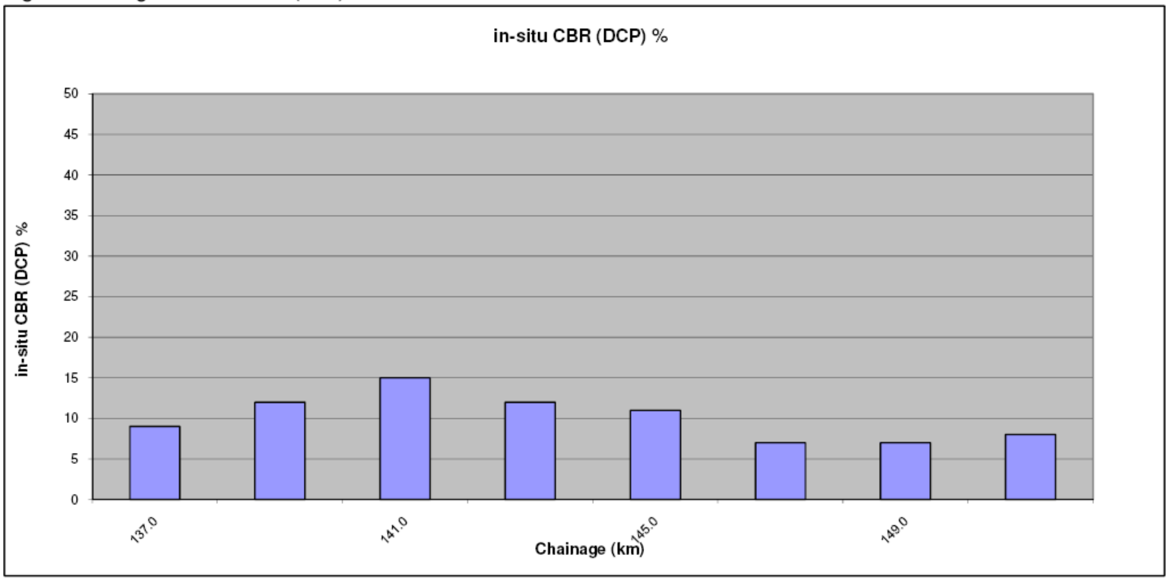
Road Section: M3 Comrat - R38

Figure 1.2: Subgrade in-situ CBR (DCP) values



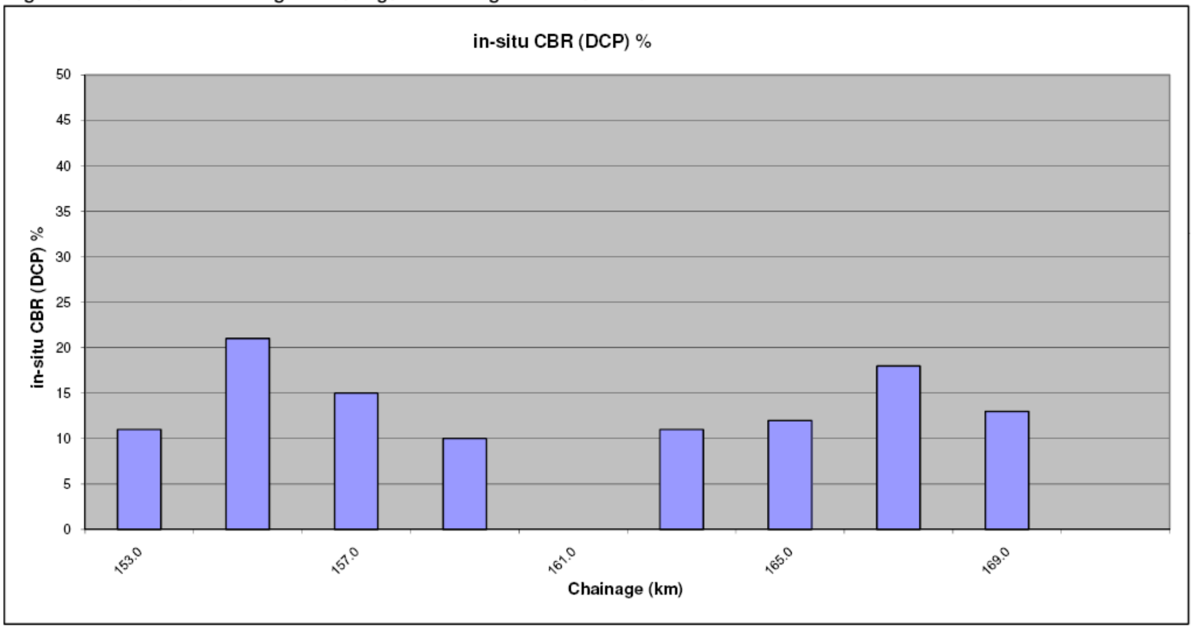
Road Section: M3 Junction R38 - Ciumai

Figure 1.3: Subgrade in-situ CBR (DCP) values



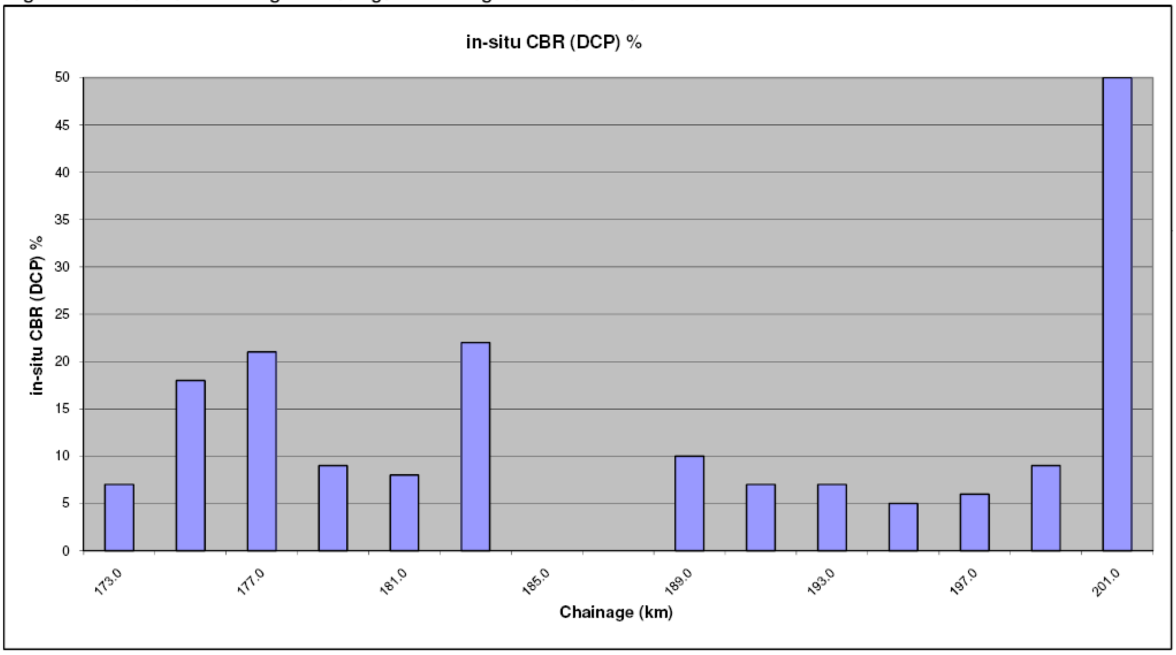
Road Section: M3 Ciumai - Vulcanesti

Figure 1.4: Distribution of Subgrade Strength according DCP-Test results



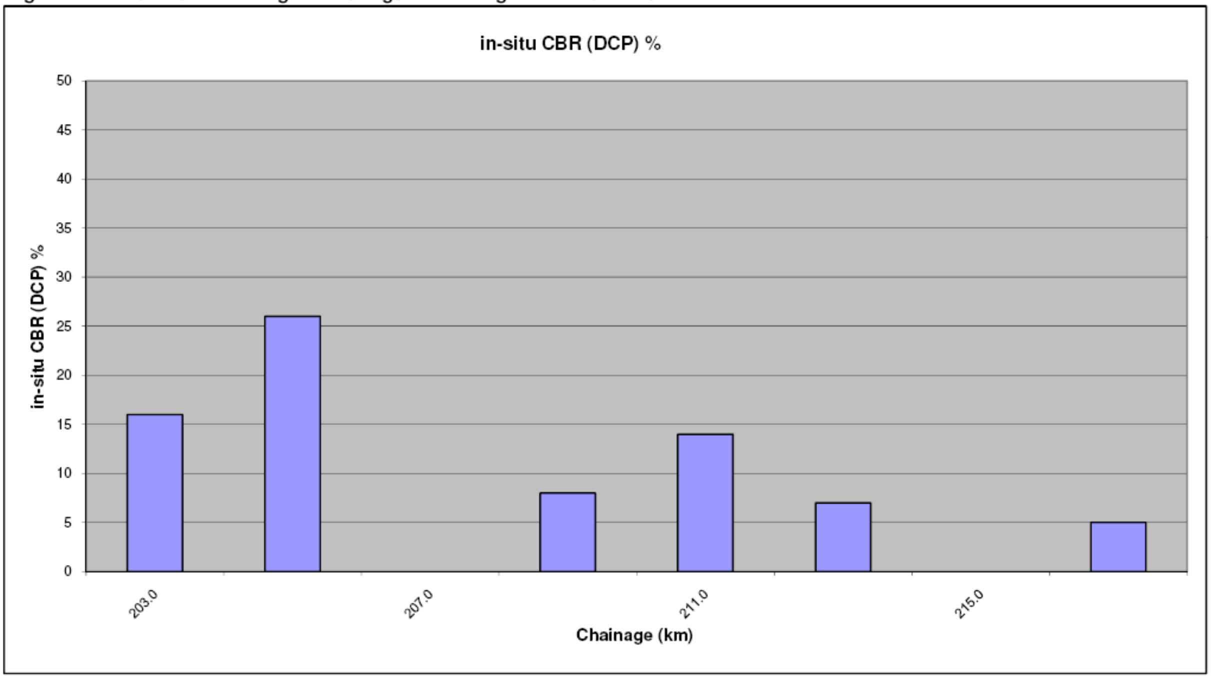
Road Section: M3 Vulcanesti - Slobozia Mare

Figure 1.5: Distribution of Subgrade Strength according DCP-Test results



Road Section: M3 Slobozia Mare - Giurgiulesti

Figure 1.5: Distribution of Subgrade Strength according DCP-Test results

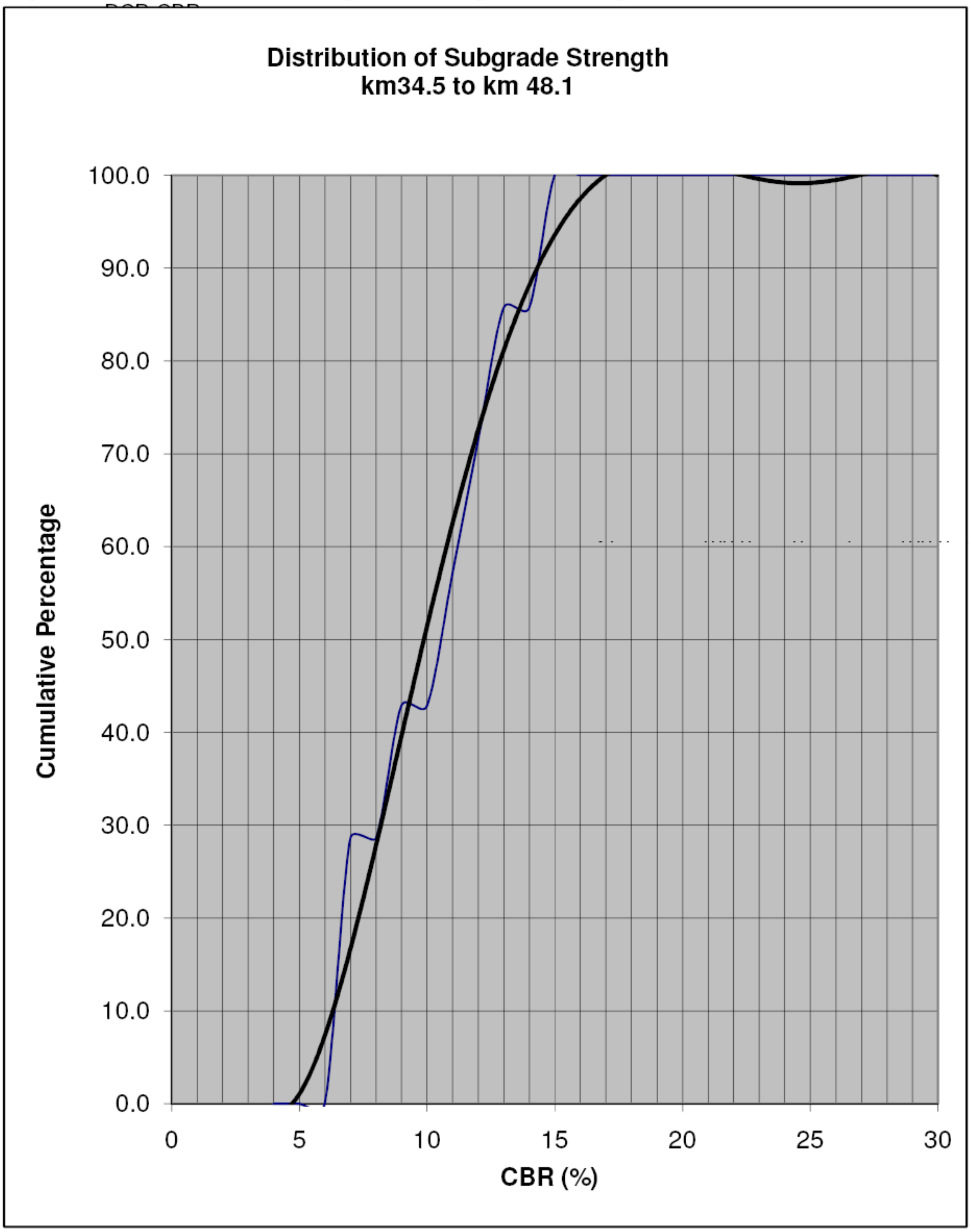


ANNEX 2

Subgrade Strength – M3

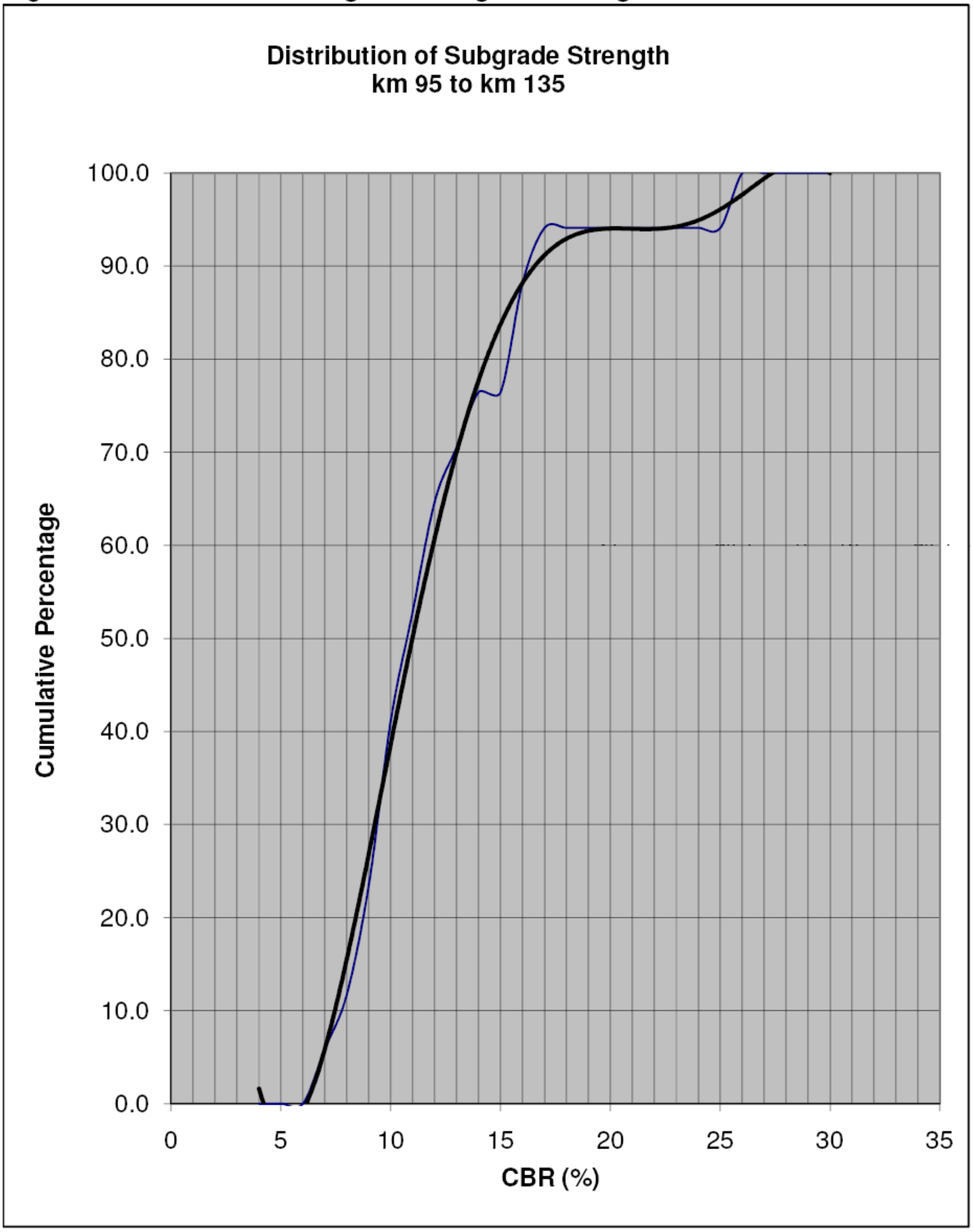
Road Section: M3 Porumbrei - Junction R3

Figure 2.1: Distribution of Subgrade Strength according DCP-Test results



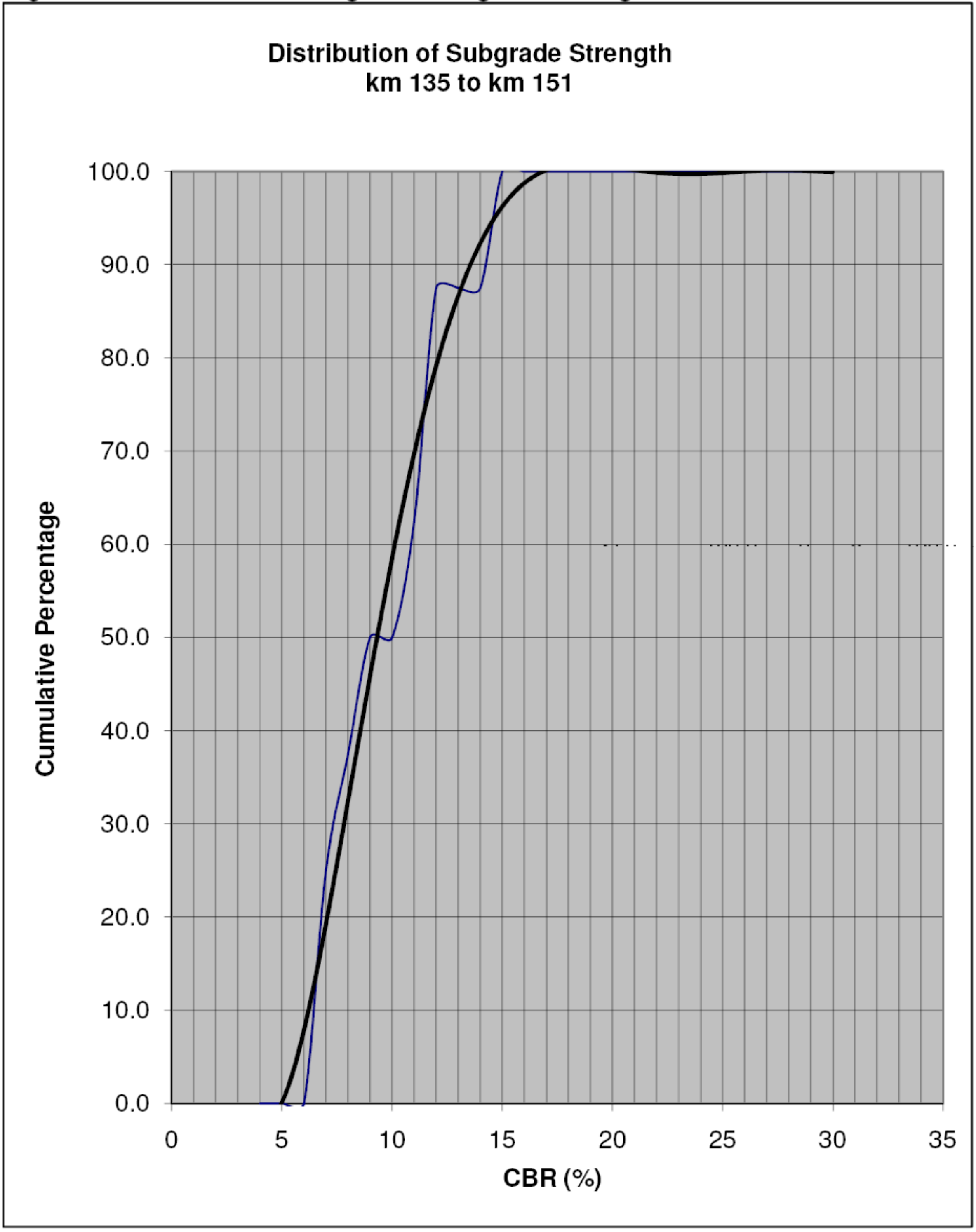
Road Section: M3 Comrat - Junction R38

Figure 2.2: Distribution of Subgrade Strength according DCP-Test results



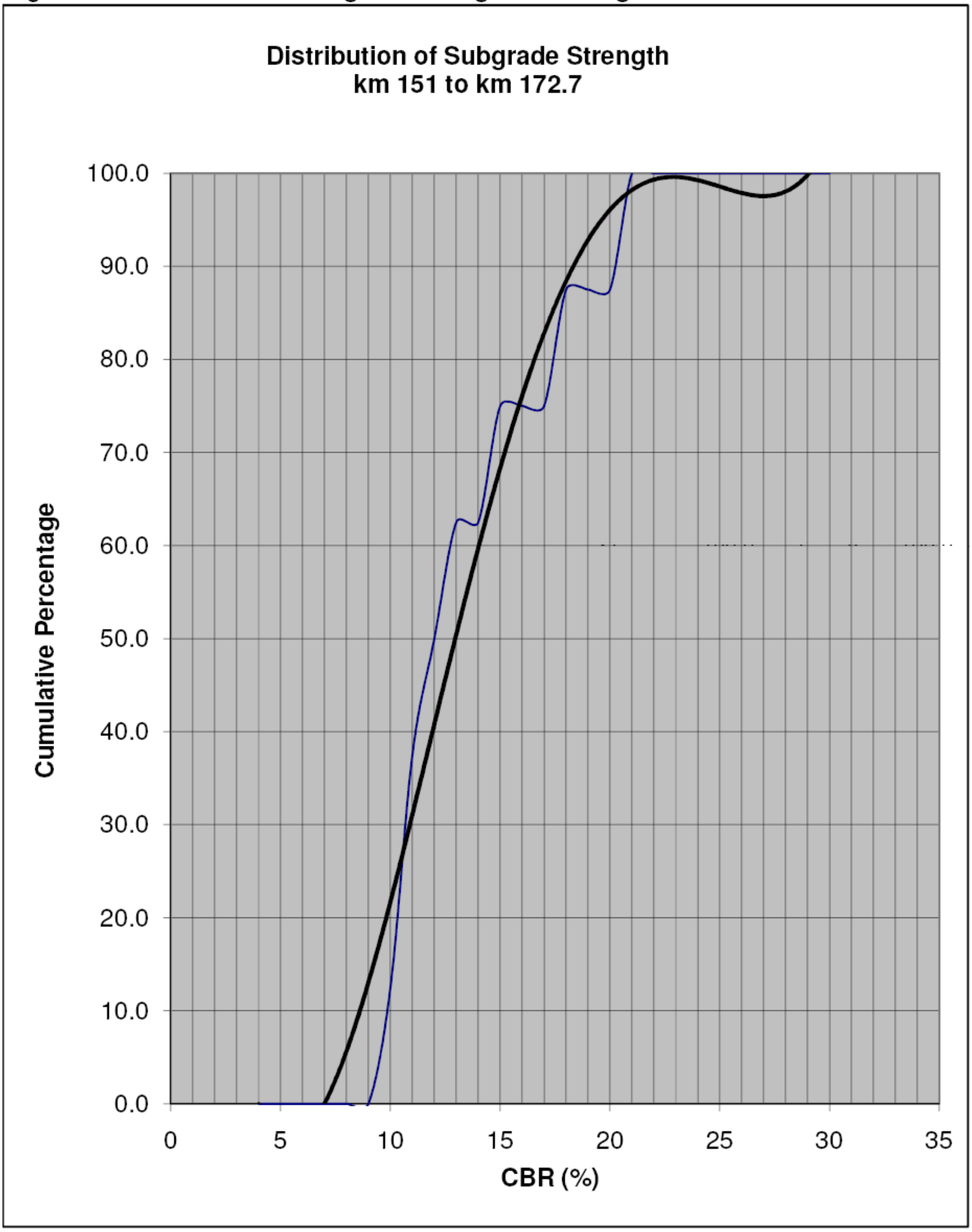
Road Section: M3 Junction R38 - Ciumai

Figure 2.3: Distribution of Subgrade Strength according DCP-Test results



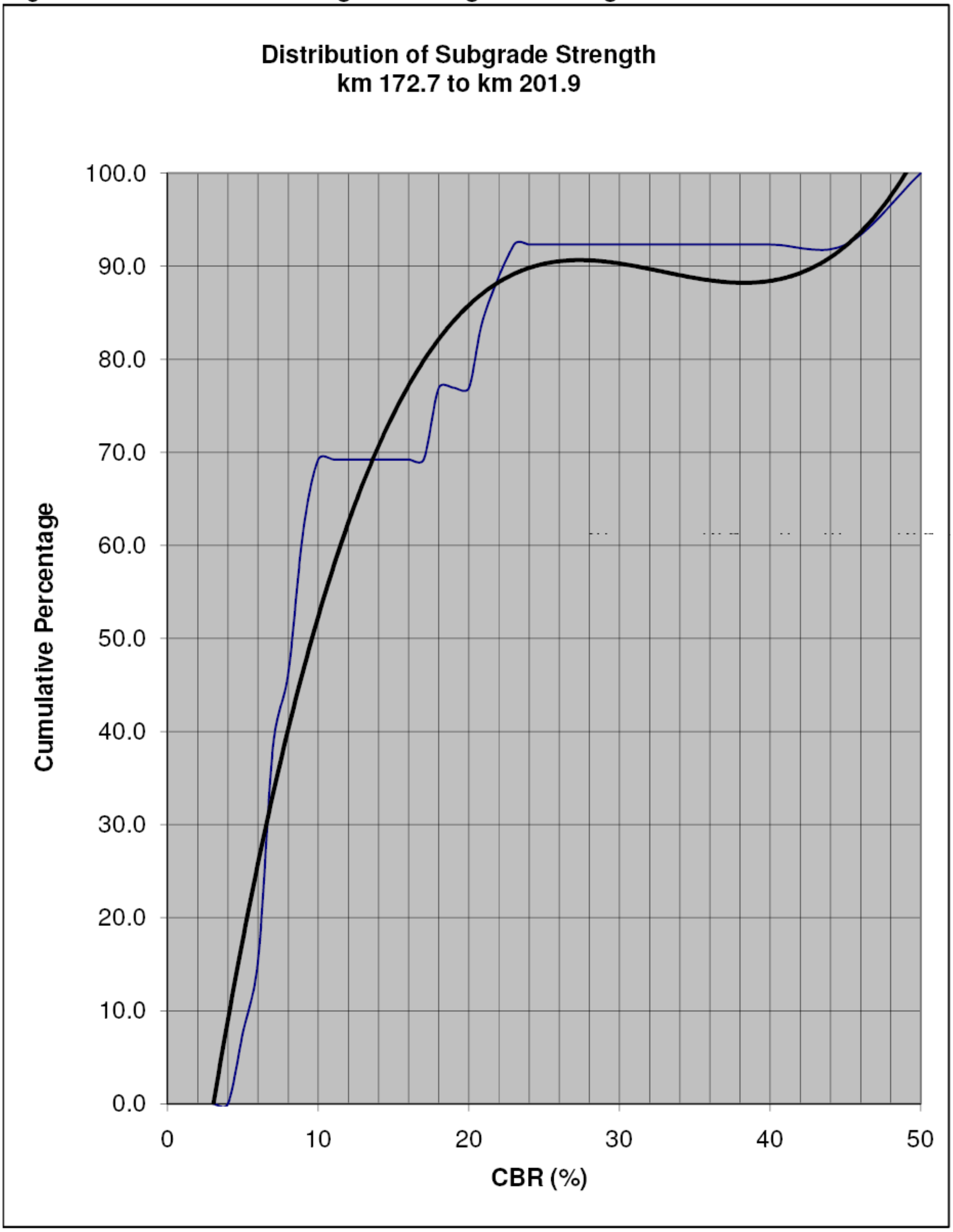
Road Section: M3 Ciumai- Vulcanesti

Figure 2.4: Distribution of Subgrade Strength according DCP-Test results



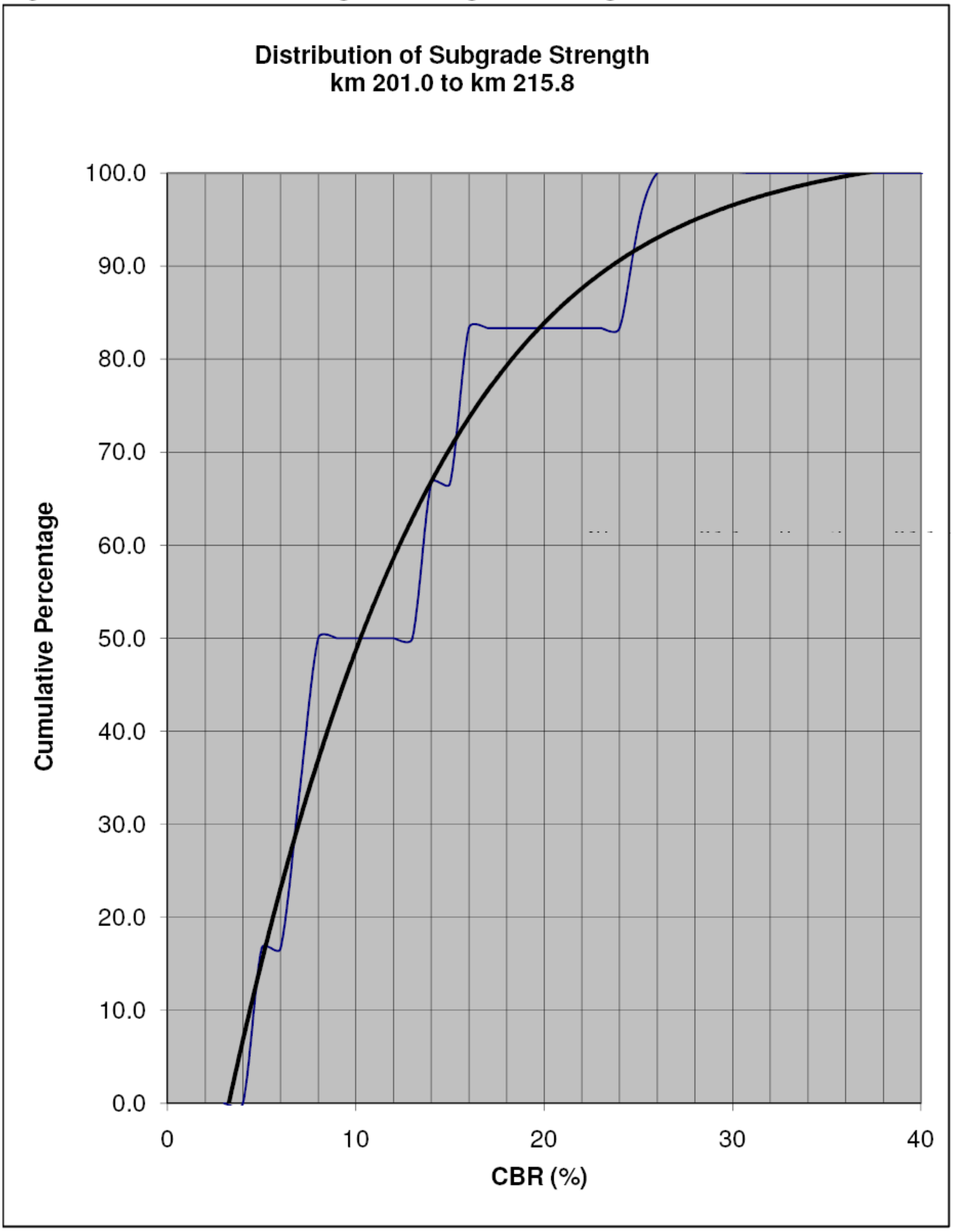
Road Section: M3 Vulcanesti - Slobozia Mare

Figure 2.5: Distribution of Subgrade Strength according DCP-Test results



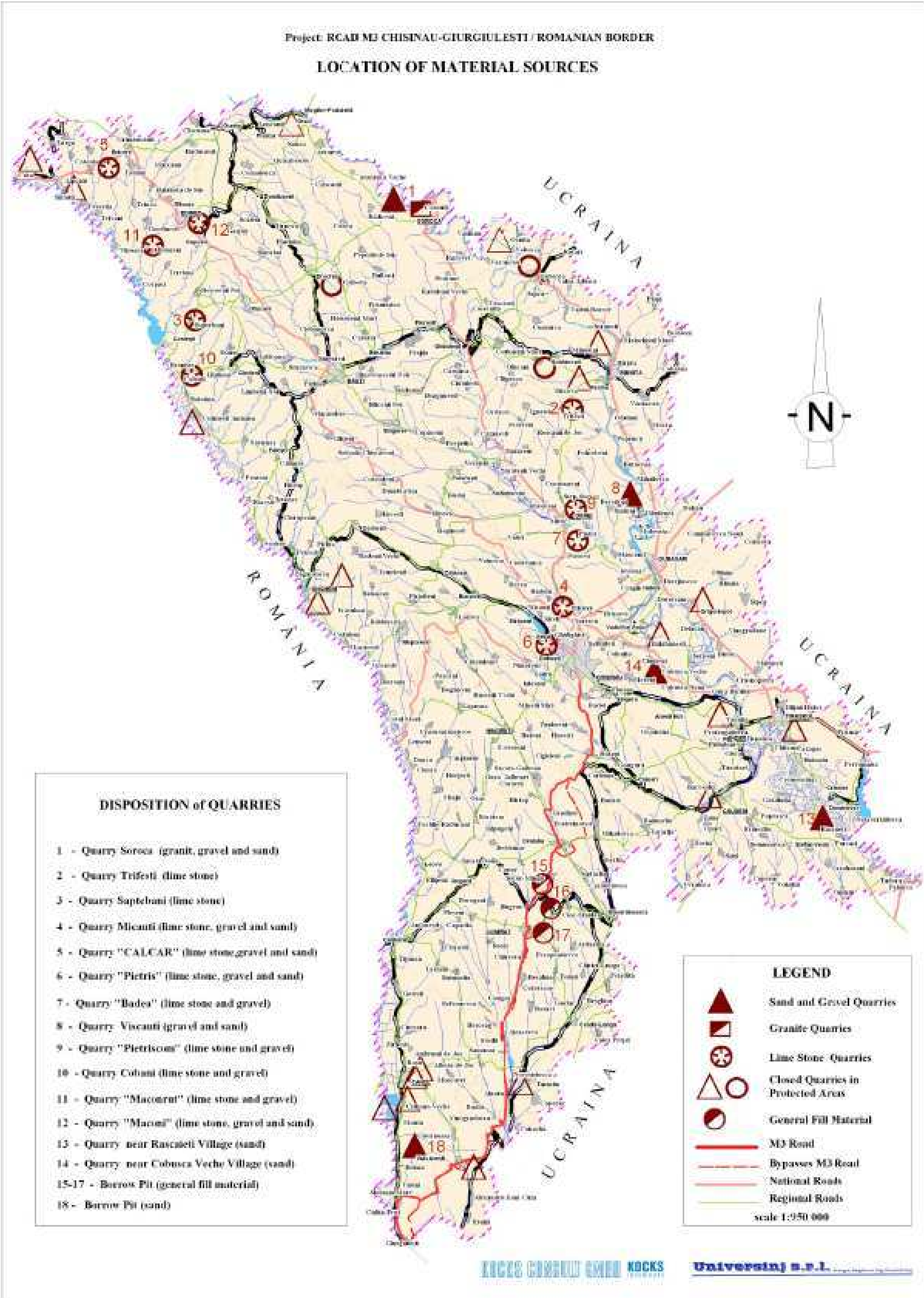
Road Section: M3 Slobozia Mare - Giurgiulesti

Figure 2.6: Distribution of Subgrade Strength according DCP-Test results



ANNEX 3

Material Sources Location Map


Project: ROAD M3 CHISINAU-GIURGIULESTI / ROMANIAN BORDER
LOCATION OF MATERIAL SOURCES
UCRAINA
ROMANIA
UCRAINA
UCRAINA
N
DISPOSITION of QUARRIES
1 - Quarry Soroca (granit, gravel and sand)
2 - Quarry Trifesti (lime stone)
3 - Quarry Saptebani (lime stone)
4 - Quarry Micauti (lime stone, gravel and sand)
5 - Quarry "CALCAR" (lime stone,gravel and sand)
6 - Quarry "Pietris" (lime stone, gravel and sand)
7 - Quarry "Badea" (lime stone and gravel)
8 - Quarry Viscauti (gravel and sand)
9 - Quarry "Pietriscom" (lime stone and gravel)
10 - Quarry Cobani (lime stone and gravel)
11 - Quarry "Macomrut" (lime stone and gravel)
12 - Quarry "Macini" (lime stone, gravel and sand)
13 - Quarry near Rascaieti Village (sand)
14 - Quarry near Cobusca Veche Village (sand)
15-17 - Borrow Pit (general fill material)
18 - Borrow Pit (sand)
LEGEND
Sand and Gravel Quarries
Granite Quarries
Lime Stone Quarries
Closed Quarries in Protected Areas
General Fill Material
M3 Road
Bypasses M3 Road
National Roads
Regional Roads
scale 1:950 000
KOCKS CONSULT GMBH KOCKS
Universinj s.r.l.

ANNEX 4

Trial Pits

Table 1.1 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Porumbrei-Junction R3	1	36+200/Right	Porumbrei	06/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	50	0.05		black		
base	gravel, crushed (limestone)		220	0.27		grey-white		moist
subgrade	clay with crushed gravel		100	0.37				moist
	clay		370	0.74		light yellow	semi-firm	moist
	clay with top-soil (organic)		260	1.00		black		dry
	top-soil (organic material)			>1,0				

Table 1.2 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Porumbrei-Junction R3	2	42+300/Right	Porumbrei	06/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	asphalt	90	0.09		black		dry
base	crushed gravel (limestone with sand)		230	0.32		grey-white		moist
subgrade	clay		680	1.00		dark grey, black, brown	firm	moist

Table 1.3 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Porumbrei-Junction R3	3	47.700/left	Porumbrei	06/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness cm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	150	0.15		black		
base	gravel, crushed (limestone)		140	0.29		grey-white		moist
subgrade	top-soil, clayey		100	0.39				moist
	clay		610	1.00			firm	moist

Table 1.4 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Comrat-Junction R38	4	97	Comrat	07/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	250	0.25		dark grey-black		
base	gravel crushed (limestone)		160	0.41		grey-white		moist
subgrade	clay		690	1.10		dark grey-black		moist

Table 1.5 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Comrat-Junction R38	5	105/right	Comrat	07/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	asphalt	170	0.17		black	solid	dry
base	gravel, crushed (limestone), and natural gravel		280	0.45		grey-white		dry
subgrade	clay		750	1.20		grey	firm	moist

Table 1.6 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Comrat-Junction R38	6	113/right	Comrat	07/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	150	0.15		black		
base	gravel crushed (limestone)		350	0.50		grey-white		dry
subgrade	clay		700	1.20				moist

Table 1.7 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km	Location	Date
Comrat-Junction R38	7	122/left	Comrat	07/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	200	0.2		black		
base	gravel crushed (limestone)		160	0.36		grey-white		dry
subgrade	clay		740	1.10			firm	moist

Table 1.8 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Comrat-Junction R38	8	129/right	Comrat	10/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement	top layer	fine graded asphalt	50	0.05		grey, black		
base	gravel crushed (limestone), at the base sandy filler		290	0.34		grey-white		dry
subgrade	Clay		660	1.00		dark grey	firm	dry

Table 1.9 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Comrat-Junction R38	9	121/left	Comrat	10/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	90	0.09		black		dry
base	gravel crushed (limestone)		120	0.21		grey-white		dry
subgrade	clay		790	1.00		brown	firm	moist

Table 1.10 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
R38 to Ciumai	10	137/right	Balaban	14/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	210	0.21		black		dry
base	top soil		150	0.36		yellow-grey		dry
subgrade	clay		640	1.00		grey-brown		dry

Table 1.11 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
R38 to Ciumai	11	145/right	Aluatu	14/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	asphalt	100	0.1		black	firm	dry
base	gravel, crushed (limestone)		280	0.38		grey-white		dry
subgrade	clay		670	1.05		yellow brown	firm	dry

Table 1.12: Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Ciumai-Vulcanesti	12	153/left	Burlaceni-Vulcanesti	14/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	100	0.1		black		dry
base	gravel crushed (limestone), top soil at the base		240	0.34		yellow-grey		dry
subgrade	sand		120	0.46		grey-brown		dry
	clay		340	0.80				dry
	sand		200	1				dry

Table 1.13 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Ciumai-Vulcanesti	13	163/left	Burlaceni-Vulcanesti	14/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	asphalt	100	0.1		black		dry
base	gravel, crushed (limestone), sand filler at the base		280	0.38		grey-white, yellow		dry
subgrade	clay		670	1.05		black, brown	firm	dry

Table 1.14 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Ciumai-Vulcanesti	14	171/right		14/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	150	0.15		dark grey, black		
base	granit crushed		260	0.41		grey-yellow		dry
subgrade	clay		590	1.00		yellow-brown		dry

Table 1.15 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Vulcanesti urban area	15	177/left	Vulcanesti bridge	15/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	50	0.05		black		dry
	2nd layer	coarse grade asphalt	110	0.16		black		
base	gravel, crushed (limestone), with some top soil		220	0.27		grey-white	firm	dry
subgrade	Clay		380	0.65		dark grey	firm	dry
	clay sand		350	1.00		grey-yellow	firm	dry

Table 1.16 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Vulcanesti-Slobozia Mare	16	183/right	Vulcanesti	15/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	90	0.09		black		
base	gravel crushed (limestone)		110	0.20		grey-white		dry
subgrade	clay		800	1.00				dry

Table 1.17 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Vulcanesti-Slobozia Mare	17	191/right	Vulcanesti-Slobozia Mare	15/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	asphalt	160	0.16		black	solid	dry
base	top soil		110	0.27		grey		dry
subgrade	clay		730	1.00		grey-brown	firm	dry

Table 1.18 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Vulcanesti-Slobozia Mare	18	201/left	Slobozia Mare entrance	15/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	90	0.09		black		
	2nd layer	coarse grade asphalt	80	0.17		black		
base	gravel crushed (limestone)		130	0.30		grey-white		dry
	top soil		230	0.53		grey		dry
	Clay		470	1.00		grey-brown		dry

Table 1.19 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Slobozia mare to Giurgiulesti	19	209/right	Cislita Prut	15/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement layers	top layer	fine graded asphalt	140	0.14		black		dry
base	crushed gravel (limestone)		200	0.34		grey-white		dry
subgrade	clay		660	1.00		grey-yellow		dry

Table 1.20 : Pavement stratigraphy and soil profiles recorded in Trial Pits

Road Section	Pit No.	Chainage km left / right	Location	Date
Slobozia mare to Giurgiulesti	20	213/left	Giurgiulesti	15/11/2008

Materials and Soils Description

Layer	Stratigraphy		Thickness mm	Depth m	Layers Scheme	Colour	Consistency	Moisture
bituminous pavement	top layer	asphalt	50	0.05		black	firm	dry
base	clay sand		500	0.55		yellow grey		dry
subgrade	crushed gravel (limestone)		80	0.63		white		dry
	clay sand		370	1.00		yellow grey	firm	dry

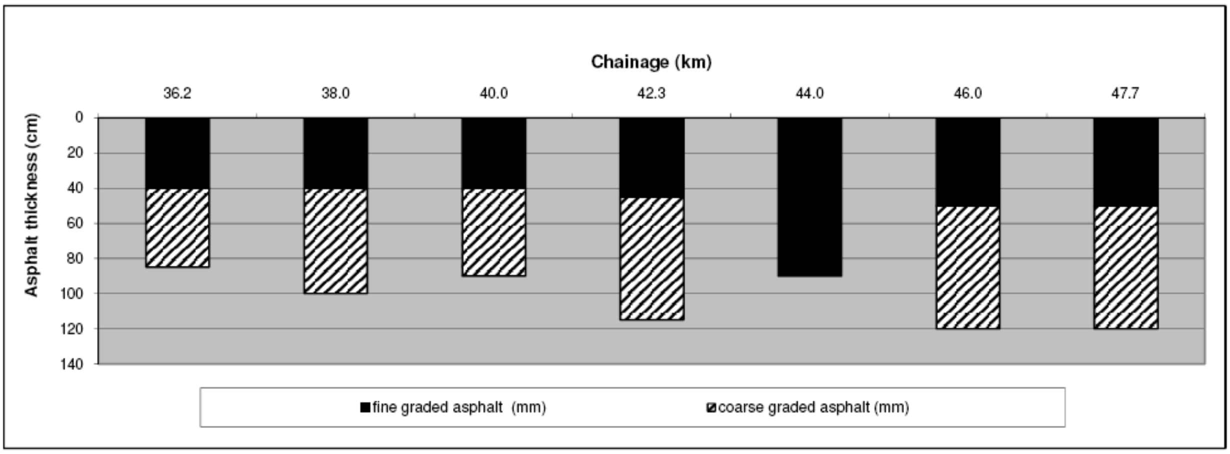
ANNEX 5

Asphalt Thickness

Road section : M3 Porumbrei - R3 junction

Table 2.1 : Structure and thickness of existing asphalt pavement according asphalt cores

Road section from - to	Chainage (km)	fine graded asphalt (mm)	coarse graded asphalt (mm)	total asphalt thickness (mm)
Porumbrei to junction R3	36.2	40	45	**85**
	38.0	40	60	**100**
	40.0	40	50	**90**
	42.3	45	70	**115**
	44.0	90	0	**90**
	46.0	50	70	**120**
	47.7	50	70	**120**



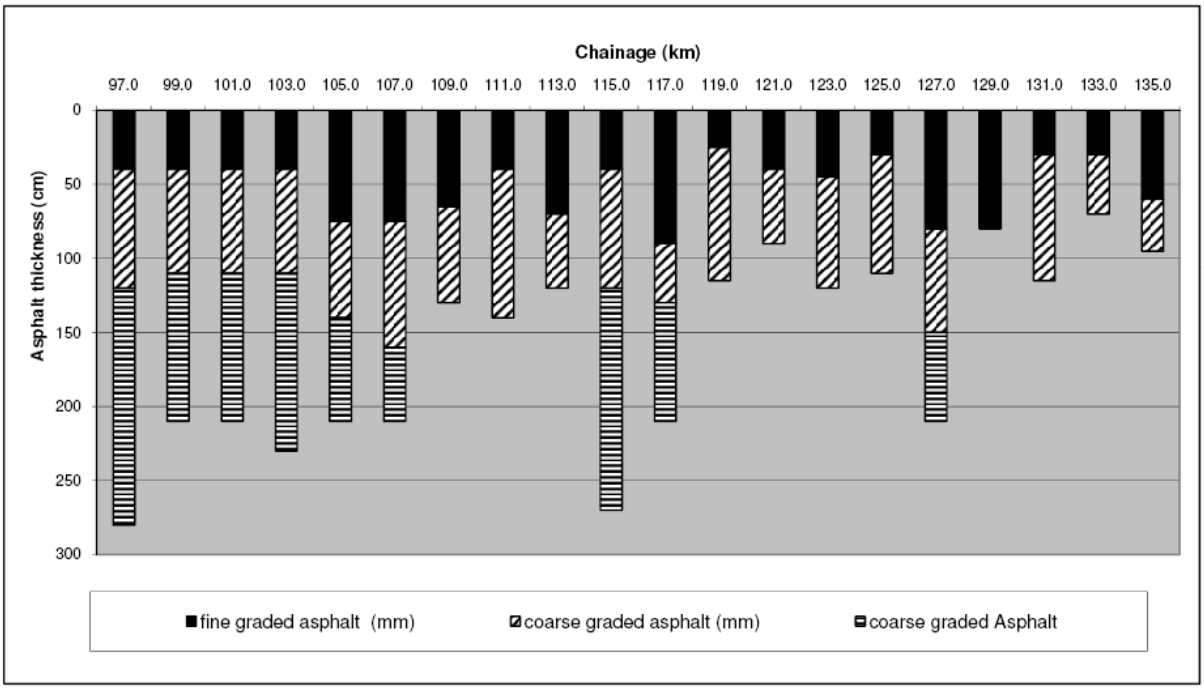
Road section : Comrat - R38 junction

Table 2.2 : Structure and thickness of existing asphalt pavement according asphalt cores

Road section from - to	Chainage (km)	fine graded asphalt (mm)	coarse graded asphalt (mm)	coarse graded asphalt (mm)	total asphalt thickness (mm)
Comrat to junction R38	97.0	40	80	160	**280**
	99.0	40	70	100	**210**
	101.0	40	70	100	**210**
	103.0	40	70	120	**230**
	105.0	75	65	70	**210**
	107.0	75	85	50	**210**
	109.0	65	65	0	**130**
	111.0	40	100	0	**140**
	113.0	70	50	0	**120**
	115.0	40	80	150	**270**
	117.0	90	40	80	**210**
	119.0	25	90	0	**115**
	121.0	40	50	0	**90**
	123.0	45	75	0	**120**
	125.0	30	80	0	**110**
	127.0	80	70	60	**210**
	129.0	80	0	0	**80**
	131.0	30	85	0	**115**
	133.0	30	40	0	**70**
	135.0	60	35	0	**95**

Road section : Comrat - R38 junction

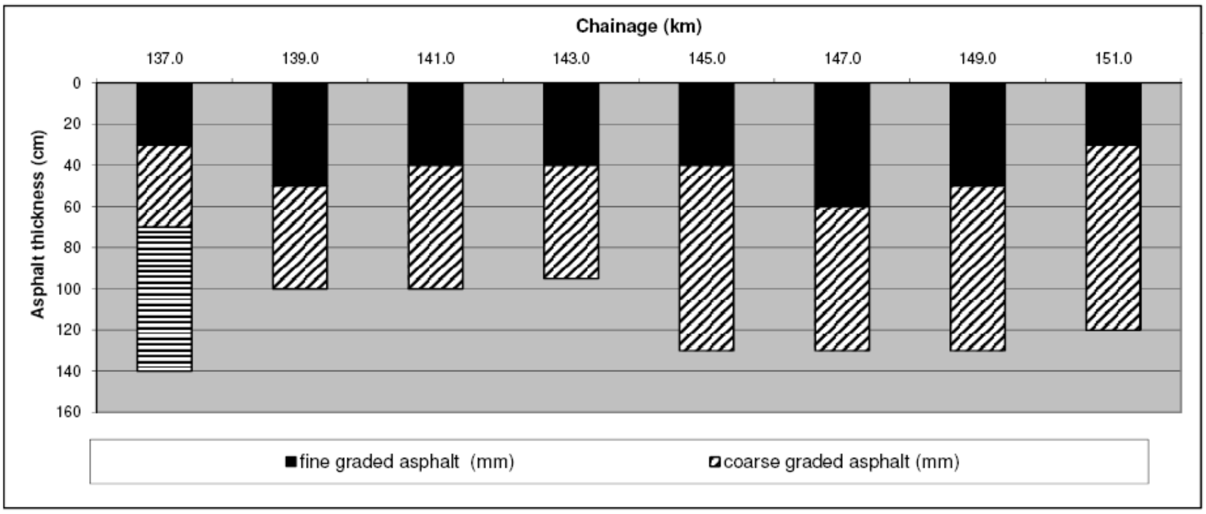
Table 2.2 : Structure and thickness of existing asphalt pavement according asphalt cores



Road section: Junction R38 - Ciumai

Table 2.3 : Structure and thickness of existing asphalt pavement according asphalt cores

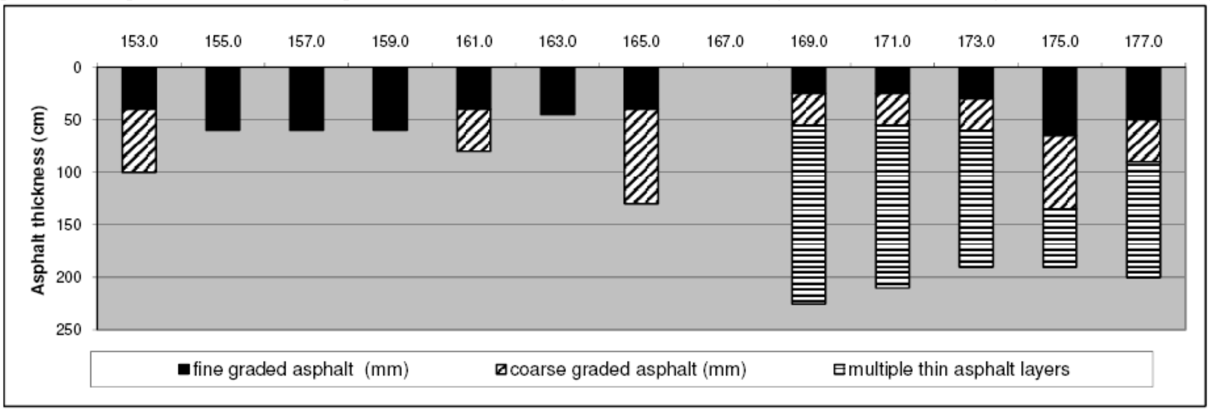
Road section from - to	Chainage (km)	fine graded asphalt (mm)	coarse graded asphalt (mm)	coarse graded asphalt (mm)	**total asphalt thickness (mm)**
Junction R38 to Ciumai	137.0	30	40	70	**140**
	139.0	50	50	0	**100**
	141.0	40	60	0	**100**
	143.0	40	55	0	**95**
	145.0	40	90	0	**130**
	147.0	60	70	0	**130**
	149.0	50	80	0	**130**
	151.0	30	90	0	**120**



Road section: Ciumai-Vulcanesti

Table 2.4 : Structure and thickness of existing asphalt pavement according asphalt cores

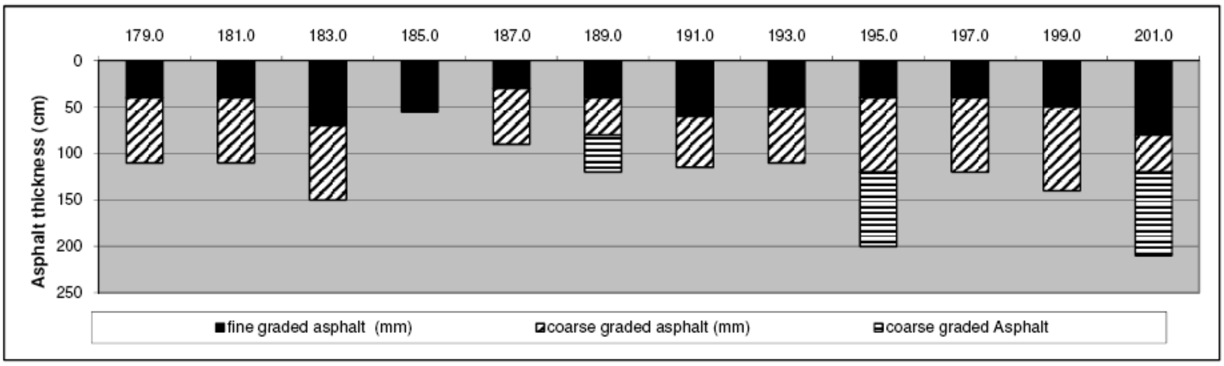
Road section from - to	Chainage (km)	fine graded asphalt (mm)	coarse graded asphalt (mm)	multiple thin asphalt layers(mm)	**total asphalt thickness (mm)**
Ciumai to Vulcanesti	153.0	40	60	0	**100**
	155.0	60	0	0	**60**
	157.0	60	0	0	**60**
	159.0	60	0	0	**60**
	161.0	40	40	0	**80**
	163.0	45	0	0	**45**
	165.0	40	90	0	**130**
	167.0	concrete			**concrete**
	169.0	25	30	170	**225**
	171.0	25	30	155	**210**
	173.0	30	30	130	**190**
	175.0	65	70	55	**190**
	177.0	50	40	110	**200**



Road section: Vulcanesti-Slobozia Mare

Table 2.5 : Structure and thickness of existing asphalt pavement according asphalt cores

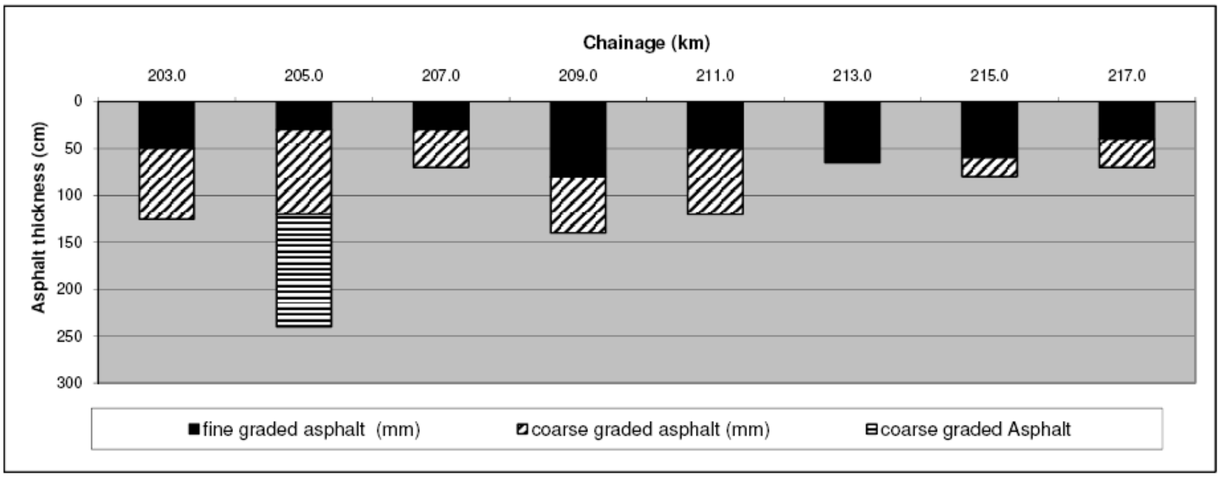
Road section from - to	Chainage (km)	fine graded asphalt (mm)	coarse graded asphalt (mm)	coarse graded asphalt (mm)	**total asphalt thickness (mm)**
Vucanesti to Slobozia Mare	179.0	40	70	0	**110**
	181.0	40	70	0	**110**
	183.0	70	80	0	**150**
	185.0	55	0	0	**55**
	187.0	30	60	0	**90**
	189.0	40	40	40	**120**
	191.0	60	55	0	**115**
	193.0	50	60	0	**110**
	195.0	40	80	80	**200**
	197.0	40	80	0	**120**
	199.0	50	90	0	**140**
	201.0	80	40	90	**210**



Road section: Slobozia Mare-Giurgiulesti

Table 2.6 : Structure and thickness of existing asphalt pavement according asphalt cores

Road section from - to	Chainage (km)	fine graded asphalt (mm)	coarse graded asphalt (mm)	coarse graded asphalt (mm)	**total asphalt thickness (mm)**
Slobozia Mare to Giurgiulesti	203.0	50	75	0	**125**
	205.0	30	90	120	**240**
	207.0	30	40	0	**70**
	209.0	80	60	0	**140**
	211.0	50	70	0	**120**
	213.0	65	0	0	**65**
	215.0	60	20	0	**80**
	217.0	40	30	0	**70**



ANNEX 6

Laboratory Results M3

Road Section: M3 Chisinau - Giurgiulesti

Table 3: Summary of Laboratory Test Results

Chainage km	Subgrade: Depth from-to m	Soil Description	MDD KN/m³	OMC %	Plasticity (Atterberg Limits) (%) PL	LL	PI	natural moisture Content %	Density KN/m³ Bulk	Dry	Grading % passing 1.0	0.5	0.25	0.1	0.05mm	Typ of Soil USC-System	Soil Classification AASHTO
36.2	0.25-0.60	Clay	15.8	23.0												CL	A - 7 - 6
	0.50				23.0	40.0	17.0	19.0	22.7	19.1			99.0	94.0	72.9		
	1.00				25.0	45.0	20.0	20.0	22.3	18.6				92.5	75.4		
42.3	0.32-1.00	Clay	15.2	26.0												CL	A - 7 - 6
	0.50				25.0	43.0	18.0	22.0	20.8	17.0			99.5	94.5	65.0		
47.7	0.40-1.00	Clay	16.6	19.0												CL	A - 6
	0.60				19.0	30.0	11.0	16.0	22.6	19.5				78.5	38.0		
97.0	0.40-1.00	Clay	16.4	21.0												CL	A - 6
	0.60				21.0	34.0	13.0	12.0	16.9	15.1			99.0	93.0	54.7		
105.0	0.50-1.20	Clay	16.5	20.0												CL	A - 4
	0.6				20.0	30.0	10.0	16.0	22.3	19.2				95.5	74.4		
113.0	0.50-1.00	Clay	16.8	20.0												CL	A - 6
	0.6				19.0	30.0	11.0	11.0	19.3	17.4				94.5	68.2		
121.0	0.25-1.00	Clay	17.0	19.0	20.0	29.0	9.0						99.0	94.5	75.9	CL	A - 4
	0.40							19.0	19.7	16.6							
	1.00							10.0	16.9	15.4							
122.0	0.20-0.36	Clay	16.7	20.0												CL	A - 4
	0.20				16.0	24.0	8.0	10.0				99.0	94.0	87.0	57.5		
	0.60				20.0	30.0	10.0	10.0	17.1	15.5				90.5	55.4		
129.0	0.34-1.00	Clay	16.5	18.0	21.0	34.0	13.0					99.5	96.0	90.0	70.8	CL	A - 6
	0.54							10.0	21.3	19.4							
	1.00							11.0	14.5	13.1							
137.0	0.38-0.90	Clay	16.4	21.0	21.0	35.0	14.0						99.0	95.5	66.7	CL	A - 6
	0.40							14.0	20.6	18.1							
145.0	0.38-0.95	Clay	16.4	20.0	20.0	33.0	13.0							99.0	73.9	CL	A - 6
	0.45							15.0	17.5	15.2							
	0.90							12.0	16.1	14.4							
153.0	0.50-0.80	Finesand, silty	18.0	14.0	17.0	20.0	3.0					99.0	95.0	49.0	12.5	SM	A- 2 - 4
	0.50							14.0	18.7	16.4							
163.0	0.22-1.00	Clay	16.2	21.0	20.0	31.0	11.0					99.5	98.5	96.5	77.5	CL	A - 6
	0.28							15.0	19.9	17.3							
	0.95							12.0	17.4	15.5							
171.0	0.45-1.00	Clay	17.1	19.0	21.0	32.0	11.0					99.5	97.5	95.0	75.6	CL	A - 6
	0.65							12.0	17.2	15.4							
177.0	0.38-0.78	Clay	17.6	19.0	17.0	27.0	10.0						93.5	67.5	56.5	CL	A - 4
	0.45							14.0	19.1	16.8							
	1.00							10.0	17.1	15.5							
183.0	0.20-1.00	Clay	17.4	17.0	19.0	29.0	10.0					99.0	94.0	83.5	57.1	CL	A - 4
	0.30							19.0	19.7	16.6							
	1.00							11.0	14.7	13.2							
191.0	0.27-1.00	Clay	16.9	19.0	18.0	28.0	10.0							99.5	81.4	CL	A - 4
	0.40							18.0	20.1	17.0							
	1.00							19.0	17.9	15.0							
201.0	0.53-1.00	Clay, sandy	19.0	13.0	13.0	19.0	6.0					98.5	80.5	61.0	23.3	CL	A- 2 - 4
	0.80							11.0	23.1	20.8							
209.0	0.34-1.00	Clay	17.7	15.0	17.0	23.0	6.0					99.5	93.5	69.5	34.3	CL	A - 2 - 4
	0.40							12.0	20.5	18.3							
	0.80							16.0	16.4	14.1							
213.0	0.05-0.55	Silt	18.9	12.0	17.0	21.0	4.0					99.0	93.5	75.5	36.7	ML	A - 4
	0.30							8.0	17.8	16.5							

Road Section: M3 Chisinau - Giurgiulesti

Table 3: Summary of Laboratory Test Results

Road Section: M3 Chisinau - Giurgiulesti

Table 3: Summary of Laboratory Test Results

ANNEX 7

Asphalt laboratory Results M3

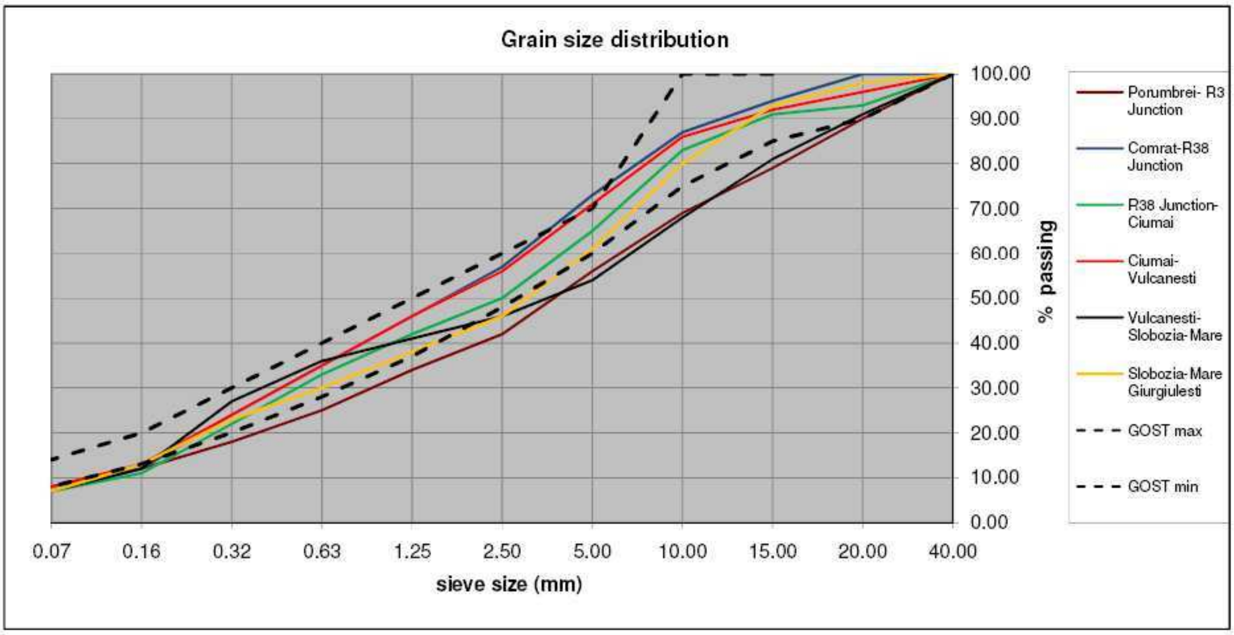
Road Section: M3 Chisinau - Giurgiulesti

Table 4.1-1: Analysis of existing top asphalt layer

Asphalt surface material												
Road section	Bitumen content (%)	GRADATION (Passing, %)										
		Sieve size (mm)										
		40	20	15	10	5	2.5	1.25	0.630	0.315	0.160	0.071
Porumbrei- R3 Junction	5.60	100.00	90.0	79.00	69.00	56.00	42.00	34.00	25.00	18.00	12.00	8.00
Comrat-R38 Junction	4.50	100.00	100.0	94.00	87.00	73.00	57.00	46.00	35.00	24.00	12.00	7.00
R38 Junction-Ciumai	4.80	100.00	93.0	91.00	83.00	65.00	50.00	42.00	33.00	22.00	11.00	7.00
Ciumai-Vulcanesti	5.00	100.0	96.00	92.00	86.00	71.00	56.00	46.00	35.00	24.00	13.00	8.00
Vulcanesti-Slobozia-Mare	6.30	100.00	91.0	81.00	68.00	54.00	46.00	41.00	36.00	27.00	12.00	7.00
Slobozia-Mare Giurgiulesti	5.60	100.0	98.00	93.00	80.00	61.00	46.00	38.00	30.00	23.00	13.00	7.00
Average bitumen content	**5.3**											

Road Section: M3 Chisinau - Giurgiulesti

Table 4.1-2: Analysis of existing top asphalt layer



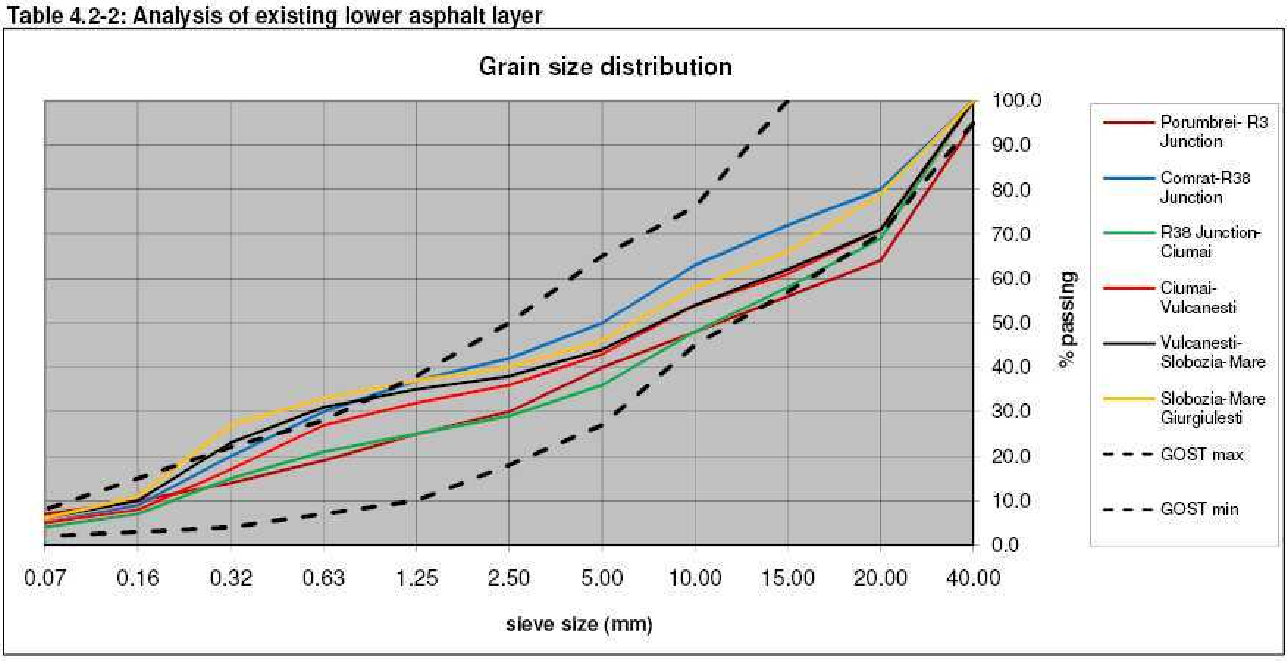
Road Section: M3 Chisinau - Giurgiulesti

Table 4.2-1: Analysis of existing lower asphalt layer

Asphalt binder and base material												
Road section	Bitumen content (%)	GRADATION (Passing, %) Sieve size, mm										
		40	20	15	10	5	2.5	1.25	0.630	0.315	0.160	0.071
Porumbrei- R3 Junction	4.40	95.0	64.00	56.00	48.00	40.00	30.00	25.00	19.00	14.00	10.00	7.00
Comrat-R38 Junction	4.50	100.0	80.00	72.00	63.00	50.00	42.00	37.00	30.00	20.00	9.00	5.00
R38 Junction-Ciumai	4.80	100.0	69.00	58.00	48.00	36.00	29.00	25.00	21.00	15.00	7.00	4.00
Ciumai-Vulcanesti	5.00	100.0	71.00	61.00	54.00	43.00	36.00	32.00	27.00	17.00	8.00	5.00
Vulcanesti-Slobozia-Mare	6.30	100.0	71.00	62.00	54.00	44.00	38.00	35.00	31.00	23.00	10.00	6.00
Slobozia-Mare Giurgiulesti	5.60	100.0	79.00	66.00	58.00	46.00	40.00	37.00	33.00	27.00	11.00	6.00
Average bitumen content	**5.1**											

Road Section: M3 Chisinau - Giurgiulesti

Table 4.2-2: Analysis of existing lower asphalt layer



ANNEX 8

Grain Size Distribution Base Course

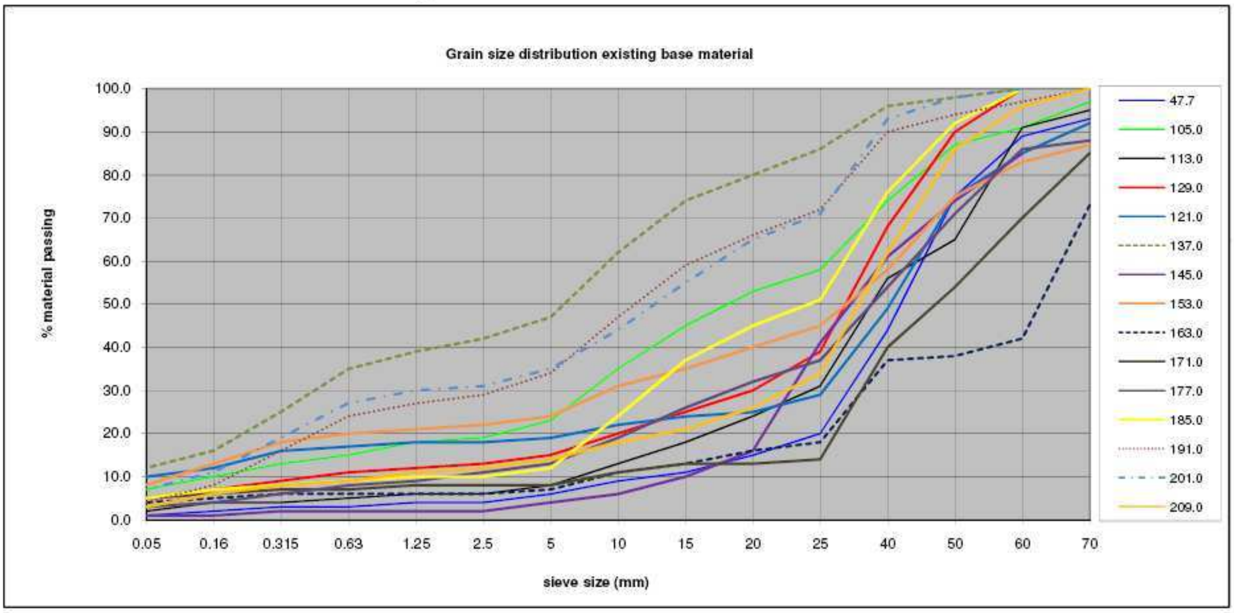
Road Section: M3 Chisinau - Giurgiulesti

Table 5-1: Grain size distribution existing base course material

LOCATION km	DEPTH m	GRADATION (Passing, %) Sieve size, mm															CLASSIFICATION ASTM – D 2487-00	
		70	60	50	40	25	20	15	10	5	2.5	1.25	0.63	0.315	0.16	0.05		
47.7	0.15-0.29	93.0	89.0	75.0	44.0	20.0	15.0	11.0	9.0	6.0	4.0	4.0	3.0	3.0	2.0	1.00	GW	Gravel,sandy
105.0	0.17-0.45	97.0	91.0	87.0	74.0	58.0	53.0	45.0	35.0	23.0	19.0	18.0	15.0	13.0	10.0	7.00	GM	Gravel,sandy, silty
113.0	0.15-0.50	95.0	91.0	65.0	56.0	31.0	24.0	18.0	13.0	8.0	6.0	6.0	5.0	4.0	4.0	2.00	GW	Gravel, sandy
121.0	0.09-0.21	92.0	85.0	75.0	49.0	29.0	25.0	24.0	22.0	19.0	18.0	18.0	17.0	16.0	12.0	10.00	GM	Gravel, silty, sandy
129.0	0.05-0.34		100.0	90.0	68.0	39.0	30.0	25.0	20.0	15.0	13.0	12.0	11.0	9.0	7.0	5.00	GW	Gravel,sandy, silty
137.0	0.21-0.35		100.0	98.0	96.0	86.0	80.0	74.0	62.0	47.0	42.0	39.0	35.0	25.0	16.0	12.00	GM	Gravel,sandy, silty
145.0	0.10-0.38		85.0	74.0	61.0	41.0	16.0	10.0	6.0	4.0	2.0	2.0	2.0	2.0	1.0	1.00	GW	Gravel
153.0	0.10-0.34	87.0	83.0	75.0	58.0	45.0	40.0	35.0	31.0	24.0	22.0	21.0	20.0	18.0	13.0	8.00	GM	Gravel,sandy, silty
163.0	0.08-0.22	73.0	42.0	38.0	37.0	18.0	16.0	13.0	11.0	7.0	6.0	6.0	6.0	6.0	5.0	4.00	GW	Gravel, silty
171.0	0.15-0.41	85.0	70.0	54.0	40.0	14.0	13.0	13.0	11.0	8.0	8.0	8.0	7.0	7.0	6.0	5.00	GW	Gravel, silty
177.0	0.16-0.38	88.0	86.0	71.0	54.0	37.0	32.0	26.0	19.0	13.0	11.0	9.0	8.0	6.0	4.0	3.00	GW	Gravel, sandy
185.0	0.09-0.20		100.0	92.0	76.0	51.0	45.0	37.0	24.0	12.0	10.0	10.0	9.0	8.0	7.0	5.00	GM	Gravel,sandy, silty
191.0	0.16-0.27	100.0	97.0	94.0	90.0	72.0	66.0	59.0	47.0	34.0	29.0	27.0	24.0	16.0	8.0	4.00	GW	Gravel,sandy, silty
201.0	0.17-0.30		100.0	98.0	93.0	71.0	65.0	55.0	44.0	35.0	31.0	30.0	27.0	19.0	11.0	7.00	GM	Gravel,sandy, silty
209.0	0.14-0.34	100.0	96.0	86.0	62.0	34.0	26.0	21.0	18.0	14.0	12.0	11.0	9.0	8.0	6.0	3.00	GW	Gravel, sandy

Road Section: M3 Chisinau - Giurgiulesti

Table 5-2: Grain size distribution existing base course material



ANNEX 9

DCP Test Summary Report

Table 6.1
Road Section: M3 Porumbrei-Junction R3
DCP Test Summary Report

Test Details					Upper Layers			Test Layers			Pavement Strength	
No.	Test Date	Chainage (km)	Location	Offset (m)	Surface Type	Surface Moisture	Base Type	Base Thickness (mm)	Sub-base Thickness (mm)	Subgrade CBR (%)	SN	SNP
1	13/11/2008	36.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	408	--	13	2.63	4.05
2	13/11/2008	38.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	318	--	12	2.32	3.67
3	13/11/2008	40.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	216	--	11	2.41	3.72
4	13/11/2008	42.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	318	--	9	3.59	4.76
5	13/11/2008	44.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	228	--	7	2.50	3.41
6	13/11/2008	46.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	159	--	15	2.63	4.16
7	13/11/2008	48.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	563	--	7	4.54	5.52

Table 6.2
Road Section: M3 Comrat – Junction R38
DCP Test Summary Report

Test Details					Upper Layers			Test Layers			Pavement Strength	
No.	Test Date	Chainage (km)	Location	Offset (m)	Surface Type	Surface Moisture	Base Type	Base Thickness (mm)	Sub-base Thickness (mm)	Subgrade CBR (%)	SN	SNP
1	07/11/2008	97.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	350	--	17	3.53	5.14
2	07/11/2008	99.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	353	--	10	3.05	4.30
3	07/11/2008	101.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	333	--	11	3.44	4.75
4	07/11/2008	103.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	541	--	12	5.20	6.59
5	07/11/2008	105.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	431	--	10	5.14	6.36
6	07/11/2008	107.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	597	--	13	4.29	5.71
7	07/11/2008	111.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	286	--	26	2.64	4.47
8	07/11/2008	113.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	733	--	9	3.54	4.68
9	11/11/2008	117.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	518	--	8	4.86	5.87
10	10/11/2008	119.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	721	--	16	4.70	6.28
11	10/11/2008	121.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	641	--	12	3.13	4.48
12	07/11/2008	121.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	463	--	10	5.30	6.52
13	11/11/2008	123.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	348	--	7	2.39	3.37
14	11/11/2008	125.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	323	--	11	2.93	4.25
15	11/11/2008	127.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	83	--	--	1.45	1.45
16	10/11/2008	129.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	405	--	16	2.86	4.44
17	11/11/2008	131.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	189	--	12	2.27	3.64
18	11/11/2008	133.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	405	--	14	3.21	4.69
19	11/11/2008	135.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	414	--	9	2.70	3.85

Table 6.3
Road Section: M3 Junction R38 - Ciumai
DCP Test Summary Report

Test Details					Upper Layers			Test Layers			Pavement Strength	
No.	Test Date	Chainage (km)	Location	Offset (m)	Surface Type	Surface Moisture	Base Type	Base Thickness (mm)	Sub-base Thickness (mm)	Subgrade CBR (%)	SN	SNP
1	11/11/2008	137.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	372	--	9	3.40	4.53
2	11/11/2008	139.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	384	--	12	3.24	4.59
3	11/11/2008	141.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	630	--	15	3.06	4.59
4	11/11/2008	143.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	181	--	12	2.36	3.74
5	11/11/2008	145.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	411	--	11	1.82	3.13
6	11/11/2008	147.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	188	--	7	1.19	2.16
7	11/11/2008	149.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	357	--	7	3.31	4.19
8	11/11/2008	151.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	295	--	8	1.77	2.81

Table 6.4
Road Section: M3 Ciumai - Vulcanesti
DCP Test Summary Report

Test Details					Upper Layers			Test Layers			Pavement Strength	
No.	Test Date	Chainage (km)	Location	Offset (m)	Surface Type	Surface Moisture	Base Type	Base Thickness (mm)	Sub-base Thickness (mm)	Subgrade CBR (%)	SN	SNP
1	11/11/2008	153.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	278	--	11	1.58	2.86
2	11/11/2008	155.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	236	--	21	2.77	4.48
3	11/11/2008	157.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	344	--	15	1.78	3.29
4	11/11/2008	159.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	406	--	10	3.42	4.65
5	11/11/2008	161.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	87	--	--	1.49	1.49
6	11/11/2008	163.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	747	--	11	1.73	3.01
7	12/11/2008	165.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	240	--	12	2.65	3.99
8	12/11/2008	169.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	486	--	18	4.66	6.29
9	12/11/2008	170.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	415	--	13	3.19	4.62
10	12/11/2008	171.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	212	--	--	2.97	2.97

Table 6.5
Road Section: M3 Vulcanesti – Slobozia Mare
DCP Test Summary Report

Test Details					Upper Layers			Test Layers			Pavement Strength	
No.	Test Date	Chainage (km)	Location	Offset (m)	Surface Type	Surface Moisture	Base Type	Base Thickness (mm)	Sub-base Thickness (mm)	Subgrade CBR (%)	SN	SNP
1	12/11/2008	173.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	263	--	7	2.64	3.53
2	15/11/2008	175.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	245	--	18	2.56	4.19
3	12/11/2008	177.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	291	--	21	2.42	4.15
4	12/11/2008	179.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	160	--	9	1.21	2.33
5	12/11/2008	181.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	242	--	8	3.17	4.27
6	12/11/2008	183.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	357	--	22	2.79	4.55
7	12/11/2008	185.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	163	--	--	1.60	1.60
8	12/11/2008	187.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	112	--	--	1.69	1.69
9	12/11/2008	189.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	266	--	10	1.76	3.01
10	12/11/2008	191.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	194	--	7	2.18	3.15
11	12/11/2008	193.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	256	--	7	2.30	3.26
12	12/11/2008	195.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	381	--	5	2.82	3.45
13	12/11/2008	197.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	443	--	6	1.96	2.67
14	12/11/2008	199.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	301	--	9	2.90	4.01
15	12/11/2008	201.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	168	--	50	2.93	5.01

Feasibility Study

Table 6.6
Road Section: M3 Slobozia Mare - Giurgiulesti
DCP Test Summary Report

Test Details					Upper Layers			Test Layers			Pavement Strength	
No.	Test Date	Chainage (km)	Location	Offset (m)	Surface Type	Surface Moisture	Base Type	Base Thickness (mm)	Sub-base Thickness (mm)	Subgrade CBR (%)	SN	SNP
1	12/11/2008	203.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	689	--	16	4.36	5.91
2	12/11/2008	205.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	831	--	26	7.74	9.57
3	12/11/2008	207.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	59	--	--	1.27	1.27
4	12/11/2008	209.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	180	--	8	1.91	2.92
5	12/11/2008	211.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	266	--	14	3.16	4.64
6	12/11/2008	213.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	626	--	7	3.49	4.47
7	12/11/2008	215.000	Lane 1	1.00	Hot Mixed Asphalt	n/a	--	59	--	--	1.86	1.86
8	12/11/2008	217.000	Lane 2	1.00	Hot Mixed Asphalt	n/a	--	375	--	5	1.94	2.57