JASPERS - LOT 4: Transport and Urban Development Framework Agreement for TA to JASPERS' Beneficiary Countries

Technical Assistance for Review and Gap Analysis of Sibiu - Pitesti Motorway Feasibility Study

GAP Analysis Report

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Halcrow
A CH2M HILL COMPANY

Document history

Gap Analysis Report

Gap Analysis of Sibiu-Pitesti Motorway Feasibility Study

For

JASPERS

This document has been issued and amended as follows:

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1 Executive Summary

The proposed Sibiu-Pitesti Motorway forms part of the pan-European transport corridor IV, representing a strategic route which, once opened to traffic, will significantly improve journey time reliability and safety for road users and will contribute towards achieving the European Union objective for improved accessibility to various regions in Romania. The route itself traverses a mountainous region of Romania and is approximately 120km long. Once completed, it will represent a major addition to the pan-European transport network.

This Gap Analysis Report was prepared by Halcrow, referencing the documentation provided by JASPERS in the Terms of Reference for this assignment. The report outlines the findings and sets out the general methodology required to comply with the Terms of Reference.

JASPERS sought assistance to support the development of the project with a view to improve the quality of project preparation for a project of this scale and national significance. Their requirements include a detailed review of the existing feasibility study in order to identify the Gaps and those areas that are of sufficient and proportionate quality in order to have a feasibility study, which would support a successful co-financing application and provide the basis for a high quality, efficient, cost-effective and timely implementation of the project.

Section 2 of the Report provides an overview of Romanian and European transport policies and how these will impact on the development of highway infrastructure in Romania. The Romanian road network is in a relatively undeveloped state compared to other western European countries and will require considerable investment to be comparable with international standards.

Section 3 of the Report outlines the compliance with Tasks undertaken as part of the Gap Analysis of the Sibiu – Piesti Feasibility Study completed by IPTANA SA in 2008 and the areas we have identified as requiring close scrutiny. It describes our understanding of the requirements of each task as follows:

- Task 1: Review all existing studies and background information and identify and analyse all significant motorway alignment options previously developed in terms of engineering, economic, social and environmental aspects and provide an assessment of their quality and suitability for use in identification of a preferred option and preliminary design;

- Task 2: Identify and Assess Gaps in the Existing Feasibility Study in line with national and EU policy, planning process and standards, identify shortcomings, if any, and Gaps for successful implementation of the project;

Section 4 of the Report provides the detailed results of the Gap Analysis completed by Halcrow. The Gap Analysis report follows closely the structure presented within the existing Feasibility Study and provides comments on each of the volumes made available for review.

Based on our review it can be noted that a detailed investigation into the various route options (corridors) for the future Sibiu – Pitesti motorway was carried out and the

reviews and recommendations were included within the Route Assessment Report. It is acknowledged that the existing topography represents a significant constraint along the route studied, which largely dictated the selection of the preferred corridor. The scope of the existing Feasibility Study did not include the section between Vestem and DN1/DN7 south west of Sibiu (the tie in to the currently constructed Sibiu bypass). The omission of this link, approximately 5 kilometres long, is not seen as a Gap related to the existing Feasibility Study. Therefore, the Gap Analysis Report will refer to it as a required addition to the project as part of the updated Feasibility Study.

However, the Route Assessment Report requires additional justification for the selection or rejection of the various alternatives. This could be achieved through a more robust multi criteria analysis. In addition, as identified in Section 4 of the Report, there are significant Gaps notably in the collection and reporting of traffic data and the analysis associated with the cost benefit process as well as ground investigation information.

Production of a full Environmental Impact Statement appears to have stalled due to local procedural requirements, as well as, the environmental survey work now being considerably out of date. Further details relating to our findings can be found in section 4. In summary, there are significant Gaps in the collection and presentation of data.

The existing Feasibility Study has been prepared under certain time constraints and limitations which impacted on level of detail provided. The Gaps identified within this report are seen as a direct consequence of the very short time allocated for the completion of the existing study and by no means are suggested as a criticism towards the Consultant involved in the delivery of the existing Feasibility Study. It is noted that given the time constraints a significant amount of information was delivered by IPTANA.

A recommendation was made for adequate time allocation for the update of the existing study which was estimated to 24 months.

2 Introduction

2.1 Background

The Romanian National Company of Motorways and National Roads (RNCMNR) requested JASPERS assistance to support the development of the project with a view to improve the quality of project preparation for an investment of this scale and national significance. JASPERS have recommended as a first action that the detailed review of the existing feasibility study be undertaken in order to identify the Gaps which need to be remedied, if necessary, and to identify those areas that are of sufficient and proportionate quality. The aim of this review is to enable the completion of a Feasibility Study which supports a successful co-financing application and provides the basis for the timely implementation of a project which is efficient, cost-effective and of high quality.

Upon review of all relevant existing studies, data and information relevant to the Sibiu – Pitesti motorway, Gaps are to be identified in the existing feasibility study in the context of the latest European Union (EU) and national policy, planning process and standards relevant to the construction of the Sibiu – Pitesti motorway. A recommended plan to complete the feasibility study is to be established and Terms of Reference (ToR) for Technical Assistance (TA) to be procured by RNCMNR are to be prepared.

This assignment shall provide technical assistance for the review and Gap analysis of the existing feasibility study for the Sibiu – Pitesti motorway, which forms part of the pan-European transport corridor IV. Its findings will be used by the Ministry of Transport and Romanian National Company of Motorways and National Roads (RNCMNR) to plan and implement the project within the period of the National Development Plan 2014-2020 with financial support from the EU Cohesion Fund.

2.2 European & Romanian Transport Policy

European Union (EU) policy in the field of road transport was developed around a fundamental principle, identifying transport as one of the keys to success for the Single Market, contributing significantly to the realisation of two of its main objectives:

1. The free movement of goods
2. Free movement of persons

The primary aims of the Transport Policy are, in summary, as follows:

- Transport Policy must primarily meet the objectives set by the Treaty, as detailed in the legal documents, which highlight the development and enhancement of the EU internal market;
- Creating a viable and flexible transportation system that would optimise energy consumption, journey time and road safety, which requires the co-ordination and funding of infrastructure costs at EU level.

Romanian strategy for transport infrastructure follows the guidelines set by the European Union. The Romanian National Development Plan (NDP) 2014-2020 provides the fundamental policies that will be used to reduce the socio-economic Gap between Romania and other EU countries. The 2014-2020 NDP represents a strategic planning document which is used by the Romanian Government as a guide to annual financial planning and is aligned to EU Cohesion Policies and Funding.

The National Development Plan consists of six main priorities, transport infrastructure being aligned with the specific objectives of Priority 2 - Development and modernisation of transport infrastructure.

In Romania, the responsibility for the implementation of the transport infrastructure policy has so far been assumed by the Ministry of Transportation and Infrastructure.

The overall objective of the partnership between the Romanian Government and the European Commission for the 2014 to 2020 programming period is to promote Romania's sustainable transport system and improve journey time reliability to a standard appropriate for a European Union member country.

One of the key objectives of the Romanian Government is to promote transport infrastructure projects that will have a significant impact on economic competitiveness and will contribute to the economic growth of the country.

Transport initiatives proposed for funding from the Cohesion Fund (CF) are therefore aligned with the EU priority transport corridors and are fundamental in achieving the EU objectives for a viable and flexible transportation system.

In order to develop a modern and safe road network to meet growing transport demands, and to comply with EU requirements, Romania initiated in 1993, a substantial program of road rehabilitation funded by International Financial Institutions and the European Commission through the Instrument for Structural Policies for Pre-Accession (ISPA) and The Programme of Community aid to the countries of Central and Eastern Europe (PHARE) programmes.

Given the actions taken to date and the priorities set for the transport infrastructure programming period 2014 to 2020, preparation of projects for financing by the Structural Instruments becomes a key factor in ensuring the prerequisites necessary to achieve the objectives of the National Development Plan.

2.3 Romanian Road Network

Based on information made available by the Romanian National Statistics Institution (through press communication Nr 92/2012), the road network in Romania at the end of 2011, included a total of 83,703km of public roads, of which only 19.9% are classified as national trunk roads. The proportion of the public road network in the country is around 33.3km/100km2 - only a third of the average for all EU member countries. Approximately 92% of the public road network is single carriageway. Substantial sections of the single carriageway network are or have been subject to a major rehabilitation programme which started in 1993.

To date there has been only limited development of a new road network, while the recent increase in traffic, coupled with projected future traffic demand, places a considerable strain on the existing network. The situation is made worse by the following deficiencies:

- Almost all trunk roads have direct accesses, an aspect that generates conflicts due to the type and category of traffic accessing the network;
- Concentration of a major proportion of international traffic and transit traffic within inter-urban and rural areas;
- The generally poor condition of the existing road pavement and lack of adequate bearing capacity. Only recently rehabilitated roads will comply with the EU requirements for bearing capacity and axle load;
- The presence of approximately 400 railway level crossings;
- The traffic capacity of existing roads, particularly near major cities, is grossly exceeded. This problem is exacerbated particularly by a lack of suitable bypass roads;
- Major at-grade junctions, particularly those situated along national roads near towns/cities are usually operating at overcapacity constituting a safety risk to road users;
- Traffic management measures, through either physical or soft measures are often deficient;
- Inadequate enforcement of highway behaviour.

Thus the improvement to the road transport network in Romania can be achieved through implementation of strategic development programmes such as the pan-European transport corridor, of which the **Sibiu – Pitesti Motorway** would provide a significant element. The Sibiu – Pitesti motorway is the only missing section of the roads Priority Axis 7 in Romania. The implementation of these projects would benefit from the harmonisation of Romanian processes, procedures and legislation with the relevant EC Directives and European Standards (EN). In applying these, preparation of a

Review of the existing Feasibility Study and the **Gap Analysis Report** is considered appropriate as a first step towards securing a planned implementation of the project.

Some of the relevant projects along the Priority Axis 7 currently being promoted by the Romanian Government are:

- The construction of Nadlac-Arad motorway
- The construction of Arad-Timisoara motorway
- The construction of Timisoara-Lugoj motorway
- The construction of Lugoj-Deva motorway
- The construction of Deva-Orastie motorway
- The construction of Orastie-Sibiu motorway
- The construction of Cernavoda-Constanta motorway

The Romanian Government also initiated a series of large Public Private Partnership (PPP) projects. Some of these projects are listed below:

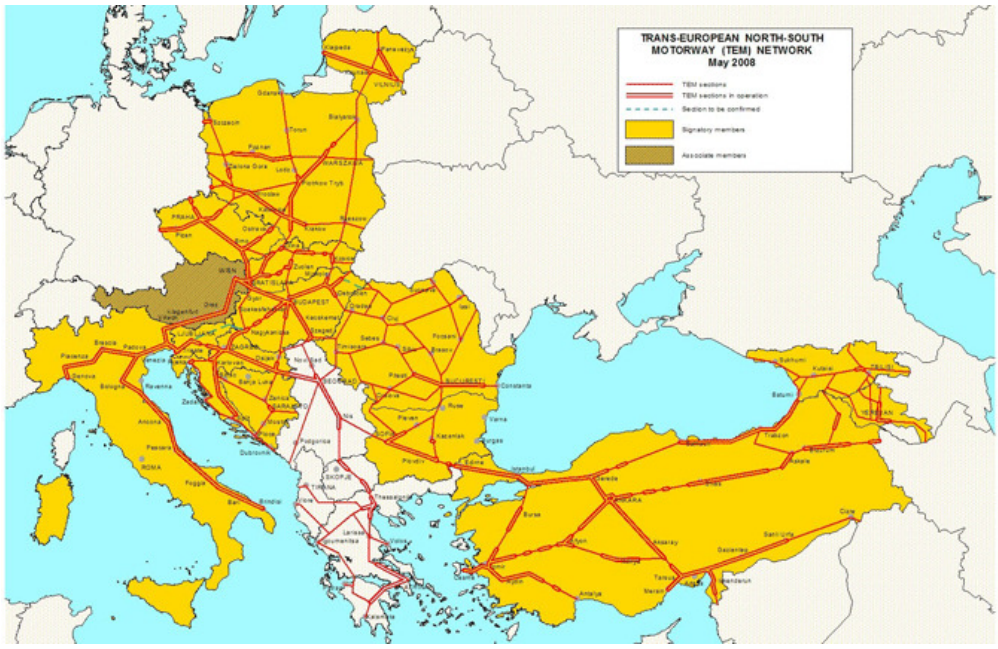
- The Construction of Comarnic – Brasov motorway in PPP system
- The construction of Bucharest Southern motorway bypass in PPP system
- The construction of Craiova – Pitetsi motorway in PPP system

Prior to joining the European Union (EU) in 2007, Romania initially developed in 2002 guidance and legislation for the preparation of Environmental Impact Assessments (EIA) in accordance with current EC Directives and amendments. This clearly identifies the scope and requirements for environmental assessments, with regard to the framework procedure, on certain public and private projects.

Romanian legislation requires that an EIA be undertaken at the beginning of the design process rather than at the application stage. The findings of the EIA and the decisions made should therefore shape the evolution of the design of the project and not simply be a process for mitigating its impacts. The context for an EIA is such that it provides a real opportunity to secure improved project and environmental outcomes. Such environmental benefits and enhancements can be implemented only if the construction and operation of the motorway adheres to the principles outlined at the design stage and follows the conclusions and recommendations of the EIA procedural studies.

2.4 Sibiu – Pitesti Motorway

The proposed Sibiu-Pitesti Motorway, forms part of the pan-European transport corridor IV, representing a strategic route which, once open to traffic, will significantly improve journey time reliability and safety for road users whilst contributing towards achieving the European Union objective for improved accessibility to various regions in Romania.



Trans-European North South Motorway (TEM) Network – source UNECE.ORG

A detailed location plan showing the Sibiu – Pitetsi route is included in Annex A to this report.

Investigations into possible routes for the Sibiu - Pitesti Motorway have been undertaken by IPTANA in recent years. The original Pre-feasibility Study was developed by IPTANA in two stages:

- the Pre-Feasibility Study for Pitesti - Cornetu subsection was completed in 1994
- the Pre-Feasibility Study for Cornetu – Sibiu subsection was completed in 1997

The Feasibility Study for the section Sibiu – Pitesti was completed by the IPTANA/Egis joint venture in year 2008.

This led to a fragmented approach in the decision making process with the possibility that essential elements of the various studies may have been missed or not covered in sufficient detail. The review carried out by Halcrow focused on all available reports

including the Pre-Feasibility Studies and the Feasibility Study, and provided comments on aspects that are seen as either omissions (gaps) or indeed aspects that require further in-depth analysis during the update of the Feasibility Study stage.

The route crosses the Carpathian Mountains and is proposed as a dual two-lane motorway. The scheme will connect with the Pitesti bypass (which was opened to traffic in 2007) and the more recently constructed Sibiu bypass, and will have a length of approximately 120km. Completion of the Sibiu - Pitesti motorway will represent a major addition to the pan-European transport corridor IV.

The complex nature of this project is confirmed by the number of structures and tunnels that were identified as part of the existing Feasibility Study. These include:

- 82 bridges longer than 100m (longest structure 1140m);
- 35 bridges shorter than 100m;
- 7 tunnels (longest tunnel 1700m);
- 99 culverts.

In addition there are eight grade separated junctions and significant lengths of access roads/tracks, which will provide connections to existing county roads, known as Drum Judetean (DJ), secondary county roads, known as Drumuri Comunale (DC), and unclassified roads.

3 Assignment Compliance and Task Methodology

3.1 Assignment Compliance

In compliance with the Clients Terms of Reference (ToR) this assignment included a comprehensive review of the existing studies (**Task 1 of ToR**) in conjunction with the most recent legislation, standards and other strategic Government initiatives such as the National Transport Master Plan.

The outcome of this review is captured in the Gap Analysis Report (**Task 2 of ToR**), which shall be used as a platform for the development of a new set of technical Terms of Reference (**Task 3 of ToR**) for the updated Feasibility Study.

Halcrow's team of key experts have undertaken and completed Task 1 and Task 2 in full compliance with the JASPERS Terms of Reference and in line with the aspects discussed and agreed during various meetings including the weekly progress meetings.

4 Gap Analysis

4.1 Task Methodology

This assignment reviewed the existing information, which was provided in the available assessment reports, checking that sufficient investigations were carried out, all factors were taken into consideration and the findings fully reported. The main aims of the assessment, analysis and reporting process were:

- To permit consideration of the likely traffic, environmental, economic and social impacts of alternative proposals;
- To allow the public and statutory bodies to comment on proposals taking account of their environmental, economic and traffic implications.

All information presented in the reports aims to be:

- Unbiased with both advantages and disadvantages of routes or corridors described impartially;
- Easy to read using clear, non-technical language with the information presented in a logical manner using appropriate maps, diagrams, sketches, etc for illustration.

It is noted that the route forms part of pan-European transport corridor IV and hence will link into other motorway networks in central and south-eastern Europe. Our review included the checking of compliance with local standards and, in addition, the principles set out in the Trans European Motorway (TEM) Standards and Recommended Best Practice Guide. It would therefore be desirable that there is no perceptible change of standard throughout the network. The existing Bucharest – Pitesti motorway and the recently constructed Sibiu bypass are generally compliant with the TEM requirements for typical cross section.

Thus, the review by our key experts focused on a consistent approach to the standards used and compared with the design with the requirements outlined within the Trans European Motorway Standards and Recommended Practice. Also the international experience of Halcrow's team of key experts aimed to bring added value to the report by inclusion of recommendations based on international best practice.

4.1.1 Task *1 - Review the existing studies and background information*

This task is listed in the Client's **ToR as Task 1**. The activities for the review of the existing studies and background information focused on the studies already referenced in the client's ToR and are divided into three main categories:

a) Review of standards used

Since the completion of the Feasibility Study in 2008 there have been significant changes to the standards through the adoption of Eurocodes and other EU norms including for example, the EN 1317 for safety barriers and other highway design standards, such as, the TEM standard third edition.

With regard to the alignment design, the applicable standards used to develop the existing Feasibility Study design were:

- Normative PD162-2002 for the design of rural motorways
- Government decision no. 43/1997 and Ministry of Transport orders 43 and 45/1998.
- TEM Standards and recommended practice TEM 2001
- European Agreement on Main international Traffic Arteries (AGR)

It is noted that the latest version of the TEM standards is Third edition published February 2002.

Following a review of the standards used in Romania (particularly those standards relevant to the proposed works) and comparing these with similar standards used in other countries of the European Union, it can be confirmed that Romania adopted many European norms such as the TEM Standards and recommended practice, the EN 1317 standard for safety barrier design and the Eurocodes for the design of Structures and Geotechnical works.

Based on the review, it can be noted that some Romanian standards (STAS) may require harmonisation in order to remove ambiguities and clarify aspects such as:

- minimum soft verge width on both motorways and national roads in order to enable the implementation of the SR EN 1317 safety barrier standards;
- applicability of safety barrier standards. It appears that STAS 1948 for safety barriers is still valid and to some extent comes into conflict with the recently adopted European norm SR EN 1317. Further clarification is therefore required to confirm which standard is applicable. It is acknowledged that an application methodology (criteria for provision of safety barriers) aligned to the SR EN 1317 standard shall be required following the removal of STAS 1948;

- applicability of either Romanian standards or Eurocodes for the design of Structures depending on the category of road and its importance. For example, it would be reasonable to continue applying the Romanian STAS for the design of structures which form part of on line road rehabilitation schemes whilst applying the Eurocodes to all new construction projects including bypasses and motorways;

- correlation between the Romanian ground investigation norm NP 074-2007 and Eurocode 7 is necessary to align requirements relating to the level of investigation whilst also cross referencing the relevant clauses from Eurocode 7. At present, the requirements for levels of ground investigation within NP 074 seem too generic.

The existing Feasibility Study was reviewed for any data relating to the Directive 89/391/EEC which was introduced on 12 June 1989. This Directive outlines measures to encourage improvements to the safety and health of workers at work – "Framework Directive" and outlines the duties and responsibilities of, amongst others, clients, project coordinators and designers – especially at the project preparation stage.

The specific application of the Directive 89/391/EEC in Romania is through law number 319/2006, the application methodology set out by the Government Decision HG 1425/2006 and through the Government Decision number 300, dated 2nd March 2006.

No information was found in the existing Feasibility Study, which related to:

- designers risk assessment showing identification of risks and mitigation measures;

- register of residual risks.

Such requirements for the assessment and mitigation of risks shall be included in the new ToR.

Generally the geometric design standards used in the development of the alignment for the existing Feasibility Study meet the European TEM requirements. However, almost all other parts of the design, including those for structures, ground investigations and safety barriers were designed to the current Romanian standards which at the time were not aligned to the European norms or Eurocode requirements. The new ToR will clarify the adoption of the Eurocode, the use of the latest EC Directives adopted in Romania with respect to Environmental Impact Assessment, Appropriate Assessments, Tunnelling, Safety and Health of Workers at Work and other applicable norms. It shall also stipulate that safety barrier design is carried out in accordance with the SR EN 1317 standard. The requirements for cost benefit analysis shall also comply with the latest guidance documents published by the European Union and JASPERS.

b) Hydraulic and hydrological studies

It is noted that the Feasibility Study does not include a report on the hydraulic calculations and assessments for the project. The relevant permit from the Water Authority, *"Administratia Nationala Apele Romane"* dated 24 July 2008, seems to suggest that the Permit was granted on the basis of documentation provided by the Consultant and it is envisaged that such documentation would have included hydraulic calculations for:

- Motorway drainage systems (both surface and sub-surface) including culverts;
- Bridges and viaducts;
- Hydraulic modelling for areas of motorway situated along the existing rivers (Arges, Olt, and Topolog) in order to determine the vertical alignment levels for a 2% assurance level.

The main Gap indentified is the lack of hydraulic calculations usually required at this stage, calculations that would normally be used to justify and validate the design proposals.

c) Field investigation reports

The review focused on the ground investigations report and information related to archaeological investigations.

The summary of findings relating to field studies, principally topographic information, ground investigations, hydrological studies, archaeological investigations and biodiversity surveys are included as part of the Task 2 Gap Analysis section of this report.

Based on the information available, it appears that no preliminary archaeological site investigations were carried out. The archaeological data made available, as part of the Environmental Impact Study, was mainly based on a desk study.

A limited amount of biodiversity surveys were carried out and the Appropriate Assessment section of this report outlines the findings and recommendations following the review of the existing study.

The main Gaps indentified were the lack of archaeological investigations and biodiversity surveys carried out as part of the existing study.

With regard to ground investigations, the level of detail provided may have been sufficient for a preliminary design stage but would, however, not comply with the requirements of Eurocode 7. The main gap in relation to the ground investigations report is the absence of boreholes logs and the absence of laboratory test results. Due to this, the data contained within the existing ground investigation report cannot be validated and therefore it is recommended that a completely new ground investigation study is commissioned.

d) Environmental information

The review focused on the existing Environmental Impact Assessment report and the Appropriate Assessment report as well as all associated drawings and relevant data made available by JASPERS.

The findings and recommendations relating to the existing environmental study are detailed within the task 2 section of this report.

The existing study generally complies with order no. 135/2010 and the relevant methodology. However, the information presented within the existing study is poorly structured and the mitigation measures are too generic. No specific impacts and mitigation measures are included for the construction of the motorway in sensitive areas such as River Olt, River Arges, River Topolog. The information relating to the affected Natura 2000 sites requires updating and must include consideration of specific impacts.

It is noted that the study does not identify the locations for site compounds or borrow pits and any associated specific impacts these may cause.

The specialised habitats surveys will need to be updated with information gathered from survey data covering at least three or four seasons in order to provide a year round analysis of the habitat. It is imperative that accurate data is gathered to identify issues and propose effective mitigation measures. The existing study, for example, does not identify the habitat migration routes or specific locations where species underpasses are required.

The Environmental Assessment shall also require the inclusion of impact and mitigation measures relating to the use of explosives for those areas where excavation into rock will be required.

The main Gap indentified in relation to the environmental study is the lack of discussions about specific impacts and their mitigation measures, the absence of information relating to impacts from, for example, temporary construction traffic, the use of explosives, the realignment of rivers and demolition of properties. In addition, no thorough reviews of those impacts relating to Natura 2000 sites were included.

There is no clear evidence of a correlation between the design and data resulting from the biodiversity surveys. Furthermore there is no discussion on whether residual adverse effects on site integrity will remain after the mitigation measures are applied.

e) Traffic study

The review focused on the existing traffic study made available by the Client.

The existing traffic study will require a complete update in order to capture the latest changes in traffic flows. Based on the data analysed, the following details can be provided:

- Only traffic count information for the DN7 is presented, and only for one year (2005);
- No traffic count information for any other road is presented, and in particular no information for the DN7C between Pitesti and Curtea de Arges (an important section of the proposed motorway alignment);
- No information is provided on historic traffic growth in the corridor;
- The report states that origin-destination (O-D) data from the 2005 census was used in the study. However no information is provided with regard to the origins and destinations of traffic in the corridor, either in tabular or graphical format;
- No information whatsoever is provided on existing travel times in the corridor. The time savings offered by the new motorway over the existing network are the most fundamental benefit of the project;
- No background information for the study area is provided – population, employment, car ownership, development plans etc., - to give the reader an appreciation of the socio-economic status of the corridor for existing and future traffic drivers.

With regard to the possible construction phasing and staging of the project, a review of the traffic volumes presented was completed. It is envisaged that due to the mountainous character of the area and AADT forecast for year 2015 in excess of 19,000 vehicles a day (this exceeds the capacity of a single carriageway) it would not be feasible to stage the construction and build a single two way carriageway as stage 1. The information related to traffic AADT flows will require further analysis and validation as part of the updated Traffic Study.

Also, the existing traffic study recommends the adoption of a 3 lane section of motorway between Vestem and Sibiu due to level of service being close to the capacity for a two lane motorway. In addition, the existing traffic study shows that the section Curtea de Arges – Pitesti will reach a level of service F in 2035. The new traffic study, which will be undertaken as part of a revised Feasibility Study, will need to review this data to provide confirmation of the number of lanes required for the Sibiu – Pitesti motorway.

The traffic study requires a complete update to take account of the latest traffic census and the data which shall be made available through the Transport Master Plan.

f) Cost benefit analysis (CBA)

The review focused on the information made available within Volume 5 of the Feasibility Study, Economic Analysis.

The outcome of the review carried out on the existing CBA report is presented within section 4.1.2.1.11 of this report. Overall, the cost benefit guidelines appear to have been followed. There are gaps in the approach adopted, as well as, a lack of information to support some of the assumptions made and parameters used. The environmental aspects are not thoroughly reviewed and analysed.

The CBA will need to be updated to take account of the results of the new traffic study, which have been recommended.

g) Review of the project calculations

It is recognised that the Sibiu – Pitesti motorway was developed to a Feasibility Study Stage. At this stage, limited engineering calculations were available.

The calculations available within the existing study include:

- the pavement design report;
- the bill of quantities and cost estimates for the scheme.

It would have been beneficial if the Feasibility Design would have included:

- hydraulic calculations for the drainage systems, including culverts and bridges. This calculation would normally provide an estimate of additional surface water discharge flows at outfall points compared to the current situation and would aim to include provisions for attenuation of the additional volumes of water through use of Sustainable Urban Drainage Systems, such as ponds where the space permits;
- calculations for the provision of climbing lanes in accordance with the requirements of the TEM standards and the Romanian PD162 norm;
- a mass haul diagram, with estimated cut fill balance and constraints for movement of earthworks materials;
- a geotechnical risk register which classifies motorway sectors in terms of risk and provides descriptions of mitigation measures required;
- calculations for tunnels, including tunnel safety equipment, such as, ventilation and smoke control.

The lack of available calculations limited the scope of the review to the drawings and reports included within the existing Feasibility Study. The revised ToR will include requirements for the minimum provisions of calculation notes relating to the above listed items.

4.1.2 *Task 2 - Identify and assess Gaps in the existing Feasibility Study*

This task is listed in the Client's **ToR as Task 2**. As part of this task, the team have used the information gathered during the Review of Existing Information stage to produce a report which provides a comprehensive analysis of the missing data, along with recommendations for further enhancements to the project, including local route realignments and additions, site investigations and surveys including geotechnical, topographical, environmental, traffic etc., all with the aim of improving the quality of the new Feasibility Study to be commissioned.

This section of the report, Gap Analysis, includes an assessment of the appropriateness and completeness of the process adopted in the previous Feasibility Study.

It also includes a review of technical engineering aspects and an analysis of other factors, which shall have a significant influence on the implementation of the project.

These include sustainability and life cycle analysis, planning and permits (including archaeology and land acquisition), environmental assessment, social impacts, traffic studies, cost estimates, cost benefit analysis (CBA) and multi criteria analysis (MCA).

The Gap Analysis Report follows the structure of the Pre-feasibility and Feasibility reports. This allows for easier review and cross referencing between the current GAP Analysis report and the existing Feasibility Study data.

4.1.2.1 *Review of the Studies within the Pre-Feasibility and Feasibility Design*

4.1.2.1.1 *Pre-feasibility Study*

The Pre-Feasibility Study was completed in two phases 1994 and 1997 and had the following structure:

Volume no.	Description	Sub-section
Volume 2	Prefeasibility Study dated December 1994	Covers route options for the section Pitesti – Curtea de Arges - Cornetu
Volume 3	Prefeasibility Study dated January 1997	Covers route options for the section Cornetu - Sibiu

It is noted that the Volume 1 Route Option assessment was updated as part of the Feasibility Stage and has a front cover dated December 2007. As such, the review of this Volume 1 is included within the Feasibility Study Section of this report.

The route options drawing made available by IPTANA during the meeting dated 9th April 2013, is included in Annex A to this report.

a) Volume 2 Pre-feasibility Study Motorway Pitesti – Curtea de Arges - Cornetu – 1994

The Pre-feasibility Study for the Pitesti – Cornetu sector was completed in 1994. The length of the route studied was 90km and provides route options for the motorway between Pitesti and Cornetu.

The route starts at the terminus point of existing Pitesti bypass, near Bascov Lake, and follows closely the River Arges and then continues along Topologului Valley.

The 90km route includes one tunnel through Momaia Hill at approximate ch 48. The length of the tunnel was estimated to be 1530m and provision for tunnel ventilation was referenced in the technical report. The designer of the Pre-feasibility Study also reviewed a viaduct option at this location, which would have removed the need for a tunnel. However, the poor ground conditions combined with a potential increase in route length by approximately 1700m, led to a decision to adopt the tunnel option.

There are four grade separated junctions within this section. They are as follows:

- Bascov junction which is located at approximate ch 13+500 and is the current terminus point of the already constructed Pitetsi bypass near Bascov Lake.

- Curtea de Arges Junction is situated at approximate ch 41 and provides a connection to the town through a link to the county road DJ704H. It is noted that this grade separated junction is situated within the boundary delineated by the DJ704H road and the Zigoneni canal thus being forced into small space available between two bridges. It is envisaged that part of the slip roads will be constructed on structures tying in to the bridge over DJ704H. The junction would still require the traffic using DN73C and DN7C to travel through the centre of the town in order to gain access to the motorway. The option to provide a direct connection between the motorway and the DN73C (which provides the main link to Ramnicu Valcea) would be beneficial. The approximate distance between Curtea de Arges and Ramnicu Valcea is 36km and the upgrade of the existing national secondary road may be analysed as part of the improved connection between the motorway and the existing road network. Considering that Ramnicu Valcea is the only major city between Pitesti and Sibiu, it would seem appropriate that improved connectivity between the motorway and the town is analysed as part of the project. This may include the modernisation and upgrade of the DN73C, through improvement of the existing national road alignment, combined with possible sections of offline realignment near existing villages, in order to remove the through traffic from the built up areas, thus providing a safe and reliable connection.

- Tigveni grade separated junction is situated near the village of Tigveni, at approximate ch 52 and provides a link to the county road DJ678A. The distance between Curtea de Arges junction and Tigveni junction is only 9km. This falls below the recommended distance, which is between 10km and 30km, outlined in PD 162/02. However, it is envisaged that the two tunnels would provide an emergency access to the existing road network in case of full closure of the Momaia Tunnel.

Similar to the Curtea de Arges junction, the Tigveni junction still requires the traffic using the motorway to travel trough the village of Tigveni in order to access DN73C.

- Valeni grade separated junction at approximate ch 65 is situated near the village of Valeni and provides access to the county road DJ703H. The grade separated junction is situated near the Topolog River. The provision of a grade separated junction at this location may have been justified by the need to have an emergency access to the existing road network half way between Tigveni and Cornetu Junction.

The information provided as part of the Feasibility Study for the grade separated junction locations will be further reviewed and comments provided as part of the relevant section of this report.

The route studied between Pitesti and Cornetu included only one main corridor with small local alignment variations such as Momaia hill tunnel. At pre-feasibility stage it would be expected that more than one corridor is studied and multicriteria analysis undertaken.

The spacing between the proposed grade separated junctions seems small (close to the lower recommended spacing as per recommended distance in PD 162/02, which is between 10km and 30km). It is envisaged that the decision on the positioning of these grade separated junctions was taken considering access to the existing road network and the requirements for emergency access points in case of full motorway closure.

The estimated earthworks quantity for this 90km section of motorway was 8.3 million cubic metres. It is acknowledged that the project stage was Pre-feasibility Study and an outline cost estimate was prepared, which for year 1994 showed an estimated scheme cost of 940 million USD. For the cost estimate exercise, it would have been beneficial if the earthworks quantities were separated into quantities for cut and fill.

b) Pre-feasibility study Motorway Cornetu – Sibiu 1997

The Pre-feasibility Study for the Pitesti – Cornetu was completed in 1997. The length of the route studied was 56.50km and provided route options for the motorway between Cornetu and Sibiu. The route was sub-divided into two main sections:

- Cornetu – Boita - ch 90 to 122
- Boita – Sibiu – ch122 to 138

The section between Cornetu and Boita follows closely the river Olt valley and is heavily constrained by the existing topography with the two main options studied both situated close to the river Olt.

Option 1, which was the preferred option, was designed closer to the river bed thus minimising the amount of excavation into rock. The technical report prepared as part of the pre-feasibility stage includes a reference to the DN7 road realignment works that required excavation into rock for a length of approximate 300m, which at the time led to significant rock falls and put the DN7 and existing railway line at risk of closure.

It is explained that Option 1 reduces this risk, but results in the motorway alignment being situated very close to the River Olt.

Option 2 provides local variations to Option 1 that would push the motorway alignment more into the mountain. While this option would keep the motorway alignment further away from the river, it was noted that the risks associated with excavation into rock would outweigh the benefits due to historical issues with the stability of the existing rock slopes.

Based on this consideration, it is noted that the Designers preference was Option 1 which, according to the Pre-feasibility Study report, also received the support from the designer of the hydro-technical works planned for the River Olt.

Due to significant constraints it is envisaged that the only feasible corridor along the sub-section Cornetu – Boita is the one studied as part of the pre-feasibility stage. A more detailed analysis of the route is presented as part of the section outlining the review of the Feasibility Study completed in 2008.

The second sub-section between Boita and Sibiu follows an alignment that finishes east of Sibiu with two grade separated junctions provided at ch 141 (DJ106) and ch 146, where it connect to the DN14. The motorway section east of Sibiu is currently opened to traffic and starts at a point south of Selimbar on the DN1/DN7 road.

It is noted that the distance between Cornetu interchange (90km) and Vestem interchange (130km) is 40km which slightly exceeds the recommended distance. It is acknowledged that the existing terrain within this area allows very little space for the development of an additional grade separated junction. However it would have been beneficial if consideration of emergency exits from the motorway onto the existing road network was included in the Pre-feasibility Study. The main cause of concern would be the need for emergency motorway closure due to potential accidents or closure of tunnels.

The Pre-feasibility Studies, completed in 1994 and 1997, lack analysis of the route options and justification for the selection or rejection of the various options. The revised ToR will include requirements for the detailed justification and selection of the preferred route along with a robust multi criteria analysis. Whilst it is acknowledged that the terrain constraints would prevent the analysis of significantly different routes within this section, it is envisaged that such constraints could and should be adequately documented in the future study in order to evidence the thinking behind these design decisions.

4.1.2.1.2 *Feasibility Study completed in – 2008*

The Feasibility Study developed by the joint venture IPTANA / Egis and completed in 2008 was largely based on the outcome from the existing Pre-feasibility Studies completed in 1994 and 1997. Therefore the Feasibility Study focused more on the corridor studied during the previous stages and included limited amount of route option analysis. Halcrow's review covered the entire documentation made available which was structured as follows:

Volume no.	Description	Sub-section
Presentation Report	Route Alignment Assessment	Covers route options for the entire scheme between Sibiu to Pitesti.
Vol. 1	Synthesis	
Vol. 2.1	Road Works	Section I Sibiu – Cornet ch 0+000 to ch 40+200
		Section II Cornet – Tigveni ch 40+201 to ch 78+500
		Section III Tigveni – Pitesti ch 78+500 – ch 116+640
Vol. 2.2	Bridges, Overpasses, Viaducts works	Section I Sibiu – Cornet ch0+000 to ch 40+200
		Section II Cornet – Tigveni ch 40+201 to ch 78+500
		Section III Tigveni – Pitesti ch 78+500 – ch 116+640
Vol. 2.3	Tunnel Works	ch 0+000 to ch 116+640
Vol. 2.4	Motorway Facilities	Section I Sibiu – Cornet ch 0+000 to ch 40+200
		Section II Cornet – Tigveni ch 40+201 to ch 78+500

Volume no.	Description	Sub-section
		Section III Tigveni – Pitesti ch 78+500 – ch 116+640
Vol. 3	General Bills of Quantities and cost estimates	
Vol. 4	Traffic Study	
Vol. 5	Economic Analysis	
Vol. 6.1	Topographical Studies	Sibiu County
Vol. 6.2	Topographical Studies	Valcea County
Vol. 6.3	Topographical Studies	Arges County
Vol. 7	Geotechnical Study	
Vol. 8.1	Environmental Impact Assessment Study	
Volume 8.2	Report to the Environmental Impact Study	
Vol. 8.3	Environmental Impact Assessment Study – Drawings	
Vol 8.4	Environmental Impact Assessment Study – Annexes	
Vol 8.5	Environmental Impact Assessment Study Non-Technical Report	
Vol 8.6	Environmental Impact Assessment Study – Public consultations	
Vol. 9	Documentation for Identification of Land Owners	
Vol. 10	Motorway communication and Traffic Control	
Vol 11.1	Relocations, Protection of Petrol, White Products, Gas, Water and Sewage Installations	
Vol 11.1 (1)	Relocations, Protection of Petrol, White Products, Gas, Water and Sewage Drawings	
Vol 11.2	Relocations and Protection of Land Reclamation installations	
Vol 11.3	Relocations and Protection of Electrical Installations	

Volume no.	Description	Sub-section
Vol. 11.4	Relocations and Protection of Telecommunication Installations	
Vol. 12	Permits and Agreements	
	Maintenance and Operation Plan	

The review of the existing information focused on all of the above volumes and the findings are identified as part of Section 4 of this report.

4.1.2.1.3 Presentation Report - Route Alignment Assessment

The Route Options Study prepared as part of the feasibility stage was mainly based on the two Pre-feasibility Studies developed for section Pitesti – Curtea de Arges – Cornetu dated 1994 and Cornetu - Sibiu dated 1997. It is noted that in addition to the Pre-feasibility Study for the Pitesti – Curtea de Arges – Cornetu section of the motorway, three more route corridors were studied mainly aimed at bringing the motorway closer to Ramnicu Valcea.

The Route Alignment Assessment report dated December 2007 divided the motorway in the following sub-sections:

- Sub-section 1 Sibiu – Racovita ch 0+000 to ch 45+500
- Sub-section 2 Racovita – Poiana – Suici – Barsesti ch 45+500 to ch 84+000
- Sub-section 3 Barsesti – Curtea de Arges ch 84+000 to ch 94+000
- Sub-section 4 Curtea de Arges – Pitesti ch 94+000 to ch 122+000

It is mentioned that the section 1 Sibiu - Racovita starts west of Vestem and does not include the link, approximately five kilometres long, to the as-built Sibiu bypass. Outline proposals for this missing link are presented within the Road Works section of this report and a route option is presented on drawing number 1 included within Annex A to this report.

Each of the sub-sections above includes route options as follows:

Sub-section 1 Sibiu – Racovita ch 0+000 to ch 45+500

Route option I East – shown in blue colour on the drawing included within Annex A

The route option I East includes the currently constructed Sibiu – bypass and is developed east of the village of Vestem. The route includes a 600m long tunnel near chainage 12+500. The route continues along river Olt valley and is characterised by a series of tunnels and viaducts. This route option between Sibiu (ch 0) and the Cornetu interchange (ch 48), generally follows the same alignment as the one studied as part of the pre-feasibility stage. Due to this the comments made as part of the Cornetu – Sibiu section of this report are also applicable to the Feasibility Study. It is noted that due to concerns relating to the stability of rock within this area the Designer (IPTANA) decided that route option I East was not desirable.

Route option I West - shown in red colour on the drawing included within Annex A

The route option I West also includes the currently constructed Sibiu bypass but is developed west of the village of Vestem. This route follows an alignment that is situated close to river Olt between ch 12+500 and ch 48. Within this length, four tunnels and several crossings of the river Olt are required.

The alignment of route option I West, closely follows the alignment studied as part of the 1997 pre-feasibility stage. Based on the statement included within the Pre-feasibility Stage report, option 1 West was also agreed with the Designer of the hydro-technical works at that time. The route options assessment, dated December 2007, does not appear to provide confirmation of acceptability from the organisation responsible for the design of the hydro-technical works (ISPH). It is acknowledged, however, that option I West was adopted as the preferred route as part of the Feasibility Study and did receive a favourable permit from Hidroelectrica SA, the body responsible for the maintenance and operation of all hydro-technical plants along the river Olt. It is noted that the favourable permit from Hidroelectrica confirms that the only plant which may be affected by the works is at SH Ramnicu Valcea, specifically relating to the works to be carried out near Cornetu grade separated junction approximate chainage 41+000. It is also clarified that the final permit will be issued based on the Technical Project (Proiect Tehnic).

Based on the cost comparison presented as part of the Route Assessment Report dated December 2007, the route 'Option I West' was proposed as the preferred route.

The route assessment report provides cost estimates for each of the two options, but it does not include a clear list of constraints, advantages and disadvantages for each option. The multi criteria analysis (MCA) focuses mainly on the technical aspects and provides comparative quantities and costs for each option. The MCA does not include any references to the Natura 2000 sites either traversed or bordered by the route.

A more detailed analysis of the preferred route is presented as part of the Task 2 section of this report.

As a general comment the skew of some of the bridges crossing over River Olt would require a more in depth analysis and possible optimisation of alignment and design. A typical example would be the bridge at chainage 11+500.

Sub-section 2 Racovita - Barsesti ch 45+500 to ch 84+000

Within this sub-section three route options were studied. These are:

- Route option II Racovita – Poiana – Suici – Barsesti ch 45+500 to ch 84+000
- Route option IIA Calimanesti – Suici – Barsesti ch 45+500 to ch 84+000
- Route option IIB Racovita – Calimanesti – Runcu – Barsesti ch 45+500 to ch 84+000.

Route option II Racovita – Poiana – Suici – Barsesti - shown in purple colour on the drawing included within Annex A

This route was developed east of the Cozia National Park (both birds and habitats directive Natura 2000 sites) and follows the existing county road DJ703. The route assessment report includes reference to active landslides within the Poiana area, ch 52+000 to ch 57+000. Four tunnels were proposed within this area in order to mitigate risks relating to potential landslides caused by open excavations.

Route option IIA would provide indirect access to Ramnicu Valcea though the Curtea de Arges interchange and the national secondary road DN73C. The option of further online improvements to the DN73C could be considered as part of the updated Feasibility Study.

Route option IIA Calimanesti – Suici – Barsesti - shown in dark green colour on the drawing included within Annex A

This route was developed along county road DJ703G and included many tunnels and viaducts. The main aspect noted in this option is the section between ch 50 to ch 65, where the route traverses the Cozia National Park. Apart from the estimated construction cost, the environmental impact related to the crossing of Cozia National Park, triggered a lower score as part of the multi criteria analysis. Based on the cost and environmental considerations, Option IIB was rejected.

Route option IIB does not provide a direct access to Ramnicu Valcea. Due to this, in addition to the cost, it can be concluded that option IIB is not feasible for adoption as the preferred route.

Route option IIB Racovita – Calimanesti – Runcu - shown in magenta colour on the drawing included within Annex A

Route option IIC follows the same alignment as option IIB between ch 45+500 to ch 70+000. The main alternative is the section between Calimanesti and Barsesti where the proposed route traverses the mountainous area of west of Runcu village. The route includes 5 tunnels, the longest tunnel being 2.21km.

This route option does not provide direct access to Ramnicu Valcea and traverses the protected area of Cozia National Park. In the absence of any significant benefits associated with this route it can be concluded that option IIC is not feasible for adoption as the preferred route.

Sub-section 3 – Barsesti – Curtea de Arges

This subsection is developed between ch 84+000 to ch 94+000 and follows the Topologului valley and river Arges. The alignment presented as part of this sub-section is the same as the one included as part of the Pre-feasibility Study for Pitesti – Curtea de Arges – Cornetu.

No other route options were presented as part of this sub-section. The comments made as part of the Pre-feasibility Study section of this report are therefore applicable to sub-section 3. A more detailed review of the proposed route is presented as part of Task 2 of this report.

Sub-section 4 Curtea de Arges – Pitesti

This subsection is developed between ch 94+000 to ch 122+000. It follows an alignment south of Curtea de Arges which continues along the river Arges. The route ties in to the currently constructed Pitesti bypass near Bascov Lake. The alignment presented as part of this sub-section is the same as the one included as part of the Pre-feasibility Study for Pitesti – Curtea de Arges – Cornetu.

No other route options were presented as part of this sub-section. The comments made as part of the Pre-feasibility Study section of this report are therefore applicable to sub-section 4. A more detailed review of the proposed route is presented as part of Task 2 of this report.

General comments and findings relating to the Route Alignment Assessment

The Route Assessment report provides cost estimates for each of the options studied, but it does not include a clear list of constraints, advantages and disadvantages for each option. The list of constraints should have included specific information on existing geology and historical data for each option, with emphasis on the challenges relating to the execution of tunnels and viaducts. The lack of a suitable connection between the motorway and Ramnicu Valcea was not captured as part of the multi criteria analysis for option IIA. The multi criteria analysis focuses mainly on the technical aspects and provides comparative quantities and costs for each option.

The main gaps identified within the route options report relate to:

- ***Lack of robust justification for selection of the preferred route and rejection of other options;***
- ***No reference to the Natura 2000 sites affected within sub-section I;***
- ***General lack of justification behind the evaluation factors and scoring system used in the MCA.***

4.1.2.1.4 *Volume 1 - Synthesis*

Investigations into the possible routes for the Sibiu - Pitesti Motorway have been considered by several parties in recent years. The original Pre-feasibility Study was developed by IPTANA in 1996 and this was followed by the completion of the Feasibility Study in 2008. This led to a fragmented approach in the decision making process with the possibility that essential elements of the various studies may have been missed or not covered in sufficient detail. Volume 1 provides an overall presentation of the project and covers the following categories of works:

a) Traffic forecast information

b) Topographical studies

c) Geotechnical studies

d) Highway alignment

e) Pavement options design

f) Drainage design

g) Road safety

h) Grade separated junctions

i) Structures

j) Earthworks and retaining structures

k) Tunnels

l) Hydro-technical works

m) Rest and service areas and maintenance centres

n) Environmental Impact Assessment

o) Relocation and protection of public utilities

p) Maintenance and operation plan

q) Land acquisition

r) Economic analysis

s) Third parties permits

t) Cost estimate (known as the 'Deviz General')

Each section of the Volume 1 Synthesis is discussed in more detail within sections 4.1.2.1.5 to 4.1.2.1.18, which covers each Volume of the Feasibility Study.

4.1.2.1.5 Volume 2.1 - Road Works

The route between Sibiu to Pitesti was generally designed in accordance with TEM Standards and the Romanian norm PD 162. The reasons for the design speed used are not clear but based on the information reviewed it appears that the design speed used for the northern and southern parts of the project was 120km/h, whilst the section in the middle along Topologului Valley and Olt River was designed to 100km/h.

The typical cross sections presented within the existing drawings comply with the requirements of the TEM standards but do not include applicabilities and due to this it is not clear where each of the two main typical sections are applied. It is envisaged that the reduced width section, 23.50m wide platform may be used between Cornetu Interchange ch 40+200 to Talmaciu Interchange ch 4+500 with the comment that the verges must be wider in order to allow adequate space for the provision of safety barriers, drainage and ducting for motorway communications and lighting.

Furthermore, it would be beneficial to have wider verges within cuttings, to allow for the clearing and storage of snow. All of these issues require consideration during the updated Feasibility Study.

The Feasibility Study also includes a typical cross section applicable within areas where a climbing lane would be required. No clear applicability is provided for the use of this typical cross section or calculations to support the need for its provision. It is noted that the Romanian standard for design of Rural Motorways, PD 162, provides detailed requirements relating to the addition of a climbing lane which are mainly based on calculations relative to the longitudinal gradient and distance, while the TEM Standards Clause 2.2.2.8 Gradients and Climbing Lanes provides a calculation methodology based on level of service and the influence of heavy vehicles for each category of terrain (level, rolling or mountainous). It is expected that the updated Feasibility Study will include adequate calculations to justify the provision of the additional climbing lane.

The TEM Standards clause 1.2.2.11 – Subsequent stages provides an outline of considerations relating to the future provision of additional lanes. The existing traffic study completed as part of the existing feasibility stage provides information about traffic growth for years 2030 and 2035. The forecasts provided seem to suggest that the section Pitesti – Curtea de Arges may require three traffic lanes in each direction as of 2035, while section Vestem – Sibiu may require three traffic lanes each way as of 2030. It is noted that a new traffic study will be required and it is expected that this will clarify the need for additional lanes. However, the existing Feasibility Study does not appear to include any discussions relating to provisions within the design for the future addition of a third traffic lane. These provisions may include, but are not limited to:

- Acquisition of land required for future widening;
- Use of the emergency lane as a traffic lane particularly during the peak hours;
- Provision for the addition of a third lane at structures;
- Earthworks design to enable future addition of a third lane either to the outside or to the inside through provision of a widened central reservation.

A requirement for consideration of such aspects will be included within the revised ToR.

The above aspects have a direct impact on the area of land to be acquired. This along with the quantities and scheme construction cost may have been underestimated.

The analysis of the proposed road works is structured as follows:

a) Highway design features such as grade separated junctions and their design in conjunction with the estimated traffic flows;

b) Reviewing the possible alignment options for the scheme tie-in to the recently constructed Sibiu bypass, which is estimated to be approximately 5km;

c) General comments about the alignment design for the preferred route;

d) General comments about the proposed drainage system with specific reference to the allowance for climate change;

e) Reviewing any information available on buildability and constructability including details relating to temporary works and the impacts generated by construction traffic;

f) Information relating to carbon footprint and whole life cost estimate;

g) Comments on road safety features;

h) Pavement options design;

i) Hydro-technical works;

j) Overall comments on the Road Works Volume.

a) Highway design features such as grade separated junctions and their design in conjunction with the estimated traffic flows;

The design for Sibiu Pitesti Motorway was developed in three main subsections as follows:

- Section I – Sibiu (Vestem) – Racovita (Cornet) - ch 0+000 to ch 40+200
- Section II – Racovita (Cornet) – Tigveni – ch 40+200 to ch 78+500
- Section III – Tigveni – Curtea de Arges - Pitesti – ch 78+500 to ch 116+000

Each of the above sections includes grade separated junctions and the specific comments are provided below.

Section I – Sibiu (Vestem) – Racovita (Cornet) - ch 0+000 to ch 40+200

Vestem Interchange ch 0+000: The grade separated junction at the start of the project was designed to ensure a connection to the future Sibiu – Fagaras expressway. It is known at this stage that the already constructed section of the Sibiu bypass includes a grade separated junction, approximately 5 kilometres north of Vestem, providing access to the national road DN1/DN7. Based on this it is envisaged that the **Vestem grade separated junction will no longer be required** and the updated project should include the **reconfiguration of the already built junction at Sibiu bypass**. Currently the existing junction includes an at-grade layout for the access to and from DN1/DN7, which in our opinion is unsafe given the high traffic volumes in the area. It is recommended that the updated Feasibility Design includes for a free flow grade separated junction at this location. Such requirements will be outlined in the new ToR.

Talmaciu Interchange ch 4+500: This grade separated junction is situated only ten kilometres south of the existing Sibiu bypass junction. It is understood that Talmaciu interchange is providing access to the small villages (Sadu, Cisnadie and others) located to the west of the motorway. Although the distance to the existing junction is relatively short it is considered that the small compact grade separated junction could be retained as part of the project.

Cornet Interchange ch 40+200: This junction provides indirect access to the DN7 through connection to the county road DJ703M. The location of this junction would provide useful access to the existing DN7 in the potential event of a full motorway closure (caused for example by the closure of the tunnels) although it is noted the space available for this junction is extremely limited. The design does not seem to provide details about the required upgrade works for the junction between DN7 and DJ703M. Such traffic capacity analysis would need to be carried out as part of the updated Feasibility Study and calculation notes made available as part of the reports. Also the visibility to the proposed junction between the interchange slip road and DJ703M will require review. The section of DJ703M between the DN7 and the motorway slip road may require upgrading and widening and such works were not identified within the existing Feasibility Study.

With regard to the three grade separated junctions proposed within the section Vestem – Cornetu, it was noted that no access to and from the motorway is available between the Talmaciu and Cornet interchanges. This is due to five tunnels being situated within this length, the longest of which is 1700m (the longest tunnel in the project) and is situated near ch 27. In our opinion, the risk of full motorway closure caused by potential accidents within the tunnels requires mitigation measures. It is accepted that the topography within this area is very difficult and provision of emergency exits would prove to be challenging. At the very least, the design should include central reservation cross-over points either side of the tunnels. The designer should also study a potential option to the east of Caineni to verify if the 1700m long tunnel could be removed. This potential eastern option may include a long span bridge over the houses situated within the Cainenii Mici valley.

Adequate provisions for intelligent signalling and warning systems will be required at Talmaciu and Cornetu interchanges in order to ensure traffic follows a diversion route along the existing DN7 road in the event of a full motorway closure.

Section II – Racovita (Cornet) – Tigveni – ch 40+200 to ch 78+500

Valeni Interchange ch 69+500: This junction provides access to the county road DJ703H. The interchange slip roads are to be constructed on a bridge crossing the river Topolog. It is recommended that an alternative location is identified for this junction in order to eliminate the need for very expensive structures. According to the Pre-feasibility Study, the location of Valeni interchange was at approximate ch 65+000. This or a similar location may be beneficial as it would be situated closer to the tunnel at ch 56+000 and would provide a better emergency access in case of full motorway closure. As mentioned for Section I, we would recommend as minimum safety measures, the addition of central reservation cross over points either side of the tunnels, combined with intelligent signalling and warning systems. A study of a simple on and off access from the motorway near the tunnel would be beneficial.

Tigveni Interchange ch 78+500: Section II – Racovita (Cornet) – Tigveni – ch 40+200 to ch 78+500. The grade separated junction provides access to the county road DJ678A and national road DN73C. Since the motorway does not provide any direct or improved access to Ramnicu Valcea we are of the view that the location and configuration of Tigveni interchange needs reviewing in order to provide a direct access and link to DN73C. It is acknowledged that the Tigveni interchange and the Curtea de Arges interchange are situated only eight kilometres apart but their inclusion in the design is beneficial as it provides for ideal emergency access in case of tunnel ch 81+000 closure.

Section III – Tigveni – Curtea de Arges Pitesti – ch 78+500 to ch 116+000

Curtea de Arges interchange ch 86+500: This grade separated junction is very important for provision of access to Curtea de Arges. It is however noted that the junction slip road ties in to the county road DJ704H and does not provide direct access to DN73C. In our opinion both junctions Tigveni and Curtea de Arges will require a review as part of the updated Feasibility Study with the aim to provide a direct access to DN73C. As part of the procurement strategy report, references to the option of addition of DN73C to the scope of works on Sibiu – Pitetsi were included.

The proposal will be to upgrade the DN73C road and provide a faster and safer connection to Ramnicu Valcea. This will enable the capturing of social and economic benefits from improved connectivity to Ramnicu Valcea.

Baiculesti Interchange ch 101+000: This grade separated junction provides access to DN7 west of Valcele reservoir. This junction is situated 14.5km from the Curtea de Arges junction and only 5km from Bascov junction. In our opinion, the addition of this junction does not bring substantial benefits. Its inclusion in the design needs to be reviewed as part of the updated Feasibility Study, using the most recent traffic data and O/D surveys.

Bascov Interchange ch 116+000: The grade separated junction at Bascov ties in to the as built Pitesti bypass section of motorway and will result in a reconfiguration of the existing at-grade junction. This is an area with many industrial developments and it is envisaged that the junction will be used by a high proportion of HGVs. It is therefore recommended that a revised layout is reviewed as part of the updated Feasibility Study. An outline proposal for this junction is presented in the drawings annexed to this report.

With regard to all grade separated junctions, it is noted that the TEM standard recommends provision of lighting. The interchanges near Sibiu, Curtea de Arges and Pitesti will require public lighting and we would recommend that the other rural interchanges are also illuminated. The Romanian standards for public lighting do not provide a recommended minimum distance for provision of lighting on approach to the junctions. We would therefore recommend that provision of lighting within the grade separated junctions is measured from the start of diverge taper to the end of merge taper. Where the distance between two interchanges is less than 3 times stopping sight distance then the motorway section between the junctions will also require provision of public lighting.

b) Reviewing the possible alignment options for the scheme tie-in to the recently constructed Sibiu bypass, which is estimated to be approximately 5km;

It is acknowledged that the existing terminus point of the Sibiu – Pitesti alignment is south of Vestem at the future connection with the Sibiu – Fagaras expressway. Also, the recently constructed Sibiu bypass, which will form an integral part of the corridor IV motorway, finishes south of Sibiu at the intersection with DN1/DN7 and bypasses the city to the east. The drawing enclosed within Annex A provides an outline route option for the 5km, missing link between the Sibiu – Pitesti motorway and the Sibiu Bypass. The general comments are that the proposed grade separated junction included as part of Sibiu – Pitesti motorway at ch 0 will no longer be required as the motorway will tie in to the existing section of the Sibiu bypass. The existing grade separated junction will require modification and upgrade in order to provide free flow movement and to remove the left turning lanes from the DN1/DN7 road.

The proposed alignment traverses a protected Natura 2000 site which is represented on the drawing with a light blue hatch. This site cannot be avoided but should be included for assessment in the updated Environmental Report.

The typical section of the motorways within this area will be determined as part of the updated Feasibility design although it may include a three lane motorway as briefly mentioned in the existing traffic study.

c) General comments about the alignment design for the preferred route with specific focus on:

Interface at the tie in to tunnels and structures: it is noted that according to the typical section for tunnels, the distance between the twin tunnels varies between 20.00m to 35.00m. It was noticed that the highways alignment does not bifurcate on approach to the tunnels and this Gap is considered relatively significant as additional structures and walls will be required in most cases to accommodate the wider cross section. Also additional land acquisition will be required.

The 3D modelling of the mainline, as well as, accommodation tracks, parking areas and service areas is lacking in detail. It is noted that many features such as local accommodation roads, local access tacks, longitudinal drainage systems, service areas or other works were not fully captured within the 3D design model for the project. This is seen as a significant Gap as the 3D design would provide an increased level of accuracy in terms of requirements for land take, retaining walls and in some cases, the buildability of the outline proposal. The new ToR will include specific requirements for full 3D modelling of the entire project, both for the mainline motorway and for all access tracks and other works including retaining structures side slopes, drainage channels etc. The full 3D modelling of the road design becomes even more important at Feasibility Stage if the project will be procured under a Design and Build contract.

Local alternative alignments to be reviewed as part of the updated Feasibility Study:

Based on the information available, it is envisaged that local alternative proposals for the horizontal alignment could be reviewed as part of the updated Feasibility Study:

- As mentioned within this report an outline proposal for the 5km long missing link to the Sibiu bypass is included in the drawings Annex to the report. This will require further analysis as part of the Feasibility Design and a reconfiguration of the existing interchange at the Sibiu bypass will also be required. Due to the high traffic flows, it is envisaged that this interchange will require a free flow layout. **The outline route option for the 5km link is presented in Drawing No. 1 within Annex A to this report;**

- Area ch 5+500 to ch 11+500: the analysis of an alignment option west of Boita would be beneficial to potentially remove some of the long bridges currently proposed in the design. Also at chainage 5+500, the alignment is designed along the Sadul stream which results in a long structure. The outline route option for this location is presented in Drawing No. 2 within Annex A to this report;

- Area ch 25+000 to ch 29+500: the analysis of an alignment option east of Caineni would be beneficial in order to analyse the removal of the Caineni tunnel. The outline route option for this location is presented in Drawing No. 3 within Annex A to this report;

- Alignment bifurcation on approach to the Lazaret tunnel at ch 18+500 to ch 20+500 requires further analysis. The main concern at this location is the close proximity of the railway, DN7 road and the River Olt, all of which would constrain the construction activities;

- Alignment bifurcation on approach to the Caineni tunnel at ch 25+500 to ch 28+500 requires further analysis. The main concern at this location is the close proximity of the railway, DN7 road and the River Olt, all of which would constrain the construction activities;

- Alignment bifurcation on approach to the tunnel ch 30+500 requires further analysis;

- Alignment bifurcation on approach to the tunnel ch 36+000 requires further analysis;

- Alignment bifurcation on approach to Poiana tunnel ch 56+000 requires further analysis;

- Alignment bifurcation on approach to tunnel ch 81+000 requires further analysis;

- An alternative alignment option may be reviewed at ch 65+000 to ch 68+500, with the view to move further east, away from the existing marshland area. The outline route option for this location is presented in Drawing No. 4 within Annex A to this report;

- A review of grade separated junction with direct link to DN73C near Curtea de Arges or Tigveni (ch 77+800) would be beneficial. The outline route option for this location is presented in Drawing No. 5 within Annex A to this report;

- Re-alignment proposal for between ch 91+000 and ch 99+000, where the current proposal is to locate the motorway very close to the River Arges and within what appears to be a marchland. The outline proposal would be to investigate the option of moving the alignment further west, closer to the 110kv overhead line. It is envisaged that relocation of the 110kv line may be required which may involve underground positioning of the line. A cost comparison will be required in order to determine the most economically advantageous option at this location. The outline route option for this location is presented in Drawing No. 6 within Annex A to this report;

- Re-alignment proposal at ch 109+000. At this location the space available between the railway and the Budeasca reservoir is very tight. A possible alternative option may be to raise the vertical alignment thus enabling the construction of the motorway on a viaduct with the soffit level above the Budeasca reservoir dam. This would enable the translation of the horizontal alignment closer to the dam and would reduce the likely clash with the railway in this location. The outline route option for this location is presented in Drawing No. 7 within Annex A to this report;

- A reconfiguration of the Bascov interchange at ch 116+200 to a diamond type junction, combined with the relocation of the maintenance and operation centre, would be beneficial. The outline route option for this location is presented in Drawing No. 8 within Annex A to this report;

- General fine tuning of the alignment is required within the areas proposed for river bed diversion works. The intention would be to minimise these works thus potentially reducing the associated environmental impacts.

The section below includes specific comments related to the above eight locations, which are based on the observations and data gathered during the site visit completed by Halcrow's team during 3rd to 5th June 2013.

These locations are as follows:

1. The addition of the 5Km missing link between Vestem and the as-built Sibiu bypass
2. Ch 5+500 to ch 11+500 – route option west of Boita
3. Ch 25+000 to ch 29+500 – route option east of Caineni
4. Ch 65+000 to ch 68+500 - relocation of the alignment further to the east in order to minimise the impact on the Topolog River
5. Additional slip road at Tigveni Grade Separated Junction providing a direct connection to DN 73C
6. Ch 91+000 to ch 99+000 – relocation of the alignment further to the west in order to minimise the impact on Arges River
7. Ch 110+500 Budeasca reservoir – relocation of the alignment closer to Budeasca reservoir combined with the provision of a structure over the reservoir dam.
8. Ch 116+200 reconfiguration of the Bascov grade separated junction.

Each of these eight locations are described in more detail, as follows:

1. **The addition of the 5km missing link between Vestem and the as-built Sibiu bypass**

   The outline proposal studied by Halcrow aims to provide the most feasible route link between Vestem and the existing Sibiu bypass. The route for the additional 5 kilometres between Vestem and Sibiu is situated to the south west of the as-built Sibiu bypass interchange. It follows an alignment which positions it close to the Cibin – Hartibaciu forest and it traverses a Natura 2000 site. Based on the site observations the terrain within this area is flat and free of structures, apart from what appears to be a derelict farm, which is unlikely to be affected by the route. A 110 Kv overhead line is situated in close proximity to the proposed motorway route, which may be affected by the proposed works. The outline proposal for the 5 kilometres route is presented on Drawings No. 1 included in the Annex A to this report.

2. **Ch 5+500 to ch 11+500 – route option west of Boita**

The alternative proposal aims to remove the multiple river Olt crossings, as well as, the long viaduct over the river Sadul at ch 5+500. It is acknowledged that multi criteria analysis will be required in order to establish the most feasible route within this area.

The alternative route option proposed west of the village of Boita would branch off from the current alignment at approximate ch 5+500, where it crosses over river Sadul. The alternative route continues to the east of Talmacel village and near to Boita, would include a viaduct over the existing houses, which can be observed on the pictures shown on drawings number 2. Alternatively, in order to avoid impacting on the properties, the alignment could be moved closer to Turcilor hill. The alternative route would rejoin the current alignment at approximate ch 12+000 where it would be situated to the west of what appears to be a small Castle. At this location, between the Castle and the re-connection to the existing route, it is envisaged that either a short tunnel or some excavations combined with retaining structures may be required. The outline route proposal is presented on Drawings No. 2 included in the Annex A to this report.

3. **Ch 25+000 to ch 29+500 – route option east of Caineni**

The alternative proposal aims to remove the Caineni tunnels and the multiple river Olt crossings in an area where the constraints, relating to the Works being near the existing railway and DN7 road, are seen as significant. For instance the need to bifurcate the alignment on approach to the tunnel portals (tunnel portals situated at 20m apart) would lead to an increase in length and skew for the bridges over river Olt. The alternative proposal may still require a tunnel of approximately 1000m long, but this would be 500m shorter than the current proposal. In addition, the alternative proposal would reduce the length of the proposed viaduct along the river Olt, at approximate ch 29+000. The outline route proposal is presented on Drawing No. 3 included in the Annex A to this report.

4. **Ch 65+000 to ch 68+500 - relocation of the alignment further to the east in order to minimise the impact on the Topolog River**

The alternative proposal aims to minimise the impact on the river Topolog and to remove the alignment from an area that appears to be marshland. It is acknowledged that multi criteria analysis will be required in order to establish the most feasible route within this area.

Based on the information available and observations from site, the currently proposed alignment is situated close to the Suici Lake and Topolog River. An aspect that would require works to be executed within the river bed. It is considered that the environmental impact related to such works is significant and the proposal outlined on drawing number 4 would aim to minimise these impacts. Also the length of the bridge over Topolog River would be reduced. The outline route proposal is presented on Drawings No. 4 included in the Annex A to this report.

5. **Additional slip road at Tigveni Grade Separated Junction providing a direct connection to DN 73C**

   The alternative proposal aims to minimise the impact generated by the traffic to and from the motorway, which according with the current proposal would use the county road DJ 678A and transit through the village of Balteni. The proposal includes the addition of a new link/slip road between the Tigveni grade separated junction and the DN73C. It is acknowledged that multi criteria analysis will be required in order to establish the most feasible route within this area. Based on the site visit observations, the proposal seems feasible and would enable faster and safer direct access to the DN73C. The distance along the DN73C from the intersection, with the new slip road to Ramnicu Valcea, is approximately 20Km. It may be beneficial that the project includes an online improvement of the existing DN73C over this length in order to provide an enhanced transport link to the city of Ramnicu Valcea. This is to be reviewed in conjunction with the Ministry of Transport strategic capital investment plan and the outcomes from the cost benefit and traffic analysis. The outline route proposal is presented on Drawing No. 5 included in the Annex A to this report.

6. **Ch 91+000 to ch 99+000 – relocation of the alignment further to the west in order to minimise the impact on Arges River**

   The alternative proposal aims to minimise the impact on the river Arges and to remove the alignment from an area that appears to be marshland. Based on data gathered during the site visit, the current alignment proposal traverses the old river bed of the Arges. The alternative alignment may impact on an existing 110 kv overhead power line which may have to be relocated underground for this locally realigned sector of the motorway. The alternative proposal would improve the horizontal geometry of the structure crossing over the river Arges at approximate ch 98+500. It is acknowledged that multi criteria analysis will be required in order to establish the most feasible route within this area. The outline route proposal is presented on Drawing No. 6 included in the Annex A to this report.

7. **Ch 110+500 Budeasca reservoir – relocation of the alignment closer to Budeasca reservoir combined with the provision of a structure over the reservoir dam.**

   The alternative proposal aims to minimise the impact on the adjacent railway line at this pinch point location, west of Budeasca reservoir. It is acknowledged that multi criteria analysis will be required in order to establish the most feasible route within this area.

   The proposal includes the construction of a viaduct over Budeasca reservoir dam and translation of the horizontal alignment closer to the reservoir. Based on the site observations, this alternative solution seems feasible although its implementation may be subject to discussions with the reservoir Administrator and the Rail Authority. The outline route proposal is presented on Drawing No. 7 included in the Annex A to this report.

8. Ch 116+200 reconfiguration of the Bascov grade separated junction

The alternative proposal aims to minimise the impact on land requirements for the construction of the grade separated junction and the maintenance and operation centre. In addition, the proposal takes account of the envisaged percentage of heavy traffic in the area, along with the capacity of the junction. It is acknowledged that multi criteria analysis will be required in order to establish the most feasible route within this area.

Based on the site observations, it can be noted that the area has potential for industrial development which would suggest increased likelihood for the growth of heavy traffic. From a road safety perspective, the current proposal involves the provision of structure over the future motorway for the DN7, an aspect which shall include a ramped approach to the proposed small roundabout. This layout is considered unsafe as vehicles could skid and fail to stop before the roundabout give way line. The outline alternative proposal would remove this risk and would involve the construction of a motorway structure over the DN7 with an ovoid shape roundabout situated at the existing DN7 level. The buildability aspects of this outline proposal have been considered and would involve a staged construction of the southern sliproads first, followed by the modifications to the motorway levels and construction of the flyover structure. The space available within the area is confined and the south-eastern slip road may require a retaining structure in order to limit its footprint. Such a compact interchange layout is not considered unusual for a grade separated junction located in an urban area. The outline junction proposal is presented on Drawing No. 8 included in the Annex A to this report.

The above are seen as some key examples of possible options, which may be considered for review as part of the updated Feasibility Study. A future Consultant may explore other ways of enhancing the project to reduce construction and maintenance risks, mitigate associated environmental impacts and minimise costs.

d) General comments on the proposed drainage system with specific reference to the allowance for climate change

The drainage system consists of lined open longitudinal ditches, filter drains and culverts.

The existing report includes reference to the provision of longitudinal opened drainage channels over an approximate length of 146km. Approximately 99 culverts were also provided.

A piped drainage system was proposed for the central reservation at locations where the surface water falls towards the median area (applicable to super-elevated sections) or at locations where the capacity of the opened channels is exceeded.

In the absence of hydraulic calculations, no comments can be made in relation to allowances in the design for impacts resulting from climate change, such as, provision for any percentage increase in rainfall intensity. It is acknowledged that such requirements are not specified in the current Romanian standards and international best practice will be used for input to the new ToR.

As general comment it is noted that no hydraulic calculations are available to back up the current design.

The new ToR will include requirements for:

- Provision of hydraulic design calculations;
- Inclusion of an allowance for global climate change through increase of rainfall intensities by 10%;
- Analysis of two drainage options: opened drainage channels and piped drainage systems.
- Review of other measures aimed at reducing the volume of surface water runoff which reaches the motorway drainage system. These measures could include cuttings of drains/ditches, herringbone filter drains for cuttings.

Highway drainage is one of the most important features for longevity of the road and for providing adequate operation under safe conditions. The drainage design shall therefore be treated with the deserved level of attention by the future Consultant.

e) Reviewing any information available on buildability and constructability including details relating to temporary works and impacts generated by construction traffic;

No information relating to temporary works is presented in the design. This is particularly important for the section of motorway situated along the Olt river where the motorway moves from the east bank to the west bank of the river and in most cases requires construction to be undertaken while the existing railway line and DN7 will be in full operation. Also no information on the impact of the construction traffic could be identified.

No information relating to the source of materials or borrow pits was identified in the project. Also a waste management plan was not identified. Requirements for such documents will be included in the new ToR;

No existing information relating to health and safety during construction, including items such as a preliminary construction health and safety plan were indentified in the information provided.

f) Information relating to carbon footprint and whole life cost estimate

Whole life costs are the costs associated with owning or managing an asset that occur throughout its lifecycle. Included in a whole life cost analysis are capital costs, operational costs and maintenance costs (including operational maintenance and capital maintenance). These costs form an integral part of any cohesion fund application and therefore must be investigated and estimated as part of the updated Feasibility Study.

No information relating to the scheme's carbon footprint and greenhouse gas emissions were identified. The requirements for a whole life cost analysis and carbon management system will be presented in the new ToR.

g) Comments on road safety features

It is noted that the design does not allow for the widening of central reservations or verges for provision of forward visibility. Also the width of the soft verge is considered inadequate to accommodate such features as safety barriers, motorway communication systems and lighting, where required. The requirements for these aspects will be clarified the new ToR.

All the grade separated junctions include a T shape at grade tie in with the existing road network. The new Feasibility Study will have to consider the adequacy of these junctions in terms of capacity and traffic safety. Ideally the T junctions would be replaced with roundabouts in order to reduce the risk of accidents.

Junction' visibility shall be checked as part of the new Feasibility Study in order to ensure that any departures from standards are indentified and submitted for approval to the Employer. Most accidents occur around junctions and it is of paramount importance that aspects such as visibility or requirements for lighting and high friction surfacing are reviewed.

It is acknowledged that the requirements for Road Safety Audits were not in force at the time of the Feasibility Study preparation and as such a road safety audit report was not included in the existing report.

The requirements for the road safety audit will be detailed in accordance with the Governmental Ordinance OG 6/2010 and Law No. 265. One aspect that will require further discussion and clarification is the methodology for the completion of a Road Safety Audit in Romania, particularly the use of internationally qualified Road Safety Auditors and the proposals for their procurement. In addition, the cost of undertaking a Road Safety Audit on a motorway scheme in Romania is estimated at €50,000.00/km which covers all stages of the project implementation. Identification of an adequate budget allocation will be required for this task.

h) Pavement options design

The existing Feasibility Study analysed four options for the pavement design as follows:

- Flexible pavement
- Flexible composite pavement
- Rigid jointed pavement
- Continuously reinforced concrete pavement

Based on the existing report the preferred pavement structure was flexible composite. While it is acknowledged that flexible composite pavements are widely used in Romania, as well as other European Union countries, no comparison of the four options is provided to justify the selection of the preferred pavement type.

The report confirms that the central reservation will be paved and that provisions for removable safety barriers (to allow for cross-over points) were considered.

A detailed pavement design report is provided within Annex A to the Volume 1 – Synthesis. The report is comprehensive and complies with the standards which were valid at the time. It is envisaged that the pavement design report will require a full update as part of the new Feasibility Study in order to take account of the following factors:

- Updated traffic data;
- Updated standards and norms;
- Updated ground investigation reports, which shall confirm the classification of the sub-formation ground by type and shall provide amongst other details, the water table level.

While it is acknowledged that the flexible composite pavements are widely used in Romania and other EU countries, it is noted that no detailed justification for the selection of the preferred pavement option was provided.

i) **Hydro-technical works**

The Sibiu-Pitesti motorway traverses the catchments of two main rivers in Romania, the Arges and the Olt. Both catchments have recently been the subject of flood mapping projects, which included flood risk management plans.

The motorway project includes a range of hydraulic works and structures which impact on, or control, river flows with the intention to provide proper management of water related issues. Based on our review, there appears to be a lack of justification provided for the sizing of such structures (including culverts) and their locations.

The project includes structural anti-erosion works including torrent control systems, slope consolidation, riverbank reinforcement, stabilisation, rectification and recalibration of the riverbeds, lateral and protection ditches, culverts and a significant number of bridges and viaducts.

The design of these works was based on the hydrological parameters of over 200 relevant cross-sections on main rivers, tributaries and non-permanent valleys, provided by the river basin water administrations of Olt and Arges-Vedea.

Further improvements to the motorway Feasibility Study, which shall be detailed in the new ToR, shall include robust requirements for:

- Analysis and design of surface and subsurface drainage systems taking into account the topography of the terrain, the size of the catchment areas and available drainage outfalls;
- Hydraulic calculations for culverts and more specifically identification and mitigation of potential impacts downstream;
- Flood defence works which may be required for the sections of motorway developed close to the Olt River or other rivers and streams. Requirements for comprehensive modelling and analysis. This will also capture requirements for allowances in the design for impacts relating to global climate change. In addition, aspects such as sustainable drainage systems (including attenuation ponds or similar) will be detailed;
- Works relating to the proposed re-alignment of river beds, as well as, other major hydro-technical works;
- Considerations of environmental impacts and mitigation measures for all and any of the above works.

The proposed design includes various hydro-technical works such as:

- Lining of side slopes to the Q = 2% level plus an overboard of 0.30m to 0.70m
- Concrete retaining walls at locations where the motorway is situated very close to the river bed. These are designed in order to avoid a reduction in the cross sectional area of the river bed.
- Protection of motorway side slopes using gabion walls.
- River bed diversions and re-calibrations. These works are of significant importance as they are of an intrusive nature and could have a great impact on existing habitats. They require careful consideration of the environmental implications. The areas proposed for river diversions, as part of the project, are:
    - Ch 40+200 to ch 45+300 river Baiesu. This is a significant length of river bed re-alignment and careful consideration to reduce the length of this type of work should be considered as part of the updated Feasibility Study.
    - Ch 47+300 to ch 48+250 river Baiesu. Given the terrain constraints within this area, the proposed works seem beneficial as they would provide an increase level of protection for the proposed motorway.
    - Ch 65+250 to ch 66+100 river Topolog;
    - Ch 67+300 to ch 69+900 river Topolog;

- Ch 91+200 to ch 98+750 river Arges – proposal to execute a cut-off ditch to minimise the volume of surface water runoff reaching the motorway.

No calculations or hydraulic modelling was available to support the proposed river bed works. The updated Feasibility Study shall consider the impacts related to these works and shall aim to minimise the amount of river diversions through possible local fine tuning of the motorway horizontal alignment.

j) Overall comments on the Road Works Volume

The updated Feasibility Design will require the inclusion of full 3D modelling and analysis of interfaces between the various elements of the design. Also some local realignment along the proposed corridor would be beneficial to enhance the justification provided for the selection of the preferred alignment. With regard to drainage design and hydraulic modelling, the revised ToR will include a requirement for the analysis of two main options, one with opened drainage channels (which represents the traditional option in Romania) and a second option with a piped drainage system which may prove to be more suitable for this project. In addition, the new ToR will provide requirements relating to allowance for climate change, including measures for attenuation of surface water run off through consideration of measures outside the scheme boundary such as cut-off drains or similar. While such measures can prove to be effective flood prevention tools they will, however, require consideration in terms of impacts and land take.

Also the new ToR will require that a CBA and Traffic Analysis is carried out for all route options such that the Route Options report can be updated with a robust justification for rejection of various options. The junctions will require capacity analysis in order to provide adequate evidence for the selection of the preferred layout. An important aspect relating to road safety will be addressed through visibility checks for the mainline carriageway and junctions. Furthermore a clear identification of departures from Standards shall be included in a separate chapter of the Technical Report in order to enable Employer's Approval.

The updated Feasibility Study shall also include an analysis of specific buildability issues including temporary measures for the major categories of works. As part of the buildability issues to be reviewed in the new Feasibility Study, a review of access to the motorway site during the construction stage shall be required. In addition, the impact on local roads, including the need for new temporary roads requiring land acquisition, shall require review. Such aspects will include considerations for environmental impacts and the potential need for the application for various additional third parties permits.

The inclusion of the DN73C sector between Tigveni and Ramnicu Valcea, within the scope of works for Sibiu – Pitesti motorway, may require a high level decision from RNCMNR and the Ministry of Transport and it may be conditioned by the Romanian Government capital expenditure strategy. Following a discussions between Halcrow's team and JASPERS specialist Mr. Fergal Trace, it was outlined that the potential inclusion of the approximately 20 Km of DN73C road within the scope of works for Sibiu – Pitesti motorway project, may positively contribute to the scheme's Internal Rate of Return and would enhance the connectivity to Ramnicu Valcea, the only major city (located almost at the midway point) between Sibiu and Pitesti.

With regard to all grade separated junctions, it is noted that the TEM standard recommends provision of lighting. The interchanges near Sibiu, Curtea de Arges and Pitesti will require public lighting. In addition, we would recommend that the other rural interchanges are also illuminated. This recommendation will be aligned with the RNCMNR Director General decision number 16 dated 27.08.2009, which includes mandatory requirements for provision of public lighting at:

- grade separated junctions,
- rest and service areas,
- all structures and tunnels,
- junctions with national (DN) and county roads (DJ),
- pedestrian crossings.

The Romanian standards for public lighting do not provide a recommended minimum distance for the provision of lighting on approach to junctions. We would therefore recommend that lighting provision within the grade separated junctions starts at the diverge taper and finishes at the end of merge taper. Where the distance between two interchanges is less than 3 times the stopping sight distance then the motorway section between the junctions shall also require provision of public lighting.

The Volume 3 of the existing Feasibility Study includes a comprehensive bill of quantities which is more detailed than expected for a Feasibility Stage. However, due to the inadequate 3D modelling of the design, as well as, the lack of correlation at the interface between various categories of works, such as transitions from structures to tunnels, modelling of rest and service areas, design of retaining structures and the lack 3D modelling of all access tracks, the absence of verge and central reservation widening for visibility, it makes validation of the existing quantities impossible.

The existing Feasibility Study has been prepared under certain time constraints and limitations which have had an impact on the level of detail provided. Based on this, our proposal is that adequate time be allocated for the update of the existing study. It is estimated that the required duration for the completion of the updated study will be approximately 24 months.

4.1.2.1.6 Volume 2.2 - Bridges, Overpasses, Viaducts Works

This section of the report covers aspects relating to Structures in the Feasibility Study.

The following documents have been reviewed as part of this assessment on Structures:

- Reference 1: The Feasibility Study;
- Reference 2: Volume 2.2 - Bridges works, Overpasses and Viaducts Study, (IPTANA 2008);
- Reference 3: Volume 2.3 - Tunnel works (IPTANA 2008).

The structures information presented in the existing study is limited. The comments made are confined only to the information made available. In many cases it has not been possible to validate the feasibility of individual solutions or sections of works. This is due to the absence of ground information and the lack of detail at the interface between the structures and adjacent works.

It is acknowledged that in 2008 the Norms used in the design did not incorporate the requirements of the Eurocodes and this will have to be addressed as part of the updated Feasibility Study. As such, the following Eurocodes, which were formally adopted in Romania in 2010, shall apply to the updated Feasibility Design:

- Eurocode 0 Basis of Design
- Eurocode 1 Actions on Structures
- Eurocode 2 Design of Concrete Structures
- Eurocode 3 Design of Steel Structures
- Eurocode 4 Design of Composite Structures
- Eurocode 7 Geotechnical design
- Eurocode 8 Seismic Design

Therefore, the comments presented below relate to the standards in force at the time of completion of the existing Feasibility Study and to more general aspects, such as:

- adequacy of ground investigations;
- procurement and transport of materials including, but not limited to, the need for temporary access roads for transport of precast beams and routes for abnormal loads (the longest span proposed in the design is 120m);

- interface at the transition from tunnel to structure with possible alteration to the tunnel portal location and inclusion of a section of embankment cutting between the two structures;

- analysis of possible allowance for the subsequent addition of a third traffic lane.

There are 117 structures presented in the Feasibility Study and the total length is approximately 32km (27% of the entire length of the project). These are sub-divided as follows:

– Section I – Vestem – Racovita (Cornet) total length of structures L = 11.835 Km which represents approximate 30% of the section I length.

– Section II - Racovita (Cornet) – Tigveni total length of structures L= 12.015 km which represents approximately 31% of the section II length.

– Section III – Tigveni – Pitesti total length of structures L= 8.15 km which represents approximately 22% of the section III length.

The Feasibility Design also includes reference to approximately 99 culverts to be executed along this 116km long section of motorway.

According to Volume 2.2 of the existing Feasibility Study, the design of structures was undertaken using STAS 3221-86 (Typical convoys and loading classes). The Gap report considers the applicability of this standard and provides an outline comparison with the guidelines given in the Eurocodes.

As part of the Feasibility Study, a series of long sections have been produced showing the proposed route alignment and a preliminary ground model. In addition, a series of plans and cross-sections have been provided. This information has been used to delineate various elements of the earthworks and structures.

Proposed improvements

At Feasibility Stage, an initial assessment of foundations is required. This assessment does not require detailed calculations, rather a high level appraisal of the following:

- Adequacy of the ground model to assess global stability of the structure;

- Adequacy of the ground model to assess settlement of foundations for integral structures. This includes immediate and long term settlements and influences the type of structure proposed;

- Buildability of each of the proposed structures (also accounting for the access routes of each construction site).

Suggested objectives at Feasibility Stage

The objectives at Feasibility Stage should be to give information relating to the preliminary design of each structure. For of each of the proposed structures, the following information, as a minimum, would be expected at Feasibility Stage:

- Specification of the envisaged foundation level for spread foundations;
- Specification of number of piles, diameter and their disposal on the pile cap for piled foundations;
- Determination of rock and soil properties and mass characteristics based on the Ground Investigation data;
- State of weathering of rock;
- Definition of hydro-geological conditions including groundwater levels (especially for structures that have foundations near rivers or streams) and the presence of aquifers;
- Information of Seismicity;
- Identification of potential construction risks including access to site and transportation of abnormal loads;

The above objectives may be achieved by employing a number of methods and techniques including:

- The level of ground investigation that shall comply with the Romanian standards, as well as, Eurocode 7 (Geotechnical design) and Eurocode 8 (Design of structures for earthquake resistance). It is noted that the ground investigation was carried out in accordance with Romanian Standard NP 074-2007. This document does not explicitly state any direct alignment with Eurocode 7 (although it's preceding edition NP 074-2002 is aligned with Eurocode 7);
- In order to provide the basis for the proposed foundation solution at structures, the minimum laboratory data (for each encountered layer) should include:
    1. Classification by type of the ground (P1-P5) general characteristics;
    2. Physical characteristics (general observations);
    3. Compressibility characteristics;
    4. Free expansion (if is the case);
    5. Volumetric weight;
    6. Cohesion;
    7. Consistency parameter (index);

8. Plasticity coefficient;

9. Bed coefficient;

10. Compression medium resistance for natural state rocs;

11. Earth degree of compaction;

12. Internal friction angle.

- The geotechnical study must also recommend the type of foundation for structures (spread or piled). Each borehole should have at least one picture attached to the report which could be used for identification on site;

- The geotechnical investigation for culverts should involve, as a minimum, one 2.00m deep borehole for each culvert. If the bed rock is at a depth of less than 2.00m, then the borehole should continue 1.00m into the respective layer. The depth will be measured from the lower level of the foundation (considering the approximate height of the culvert) and shall also depend on the site conditions (access on the designated position);

- For bridges, overpasses and viaducts there should be a minimum of one borehole per each infrastructure foundation. The depth will vary depending on the depth of the rock layer but typically it is expected to reach 15 or 20m below the existing ground level. The borehole should also be driven at least 2.50m into the rock layer;

- In-situ groundwater measurements and monitoring.

For most of the structures it important that a preliminary calculation (using finite element software) is completed at Feasibility Stage in order to establish the main characteristics of the structures, such as, the number of piles and their layout, thickness of the infrastructures, etc.

Review of available information

The available information is not considered sufficiently developed for the structures and therefore the above mentioned aspects are to be considered as part of the updated Feasibility Design. For example, the embankments situated within the floodplain, should be lined in order to provide protection up to the level required for a 2% assurance plus a minimum 0.5m overboard. Considering Point no. 7 from the Water Authority Permit, the project must include a detailed hydrological study in order to justify the realignment of the Arges River between the Zigoneni and Valcele accumulation lakes.

No in-situ testing results have been provided and it is not clear whether any such tests have been carried out. Furthermore, no laboratory test information from the route has been provided. As a result of this absence of testing, the soil and rock characteristics cannot be validated. Due to the lack of laboratory testing and GI data validation, no informed comments can be made with regard to adequacy of foundation solutions for structures.

Preliminary design

Structures drawings have been presented in Vol. 2.2 of the Feasibility Study. These drawings show the proposed outline solutions for each structure. Cross section details are shown in typical sections 1, 2 (structures on the motorway) and typical sections 3, 4 (structures over the motorway).

No specific information about the precast beam dimensions or bearing capacity was found in the design.

The typical cross section should accommodate the installation of future ducting for both communication and power cables.

At this stage, no information has been provided on construction sequence, access roads, drainage measures or the classification of allowable earthworks materials.

The general arrangements for the structures over streams or rivers, do not include the level information for the 2% assurance. It is envisaged that the flows required for the hydraulic calculations will be provided by the Water Authority as part of the updated Feasibility Study.

The information relating to surface water drainage and arrangements at outfalls (gullies) along the bridge is not presented. It is recommend that the updated design allows for the continuation of the gully connection pipes to the bottom of the piers, where special measures to enable treatment and infiltration of water can be adopted.

Key buildability aspects

The interface between structures and tunnels will require a detailed review as part of the updated Feasibility Study. For example, special attention is required at the following locations: ch 20+230, ch 26+400, ch 27+980, ch 35+000, ch 36+220 and ch 55+000. The interface between structures and tunnels could lead to significant modifications to the road alignment due to the required distance of either 20m or 35m between the twin tunnels.

Considerations for temporary access roads during construction shall be reviewed as part of the updated Feasibility Study. This has a significant implication on the amount of land to be acquired and could influence the construction cost.

The culverts which are proposed for use in the project, means that access to fields should be analysed in terms of horizontal and vertical headroom required to enable their use by tractors or other types of vehicle.

The designed solutions should be standardised as much as possible in order to increase the construction efficiency.

In order to evaluate the construction costs it is important that identification of sources of materials is carried out at Feasibility Study stage. Such information was not available in the existing study.

Conclusions

The existing feasibility study includes many Gaps in terms of level of detail for structures and the correlation of the design with the ground investigations report. A number of aspects are to be addressed within the updated study and these are summarised below:

- The new design for foundations will have to be correlated with the updated ground investigation report;
- The design will be carried out in compliance with the Eurocodes standards that were adopted by Romania in 2010.
- The design will aim to adopt, as much as practically possible, standardisation of the type of structures to increase construction and maintenance efficiency.
- A buildability review will be required in order to address aspects such as:

    1. procurement and transport of materials including, but not limited to, the need for temporary access roads for the transport of precast beams and the routes required for abnormal loads (longest span proposed in the design is 120m);
    2. Interface at transitions from tunnel to structure with possible alterations to the tunnel portal location and the inclusion of a section of embankment cutting between the two structures;
    3. Analysis of possible allowance for the subsequent addition of a third traffic lane.

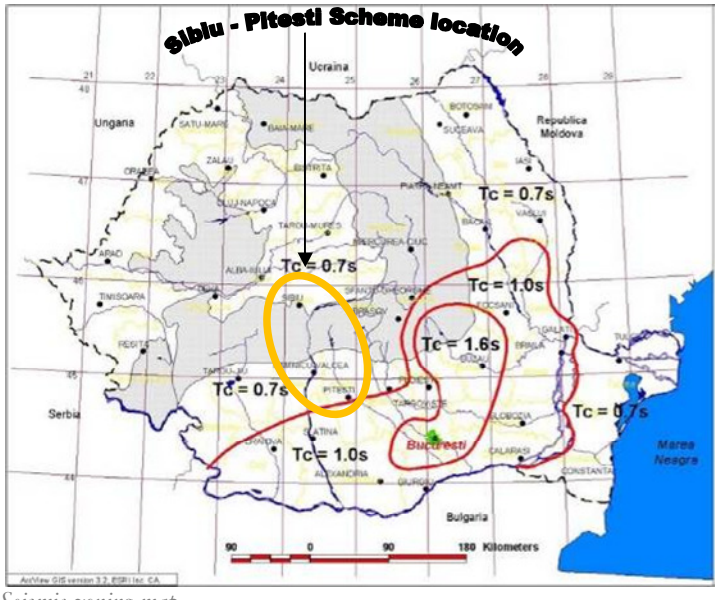
It was noted that the technical report, included as part of the Feasibility Study, made reference to the provision of retaining structures in order to minimise land take. In our opinion, a comparison between the cost of land within the relevant areas and the cost of building and maintaining retaining structures would be required to ensure that best value for money is achieved. It may be advisable, subject to other constraints, to design shallow side slopes (particularly for cuttings), thus providing an open space for easier maintenance while also reducing the risk of snow drifts.

An important aspect that does not feature in the existing report, relates to the provision of systems for protection of the motorway against avalanches and snow drifts. In determining the outline provisions, the designer shall consider any historical data within the region, with particular reference to sections of the existing road network that may have been subject to blockage or closure due to snowdrifts or avalanches. A specific requirement for consideration of these aspects shall be included in the new ToR.

Desk study and survey information

In general, it is concluded that there is insufficient information to properly assess the economic and environmental feasibility of the proposed structures. An extensive desk study is required, where geological, hydro-geological and geotechnical information is collated to enable an informed assessment of each element of work. The level of ground investigation is generally poor. Borehole coverage is inadequate and no field or laboratory tests have been made available. Whilst the preliminary drawings can be used to evaluate some adopted solutions, it is impossible to validate the design parameters.

The seismic study will follow the classification of the area traversed by the motorway route according to the provisions of the relevant local design codes. At European level, Romanian seismic activity can be characterised as average, but with the particularity that the earthquakes generated in the Vrancea area, located in central eastern Romania, may cause damage to vast areas including regions outwith Romania. With the propensity for damage, it is therefore important that sufficient investigation is carried out to evaluate mitigation of any seismic impact on proposed structures and the road infrastructure. According to the existing report, the Sibiu – Piesti motorway is situated within the seismic intensity area equivalent to a grade 7 earthquake measured from the Medvedev–Sponheuer–Karnik scale, also known as the MSK. Due to this, special consideration shall be given in the design to seismic analysis of all structures.



Seismic zoning map

Below is the Summary Table of Geotechnical Information at Structures with comments relating to requirements for additional GI data:

Section I – Vestem - Cornetu

Structure No.	Ch	Length (m)	Description	GI info available	Additional boreholes required for detailed design
S1	Offline	20	Over bridge	FR1 @ Ch 000	4
S2	1040-1560	520	13 span bridge	SR3@ Ch 1300 FR3@ Ch 1400	28
S3	2890-2910	20	Single span bridge	FR4@ Ch 2920	4
S4	5280-6100	820	23 span bridge	FR5 @ Ch 5310 FR6 @ Ch 5750 SR14 @ Ch 5470	48
S5	6220-6320	100	3 span viaduct	FR7 @ Ch 6250	8
S6	7080-7280	200	3 span viaduct	FR8 @ Ch 7100	8
S7	8120-8800	680	21 span bridge	FR9 @ Ch 8120 SR19@ Ch 8510 FR10 @ Ch 8750	44
S8	9800-10000	200	9 span viaduct	FR11 @ Ch 9810	20

Structure No.	Ch	Length (m)	Description	GI info available	Additional boreholes required for detailed design
S9	10300-10460	160	3 span bridge	SR21 @ Ch 10320 FR12 @ Ch 10460	8
S10	11130-11630	500	6 span bridge over River Olt	FR13 @ Ch 11130 FR14 @ Ch 11530	14
S11	11950-12100	150	Single span bridge	SR22 @ Ch 11950 FR15 @ Ch 12100	4
S12	12260-12600	340	3 span viaduct	FR16 @ Ch 12610	8
S13	12760-12880	120	Single span viaduct	None	4
S14	13280-13700	420	3 span bridge	SR24 @ Ch 13250 FR17 @ Ch 13710	8
S15	14040-14260	220	4 span viaduct	FR18 @ Ch 14040 SR24bis@Ch 14300	10
S16	14600-14740	140	3 span viaduct	FR19 @ Ch 14560	8
S17	14920-15060	140	4 span viaduct	None.	10
S18	15220-15340	120	3 span bridge	FR20 @ Ch 15190 SR25 @ Ch 15350	8
S19	15610-15680	70	2 span bridge	FR21 @ Ch 15710	4

Structure No.	Ch	Length (m)	Description	GI info available	Additional boreholes required for detailed design
S20	15920-16340	420	6 span viaduct	SR26 @ Ch 16050	14
S21	16640-16960	320	3 span viaduct	SR27 @ CH 16750	8
S22	17000-17060	60	Single span bridge	None	4
S23	17440-17850	410	6 span bridge	FR23 @ Ch 17400 SR28 @ Ch 17820	14
S24	18480-18820	340	7 span bridge	FR24 @ Ch 18510 SR29 @ Ch 18810	16
S25	19060-19170	110	4 span bridge	FR25@ Ch 19100	10
S26	20240-20360	120	3 span bridge	FR26 @ Ch 20300	8
S27	20700-21000	300	7 span bridge	FR27 @ Ch 20780	16
S28	21150-21170	20	Single span bridge	SR30 @ Ch 21170	4
S29	21280-21340	60	Single span bridge	None	4
S30	21840-22140	300	7 span bridge	FR28@ Ch 21930	16
S31	22770-22900	130	3 span viaduct	SR32 @ Ch 22910	8
S32	23280-23340	60	2 span viaduct	FR30 @ Ch 23300	6
S33	23720-23960	240	3 span viaduct	FR31 @ Ch 23850	8

Structure No.	Ch	Length (m)	Description	GI info available	Additional boreholes required for detailed design
S34	24180-24300	120	3 span viaduct	None	8
S35	24440-24480	40	Single span viaduct	FR32 @ Ch 24450	4
S36	24540-24600	60	Single span viaduct	None	4
S37	24720-24800	80	2 span viaduct	None	6
S38	24980-25300	320	5 span bridge	FR34 @ Ch 25300	12
S39	26000-26400	400	6 span bridge crossing River Olt	FR34b @ Ch 26040 FR35 @ Ch 26390	14
S40	27980-28580	600	7 span bridge crossing River Olt	FR36 @ Ch 28010 SR34 @ Ch 28430	16
S41	28810-29560	750	23 span viaduct	SR35 @ Ch 29050 FR37 @ Ch 29350 SR36 @ Ch 29550	48
S42	31630-31650	20	Single span viaduct	None	4
S43	32050-32250	200	3 span bridge	FR42 @ Ch 32090	8
S44	32380-32530	150	3 span viaduct	FR43 @ Ch 32600	8
S45	33420-32580	160	3 span bridge	None	8

Structure No.	Ch	Length (m)	Description	GI info available	Additional boreholes required for detailed design
S46	34240-34460	220	3 span viaduct	None	8
S47	35190-35230	40	Single span viaduct	None	4
S48	35340-35650	310	4 span viaduct	None	10
S49	36200-36900	700	15 span viaduct	FR48 @ Ch 36230 FR49 @ Ch 36850	32
S50	37730-38620	890	17 span bridge	SR44 @ Ch 37800 FR51 @ Ch 38110	36

Section II – Cornetu - Tigveni

Structure No.	CL Chainage	Length (m)	Description	GI info	Additional boreholes required for detailed design
S51	40630-40750	120	3 span bridge	FR56 @ Ch 40+590 SR45 @ Ch 40+750	8
S52	41580-41740	160	4 span bridge	None	10
S53	41800-41900	100	2 span bridge	None	6
S54	42200-42250	50	Single span bridge	None	4
S55	43800-44380	580	11 span bridge	FR57 @ Ch 44+110 FR58 @ Ch 44+400	24
S56	44470-44570	100	2 span bridge	None	6
S57	44620-44800	180	4 span bridge	SR52 @ Ch 44+680 FR59 @ Ch 44+770	10
S58	44950-45150	200	5 span bridge	FR61 @ Ch 45+000 FR62 @ Ch 45+200	12
S59	45330-45420	90	3 span viaduct	None	8
S60	45860-46270	410	6 span viaduct	SR54 @ Ch 45+950 FR63 @ Ch 46+280	14
S61	47300-47740	440	9 span viaduct	SR57 @ Ch 47+500 FR64 @ Ch 47+700	20

Structure No.	CL Chainage	Length (m)	Description	GI info	Additional boreholes required for detailed design
S62	47880-48930	1140, 340 & 340	17 span semi-viaduct, 6 span semi-viaduct, 6 span semi-viaduct	SR58 @ Ch 48+250 FR65 @ Ch 48+600 FR66 @ Ch 48+900	36
S63	49120-49280	160	3 span Viaduct	FR67 @ Ch 49+210	8
S64	49370-49520	150	3 span Viaduct	FR68 @ Ch 49+510	8
S65	49840-50280	440	6 span Viaduct	FR70 @ Ch 50+200	14
S66	50470-50580	110	3 span Viaduct	FR71 @ Ch 50+600	8
S67	51180-51530	350	9 span Viaduct	SR59 @ Ch 51+350 FR73 @ Ch 51+500	20
S68	53320-53500	180	4 span Viaduct	SR64	10
S69	54920-54940	20	Single span structure	SR68	4
S70	57740-58230	490	6 span Viaduct	SR71 @ Ch 57+800 FR77 @ Ch 58+030	14
S71	58290-58470	180	3 span Viaduct	SR72 @ Ch 58+410	8
S72	58710-58870	160	3 span viaduct	SR73 @ Ch 58+670 FR78 @ Ch 58+810	8
S73	58960-59110	150	3 span viaduct	SR74 @ Ch 58+970	8

Structure No.	CL Chainage	Length (m)	Description	GI info	Additional boreholes required for detailed design
S74	59220-59420	200	3 span viaduct	SR75 @ Ch 59+200 SR76 @ Ch 59+310 SR77 @ Ch 59+410	8
S75	59570-60010	440	9 span viaduct	FR79 @ Ch 59+610 FR80 @ Ch 59+860	20
S76	60210-60650	440	6 span viaduct	SR78 @ 60+370 FR81 @ 60+650	14
S77	60780-60930	150	3 span viaduct	None	8
S78	61280-61330	50	3 span viaduct	FR82 @ Ch 61+350	8
S79	61770-62100	330	6 span viaduct	FR83 @ Ch 61+820	14
S80	62160-62340	170, 100, 40	3 span viaduct, 3 span viaduct, single span viaduct	None	16
S81	63800-64040	240	4 span viaduct	SR84	10
S82	64260-64720	460	6 span bridge	None	14
S83	65380-65970	590	9 span bridge	FR87 @ Ch 65+510 SR86 @ Ch 65+900	20
S84	67560-67710	150	3 span bridge	None	8
S85	68900-69080	180	3 span bridge	None	8
S86	69220-69240	20	Over bridge	FR91	4
S87	69760-69930	170	3 span bridge	None	8

Structure No.	CL Chainage	Length (m)	Description	GI info	Additional boreholes required for detailed design
S88	70700-70920	220	3 span viaduct	FR94 @ Ch 70+860	8
S89	71520-72380	860	12 span viaduct	SR96 @ Ch 71+560 SR97 @ Ch 71+900 FR95 @ Ch 72+230	26
S90	74120-74320	200	5 span bridge	SR102@Ch 74+260	12
S91	75470-75600	130	3 span bridge	FR98 @ Ch 75+570	8
S92	76240-76470	230	6 span bridge	SR107@Ch 76+340	14
S93	76800-76940	140	3 span bridge	None	8
S94	77240-77600	360	6 span viaduct	SR109@Ch 77+250 FR100A@Ch77+560	14

Section III – Tigveni - Pitesti

Structure No.	CL Chainage	Length (m)	Description	GI info	Additional boreholes required for detailed design
S95	79850-78980	130	3 span viaduct	SR104bis @ Ch 78+890	8
S96	79140-79800	660	7 span viaduct	FR100bis @ Ch79+180 SR105B@ Ch 79+420 FR101B@ Ch 79+570 SR106B @ Ch 79+710	16
S97	82830-83230	420	6 span bridge	SR108B @ Ch 82+900	14
S98	83940-84040	40	3 span viaduct	SR111@ Ch 83+960	
S99	84100-84270	170	4 span viaduct	FR105B@C h 84+160	10
S100	85850-86550	700	12 span viaduct	SR114 @ Ch85+900 SR115 @ Ch86+000 SR116 @ Ch86+250 FR108B @ 86+500	26
S101	87000-87570	570	9 span viaduct	FR109@Ch 87+250 SR117@CH 87+450	20
S102	88100-88200	100	3 span viaduct	None	8
S103	91150-91580	430	9 span viaduct	FR112@Ch 91+450	20
S104	92720-92740	20	Single span viaduct	FR113@Ch 92+700	4

Structure No.	CL Chainage	Length (m)	Description	GI info	Additional boreholes required for detailed design
S105	94640-94690	50	Single span viaduct	None	4
S106	95050-95550	510	9 span viaduct	None	20
S107	98250-100070	1820	14 span bridge	SR133 SR134 FR116 SR135 SR136 FR117 SR136bis	30
S108	104000-104500	500	9 span viaduct	FR121@Ch 104+250	20
S109	104680-104710	30	Single span bridge	None	4
S110	105400-105600	200	6 span bridge	FR122@Ch 105+600	
S111	105750-106870	1120	10 span viaduct	SR141@105+830 SR142@106+080 FR123@106+300 SR143@106+500 FR124@107+100	22
S112	108200-108300	100	3 span viaduct	SR145@108+200	8
S113	108750-109200	450	9 span viaduct	FR125@108+700 SR146@108+900	20
S114	109750-109980	230	6 span viaduct	FR126@ 109+840	14

The estimated number of additional boreholes at structures for all three sub-sections is 1424 boreholes. The level of ground investigations required for this project will be clarified within the revised Terms of Reference.

The structures are to be designed to Eurocodes and considerations for the standardisation of the type of proposed structures shall be reviewed. A detailed analysis of buildability issues including the requirements for temporary access to the site shall be considered.

4.1.2.1.7 Volume 2.3 – Tunnels

This section of the report provides assessment of aspects in the Feasibility Study relating to the design and construction of the tunnels.

The following documents have been reviewed as part of this assessment:

- Reference 1: The Feasibility Study (as translated and with associated drawings)
- Reference 2: Tunnels Volume 2.3

It should be noted this section does not discuss the geology or geotechnical investigation requirements for the tunnels, the earthworks relating to approach cuttings and portals, nor general highway related aspects of the general route alignment etc. These are covered in section 4.1.2.1.5 Highways and section 4.1.2.1.13 Geotechnical.

General Appreciation

There are seven tunnels and one section of 'open earthworks' (assumed to be the 'cut and cover' method of tunnelling at shallow depth) proposed, comprising approximately 7.4km of the overall route. The proposals are summarised in Section 2.3 of the Feasibility Study.

The tunnels are listed in Table 1, with key data shown for reference. All of the tunnels are twin tube, generally two lane road tunnels; with a third crawler lane included in the Poiana Tunnel section.

Tunnel	Chainage	Length (m)	Approx. Maximum Depth (m)	Approx. Minimum Cover <20m	Prevailing Rock Type
Lazaret Nord	19+180 to 20+240	1060	250	-	Mica-gneiss
Lazaret Sud	20+370 to 20+700	330	60	-	Mica-schist
Caineni A (north)	26+390 to 26+940	550	175	-	Gneiss/amphibolite/marble
Caineni B (cut and cover)	26+940 to 27+080	140	Cut and Cover	Min 2m	Gneiss/amphibolite/marble
Caineni C (south)	27+080 to 27+980	900	240	-	Gneiss/amphibolite/marble
Robesti	30+550 to 31+450	900	60	<20	Gneiss
Balota	35+745 to 36+200	455	50	<15m	Gneiss/amphibolite
Poiana	55+135 to 56+835	1700	110	-	Possible marl, possible weathered metamorphic.
Curtea de Arges	80+800 to 82+150	1350	85	-	Marl, Shale

Table 1 Summary of Tunnels and Geology

The driven tunnels range from approximately 330m in length to 1700m, with depths up to approximately 250m. Some tunnels have low cover sections (i.e. less than 20m) which may also require careful tunnelling. The cut and cover tunnel at Caineni is approximately 140m long.

The general alignment connects Sibiu to the north (at an altitude of approximately 440m) and Pitesti to the south (at an altitude of approximately 290m) and crosses the South Carpathian Mountains which reach an altitude of approximately 2000m. The alignment, however, avoids the highest mountains by following the valleys of the Rivers Olt and Topolog, connected by the Poiana Pass at an altitude of approximately 800m. The consequence of this alignment is that the route generally follows the line of a major fault system, which forms the major river valleys in a generally north-south direction. This has a detrimental effect on the general quality of the rock masses through which the tunnels must be driven to maintain the required alignment.

Difficult tunnelling conditions are therefore to be expected in most of the tunnels, although the Feasibility Study notes that the alignment has been selected to avoid the major fault segments (although this needs confirmation by further more detailed ground investigations).

The geology is described in general terms in the Feasibility Study and particular comments on the adequacy of the available geotechnical data and its interpretation to provide design data are included in the Geotechnical section of this report.

Design Standards

Section 1 of Volume 2.3 of the Feasibility Study lists the design standards adopted for the design of the tunnels, and these are considered to be appropriate.

Tunnel Geometry

The requirements for tunnel geometry, as set out in Section 4.1 of Volume 2.3 of the Feasibility Study, are considered to be generally appropriate for tunnels of the lengths required.

Tunnel Temporary and Permanent Support

A conventional approach using temporary ground support which is required to stabilise the tunnel excavation for the construction period only, followed by a permanent concrete lining required to sustain the ground loads in the long term (on the assumption that the temporary support degrades over the life of the tunnel), is proposed in the Study.

Although not specifically defined, a waterproofing system is proposed between the temporary and permanent linings. This is likely to consist of a drained welded sheet membrane system which is an appropriate and typical approach, subject to appropriate specification and careful construction. The membrane is not pressurised and groundwater drains around the extrados of the membrane and into a drainage collection system for removal from the tunnel.

The Study states that a dual drainage system is to be provided, which are to be physically separated. One system is for clean groundwater, and the other for dirty water from road drainage, cleaning water etc. This is an appropriate and typical approach. The sumps and pumping requirements will need to be designed in due course.

The Study groups the tunnels in the Olt Valley together in terms of likely temporary support requirements (i.e. for the Lazaret, Caineni, Robesti and Balota tunnels), and anticipates two generic types of support for

(i) hard , blocky rock conditions; and

(ii) weak (faulted) ground conditions.

These support types are referred to as Type 1 Olt Valley and Type 2 Olt Valley, respectively.

This is a reasonable approach, although the details should be reviewed further and appropriate analyses undertaken when more detailed ground investigation data is available.

An initial proposal for the support of the Poiana Tunnel in weak marls is provided in the Study. This also needs to be reviewed in detail and appropriate analyses undertaken when more detailed ground investigation data is available.

Design and construction of the Curtea de Arges Tunnel by open face methods in 'soft ground' will be particularly demanding and will require more detailed design studies when more detailed ground investigation data is available.

Excavation Methods

The four tunnels in the Olt Valley are proposed to be excavated by 'drill and blast' methods, which will include mechanical excavation in weak faulted ground. The remaining tunnels in the weak marls and shakes will be excavated by mechanical means.

Some of the anticipated rates of excavation may be optimistic and should be reviewed at the next stage of study.

Some of the tunnels have portals located on hillsides and join to bridge structures. Careful construction planning will therefore be required to manage the interfaces between the tunnel and the bridge works. Temporary access adits may be required to allow early access for tunnel works if the main portal areas are not available or not accessible.

More detailed comments on individual tunnels are included below.

Tunnel Design and Construction

This section provides a brief assessment of the likely tunnelling conditions for each of the tunnels, commencing at the northern end of the route. Any significant Gaps identified in the current studies are noted.

Lazaret Tunnels

The Lazaret Tunnels consist of two tunnels, separated by a short bridge structure. The northern tunnel is approximately 1060m long and the south is approximately 330m long.

Although the two tunnels are generally located in hard rock types, gneisses and mica shists, the Study notes that the faulting may lead to significant lengths being in poor quality ground and where significant groundwater may be present. These sections of poor water bearing ground may alternate with better conditions, with the possibility of abrupt changes in ground conditions encountered. The need for comprehensive ground investigations, routine forward probing and methods for dealing with poor ground and water conditions is therefore indicated.

The Study notes the likely difficulty of constructing the portals for the south tunnel in particular, and this will need further detailed consideration.

The use of temporary access adits could be considered as a means of achieving early access to the tunnel drives if access is not immediately available at the main portal sites.

Caineni Tunnels

The Caineni Tunnels consist of two driven tunnels separated by a short length of cut and cover tunnel in the Uria Valley. It is not clear why this section needs to be in cut and cover tunnel rather than open excavation, but it is assumed that the reinstatement of passage for various species may justify the proposal. However, this is to be further analysed as part of the updated study. The ground conditions in the driven tunnels are again expected to be variable due to the proximity of the Olt Valley fault system.

There are construction access constraints for these tunnels noted in the Study, which require further detailed investigation and planning. There appear to be no drawings showing construction access proposals in the current Study and it is therefore difficult to understand all of the constraints.

Robesti Tunnel

The Robesti Tunnel is again located in the Olt Valley and therefore subject to persistent faulting. This tunnel has generally low cover (<60m, and <20m in places). The low cover may lead to additional weak rock conditions due to weathering effects and/or access to groundwater, which may add additional difficulties to open face tunnelling. Depths of weathering need to be established from additional ground investigation boreholes.

Access to this tunnel appears to have fewer constraints than the other tunnels, but more detailed construction planning is required.

Balota Tunnel

The Balota Tunnel also has generally low cover (<50m, and <15m in places). It is the last and southern-most of the four tunnels to be located in the Olt Valley fault system. The Study notes the additional difficulties presented by the combination of faulted rock and low cover.

The portals for this tunnel are at an elevated location, which shall require some temporary works to achieve access to the portal face.

Poiana Tunnel

The Poiana Tunnel is at the highest elevation (approximately 800m elevation) of the route between the Olt and Topolog valleys. The geology appears to be particularly unfavourable for tunnelling with reference to marls and sandy shales, and possibly unstable slopes. (Marls are chalky clays and shales may be otherwise described as mudstones, both generally being weak rocks). The geomorphology of this area needs to be considered in detail as the current study gives conflicting assessments of the conditions.

The maximum depth of the tunnel is approximately 110m and the weak rock conditions need particular consideration in the design, as stress induced effects may determine the tunnelling excavation and support methods. More comprehensive site investigation, interpretation and design study is again indicated.

The Study does not anticipate particular access difficulties for this tunnel, but again drawings are required.

Curtea De Arges Tunnel

The Study descriptions of this tunnel suggest that it is a 'soft ground' tunnel, which is proposed to be excavated by open face tunnelling techniques. There are particular high risks associated with this approach, which need to be identified and addressed during design. The conditions may require the use of a tunnelling shield ('digger shield') which would support the face and erect precast concrete tunnel lining segments as the finished lining. There is some appreciation of these difficulties in the Feasibility Study, but the conditions need to be defined more closely and appropriate, more detailed design studies undertaken. The northern section is dominated by 'sandy marls', whereas the southern section is expected to be 'dry sands, marls and some weakly consolidated shales'. It will be important to characterise these ground conditions in more detail during the next phase of investigation and study. Groundwater conditions need careful attention to confirm that conditions will be 'dry' as stated.

There is no comment on construction access to this tunnel in the Study, although construction is anticipated to be from both ends.

Tunnels - Summary of the Gaps in information

The following are the Gaps identified in respect of tunnel design and construction (tunnel ventilation and fire safety are considered separately below):

- ***The ground conditions for all of the tunnels will be difficult because of the route alignment along the River Olt and River Topolog valleys which is a major fault alignment, and the weak geological conditions at Poiana and Curtea de Arges; these conditions and the associated risks need to be emphasised in future studies, mitigation measures must be fully reviewed and current proposals consolidated. The existing Feasibility Study does not include specific reference to such difficult conditions;***

- ***No preliminary design of tunnel drainage was included;***

- ***No review and analysis of tunnel temporary support proposals was included. Such information shall require review when more detailed ground investigation data is available;***

- ***No review of rates of tunnel excavation was included. Such information shall require review when further design studies have been completed***

- ***No buildability issues are discussed within the existing reports. More extensive construction planning studies to establish feasible access requirements for tunnel construction, with drawings and preliminary design of any necessary temporary works shall require inclusion within the updated Feasibility Study.***

Gaps in the geotechnical studies with respect to tunnel design and construction are outlined in the Geotechnical section 4.1.2.1.13 of this report.

Tunnel Ventilation and Fire Safety

Assessment

In Volume 2.3 of the Feasibility Study, the sections which relate to tunnel ventilation and fire safety are listed below, with review and comments added as necessary.

Section 5 – Safety:

Exits to the ground surface and or cross-passages between the tunnel tubes, are not discussed. Exits to the surface and or cross-passages between the tubes, are required by the 'EU Directive on Road Tunnels' (Directive 2004/54/EC, as referenced in the Feasibility Study) for all tunnels greater than 1000m in length. These points of egress are required at a maximum of 500m intervals. A more detailed review of design compliance with the current directives is therefore identified as a Gap in the current study.

Section 6 – Ventilation:

It is stated that the following guidance has been used in the specification of the ventilation system:

- EU Directive on Road Tunnels 2004/54/EC

This directive is considered to be appropriate.

World Roads Association Permanent International Association of Road Congresses (PIARC) 'Recommendations for Road Tunnels' is not referenced, but the general requirements outlined are as expected.

A longitudinal approach to ventilation for smoke control using jet fans is proposed. This is considered to be appropriate for the length of tunnels proposed in this project (i.e. up to approximately 1700m).

The study indicates that calculations have been undertaken for both smoke control and pollution mitigation in order to determine the number and power of the jet fans required. However, the calculations do not appear to be included within the Study.

The design fire adopted is appropriate, but without considering Dangerous Goods Vehicles (DGVs) specifically. Risks and procedures for the transport of DGVs through the tunnels are not considered in the current study.

The risks from DGVs and appropriate mitigation measures should be considered in future studies and this is identified as a Gap in the existing study.

It is also not clear whether allowance has been made for fan redundancy and or fans destroyed by fire. Without access to the detailed calculations, it is not possible to check the number of fans, although the overall approach is generally as expected. However, the lack of detail in the information provided is identified as a Gap in the current study.

Section 7 - Electrical and Mechanical Equipment

The following are specific comments relating to the proposed electrical and mechanical equipment with regard to fire safety.

The safety systems listed include the major systems which would be expected in these types of road tunnel:

- Emergency lighting
- Fire main
- Emergency telephones and communications
- Traffic control systems
- Closed Circuit Television (CCTV) and Automated Incident Detection (AID)
- Tunnel control centre.

However, there is little detail on the performance requirements for each of these systems. These need to be defined in future studies.

The power supplies to safety equipment have redundancy, as required.

No mention is made for provision of a Fixed Fire Suppression System (FFSS). An FFSS is not required by the EU Directive, but can offer benefits for life safety, asset protection and savings on the ventilation system. Further study of these systems is therefore recommended for future work.

Tunnel Safety - Gaps Summary

The following are the Gaps identified in respect of tunnel ventilation and fire safety:

- ***No consideration of requirements for emergency exits to the ground surface and or between tunnel tubes, were identified;***
- ***No consideration of risks from Dangerous Goods Vehicles (DGVs) and control measures, were identified;***
- ***Not enough detail is provided in relation to the design of fans;***

- ***Insufficient details were provided in relation to the performance requirements for tunnel equipment;***

- ***No consideration of Fixed Fire Suppression Systems (FFSS), were discussed;***

4.1.2.1.8 Volume 2.4 – Motorway Facilities

Proposed location for motorway services areas and maintenance centres

The design, presented on plan layouts within Volume 2.1 of the Feasibility Study, do not include the proposed locations for the service areas and maintenance centres. The location of these services is, however, presented on the drawings included within Volume 2.4 of the Feasibility Study. These drawings show an outline shape of the proposed service or maintenance areas without any detail relating to the earthworks interface. This implies that the earthworks quantities related to these works and the area of land to be acquired, may have underestimated in the existing design.

The design does include typical layouts for such service areas.

The proposals for motorway services are included within Volume 2.4 of the Feasibility Study. Thus the proposals for motorways services and rest areas are:

- Service area type S1 ch 6+700. This service area is situated in close proximity to two structures and also close to the Talmaciu grade separated junction. It is envisaged that diverge and merge tapers for the junction and the service area will overlap and as a result, it is recommended that an alternative location for this area is identified. It is noted that the design does not include a 3D model of the service area, which implies that the earthworks, as well as other potential works, were not accurately captured as part of the design.

- Short Stay Parking area ch 25+500. This parking area is situated in an area of difficult terrain constraints and is limited by two structures either side. It is also in close proximity to the Caineni tunnel. It is noted that the design does not include a 3D model of the service area, which implies that the earthworks, as well as other potential works, were not accurately captured as part of the design. The length of diverge and merge tapers will extend over the bridge which would require the provision of a wider bridge deck. It appears, such aspects have not been considered in the design. Also, the distance between the twin tunnels is specified as 20m. This would require bifurcation of the highway alignment design on approach to the tunnel, while maintaining compliant geometric elements. Due to this alignment bifurcation, it is envisaged that the parking area would require significant retaining structures or at the very least, may lead to significant buildability issues. It is recommended that the proposal is studied in more detail and if possible an alternative location identified.

- Service area type S1 ch 34+100. This service area is situated in between two proposed structures. It is envisaged that diverge and merge tapers will extend over the bridges, which would require the provision of a wider bridge deck. It appears, such aspects have not been considered in the design. It is noted that the design does not include a 3D model of the service area, which implies that earthworks, as well as other potential works, were not accurately captured as part of the design.

- Maintenance and operation centre CIC ch 38+850. The proposed location for the maintenance centre is near Cornetu grade separated junction. It is noted that the space available within this area is relatively tight and the design does not include a 3D model of the maintenance centre, which implies that the earthworks, as well as other potential works, were not accurately captured as part of the design.

- Short stay parking area ch 57+500. This parking area is situated very close to the Poiana tunnel. According to the tunnel drawings the distance between the twin tunnels should be 35.00m. Due to this, the alignment design should bifurcate on approach to tunnels and the associated parking area should normally include allowance for additional earthworks and or retaining structures. It is noted, that the space available within this area is relatively tight and the design does not include a 3D model of the maintenance centre, which implies that the earthworks, as well as other potential works, were not accurately captured as part of the design.

- Maintenance and operation centre CIC ch 69+350. The maintenance centre is situated next to Valeni grade separated junction and is constrained by the river Topolog and the DJ703H. It is noted, that the space available within this area is relatively tight and the design does not include a 3D model of the maintenance centre, which implies that the earthworks, as well as other potential works, were not accurately captured as part of the design.

- Service areas type S1 ch 70+500 right and 71+200 left. This service area is situated in between two proposed structures. It is envisaged that diverge and merge tapers will extend over the bridges, which would require provision of a wider bridge deck. Such aspects do not appear to have been considered as part of the design. It is noted, that the design does not include a 3D model of the service area, which implies that earthworks, as well as other potential works, were not accurately captured as part of the design.

- Maintenance and operation centre CIC ch 86+900. This maintenance centre is situated near the Curtea de Arges grade separated junction and is limited by the mainline and the junction sliproads. The area proposed for the maintenance centre is relatively flat and should enable the construction of the centre. It is, however, recommended that a 3D model of the platform required for the maintenance area is performed as part of the updated Feasibility Study.

- Short stay parking area ch 84+500 left and ch 85+500 right. These parking areas are situated in between two proposed structures. It is envisaged that diverge and merge tapers will extend over the bridges which would require the provision of a wider bridge deck. Such aspects do not appear to have been considered as part of the design. It is noted, that the design does not include a 3D model of the service area, which implies that earthworks, as well as other potential works, were not accurately captured as part of the design.

- Service area type S3 ch 102+850. These service areas are situated east of the Valcele reservoir. While the terrain within this area is relatively flat, it is noted, that no 3D model of the area is available, which implies that earthworks, as well as other potential works, were not accurately captured as part of the design.

- Short Stay Parking Area ch 113+600. This parking area is situated west of the Budeasca reservoir. While the terrain within this area is relatively flat, it is noted, that no 3D model of the area is available, which implies that earthworks, as well as other potential works, were not accurately captured as part of the design.

- Maintenance centre Bascov ch 115+500. This maintenance centre is situated next to the Bascov grade separated junction. While the terrain within this area is relatively flat, it is noted, that no 3D model of the area is available, which implies that earthworks as well as other potential works, were not accurately captured as part of the design. This report includes an alternative proposal for Bascov junction reconfiguration, which in our opinion will maximise the space available for the construction of the maintenance centre and provide better access to the motorway. The current proposed layout shows the maintenance centre access linked to the slip road which, in our opinion, is unsafe.

The spacing between rest and or service areas, as well as, the minimum level of facilities to be provided within these areas, is detailed within the following piece of legislation:

- Ministry of Transport (MoT) order number 1506/2005 which modifies the MoT order number 2264/2004 titled Technical specifications for the design of parking, rest and services areas situated on public road within rural areas.

This MoT order explains that the recommended distance between successive parking and or rest areas is between 15km to 25km. The order also clarifies that the selection of preferred location for such services should take account of:

- terrain constraints;

- horizontal and vertical geometry of the mainline;

- enhancement of tourist attraction landmarks;

- minimisation of environmental impacts including impacts on monuments or other listed buildings,

- provisions for adequate visibility.

The spacing between rest and or service areas presented within the existing Feasibility Study is, with a few exceptions, aligned to the requirements of the above order but some of the proposed locations impact on other categories of works and these interfaces shall require a detailed review as part of the updated Feasibility Study. The shortest distance provided in the existing design between two service and or rest areas is 8.6 Km (Short stay parking ch 25+500 to Service area type S1 ch 34+100). It is envisaged that the short stay parking at ch 25+500 will require relocation due to very difficult terrain constraints.

The three maintenance centres are located at a spacing of approximate 18 km and 28 km respectively, in order to provide easy access for maintenance and adequate coverage for the entire route. The more usual spacing between such maintenance centres would be in the region of 60 km with coverage of approximate 30 kilometres either way. However, given the very difficult terrain traversed by the route and the complexity of proposed structures and tunnels it is considered that the current proposal for the positioning of the maintenance centres would provide the opportunity for an enhanced and prompt response in case of accidents and or road blockages.

A general comment applicable to all service, rest areas and maintenance centres is that the requirement for provision of public lighting does not seem to feature in the existing study. This would impact on the soft verge width and the potential need for visual screening (e.g. the plantation of poplars). The lack of 3D models of the proposed service, rest areas and maintenance centres may have led to an underestimation of land requirements and associated construction works.

4.1.2.1.9 Volume 3 – General Bills of Quantities – Confidential

This section will review the cost estimates provided in the original Feasibility Study with costs identified by the review team.

There is an attempt made by IPTANA to compare budget costs in the Route Alignment Assessment report, dated December 2007, but this deals mainly with the second section between Racovita and Barsesti in which the rates per kilometre used for comparison are dissimilar to the costs derived in the more comprehensive pricing document "Vol 3 - Deviz general liste de cantitati confidential". This latter document has been prepared on the basis of a detailed Bill of Quantities for each of the three sections identified in the Feasibility Study i.e.

1. Sector I: Sibiu – Cornet, ch 0+000 to ch 40+200
2. Sector II: Cornet – Tigveni, ch 40+200 to ch 78+500
3. Sector III: Tigveni – Pitesti, ch 78+500 to ch 116+640

A detailed breakdown of costs are provided for both the mainline and separately for each interchange and side road connection, covering the principle items in terms of earthworks, pavement, structures (bridges and culverts) and drainage elements.

In addition to the basic civil engineering works for the road infrastructure, a detailed cost analysis has been undertaken for the following principle elements of the works.

1. Environment Protection. This includes settlement tanks and attenuation and evaporation ponds, with provision for noise panels and specialist fencing for protection against animal intrusion onto the trafficked road.
2. Supplementary construction works. This relates to the provision of reinforced earth walls and concrete retaining walls to support and protect the new road and mini piling and anchor netting, to protect unstable rock faces.
3. River diversion and other hydro-technical works.
4. Service areas, rest areas (short time parking areas) and maintenance and communication centres.

It is not possible within the scope of this review to undertake a detailed audit of the individual quantities or rates used. The review concentrates on the Bill of Quantities item coverage and the linear rates produced for the main elements of works compared against the Romanian Government published rates and comparisons with other international best practice. The Government documents used to provide linear rates, which are exclusive of VAT, are:

- SCOST 1/MTI - Autostrada extraurbana pe teren plat deschis (motorway)
- SCOST 2/MTI - Autostrada extraurbana pe teren plat deluros (motorway)
- SCOST 3/MTI - Autostrada extraurbana pe teren plat muntos (motorway)
- SCOST 5/MTI - Reabilitarea unui drum tehnic clasa tehnica III (DN73C)
- SCOST 13/MTI - Strucuri autostrazi cu suprastructura executata din grnzi prefabricate L = 12 – 24m si fundatii indirecte
- SCOST 14/MTI - Strucuri autostrazi cu suprastructura executata din grnzi prefabricate L = 24 – 40m si fundatii indirecte
- SCOST 15/MTI - Strucuri autostrazi cu suprastructura executata din grnzi prefabricate L = 12 – 24m si fundatii directe
- SCOST 16/MTI - Strucuri autostrazi cu suprastructura executata din grnzi prefabricate L = 24 – 40m si fundatii directe
- SCOST 19/MTI - Tuneluri rutiere cu doua benzi de rulare
- SCOST 20/MTI - Tuneluri rutiere cu doua benzi de rulare + o banda de rulare de urgenta

Environmental protection works are included in the mainline costs which, based on the original length of the scheme of 116km, equates to €4.758m/km. If the Environmental works are removed from this element the rate will reduce to €4.650m/km. Based on the Government rates, identified above, for the motorway section, assuming 35% of the route is on flat terrain and the remainder on a combination of rolling/hilly terrain, the equivalent rate would be €4.970m/km and €5.078m/km including an allowance for environmental works. This suggests that the motorway works have been slightly undervalued. In comparison with other parts of Europe, the rate is lower but this may be due mainly to the reduced labour costs prevalent in Romania when compared with other parts of the continent. All cost are exclusive of VAT.

There are no incremental valuations of the quantities given in the Bills of Quantity to review the individual assessment for each structure, only a summary provided for each sector. This summary provides an overall length as a summation of the total length of bridges required, resulting in a total cost for each section. There is insufficient clarity in the information provided as to whether different rates have been used for different types of structure, dual or single carriageways. However, if we assume that the majority of the structures are for a dual carriageway with some single carriageway structures and that an average width of structure would lie somewhere between 21m and 26m then the cost per square metre would approximate to between €1200 and €1500. These values are not typical of estimating rates used for feasibility studies elsewhere where they could be doubled depending on the nature and complexity of the structures. In addition, it is not clear from the cost estimate if sufficient consideration was given to the difficult ground conditions expected in the central sectors.

The tunnel section contained in the cost estimate is very brief and, it is assumed, based solely on a rate per kilometre as there is no other evidence to suggest otherwise. Working with the lengths for each tunnel given in the main report, the rates used for the tunnels vary from €52m/km to €111m/km, with an overall average of €71.5m/km. The range of rates would reflect some consideration to the differing ground conditions and would not be untypical of rates in the region. However, the linear rates given in SCOST 19/MTI and SCOST 20/MTI for single bore tunnels of €19.0m/km and €27.5m/km respectively (€38m/km and €46.5m/km for twin bore tunnels) would appear to be low. We would therefore recommend that the rates used in the Feasibility Study be maintained as the basis for assessment.

The section covering the Service Areas, the Short Time Parking Areas, and Maintenance and Coordination Compounds provides the same level of detail as for the motorway assessment identifying principle items, quantities and costs. The cost estimate for each of the Short Time Parking Areas is about €2.0m per site which would not be unreasonable considering the limited amount of construction work to be carried out. However, sufficient cognisance for the provision of services, including water (both foul and clean) and electricity should be considered. This is especially true in remote areas where the cost of providing services over long distances could be substantial.

The cost estimates for both the Service Areas and Maintenance and Coordination Compounds appears low, with a maximum allowance of €2.0m for a Service Area and €4.0m for a Compound. There appears to be no allowance for the Snack Bar or Fuel Station element in the Service Area and the allowance for both buildings and fuel station within the Maintenance Compound, at €1.35m, is considered low. From recent experience in Ireland, a single side service area could cost between €5.0m to €10.0m per area depending on the level of provision for the buildings, restaurant area or coffee bar, shopping facilities, number of fuel pump dispensers and reservoir tanks, and parking spaces for cars, lorries and buses.

Other than the construction costs, the elements where there are significant differences between the estimate and our appreciation of requirements would be:

- Ground Investigation
- Site Supervision

The allowance for Ground Investigation in the cost estimate is €1.849m. This sum would not be sufficient to undertake a full ground investigation, incorporating the minimum requirements to establish ground conditions at Feasibility Study stage. If the intention was for the contractor to carry out a more detailed ground investigation then this is not reflected in the linear rates used or identified in the Bills of Quantity. Taking into consideration the difficult access in the central sector, we would anticipate a total cost, Feasibility and Detailed, of between €13.0m and €15.0m.

The second area of concern is the allowance for Site Supervision of €7.631m. Standard practice in Romania currently only requires the contractor to provide office accommodation for site supervisory staff. Site supervision costs therefore have to reflect not only salaries for site staff but also computer equipment, site vehicles and all consumables. In addition, we anticipate that the supervisory team could have as many

as 100 personnel present during the construction process for an average period of 4 years. This would suggest an allowance for site staff of between €150m and €180m.

Other elements, which do not appear to be allowed for in the estimate, are:

- Archaeology Investigations (approximately €1.0m)
- Road Safety Audits (€6.0m)
- Noise Surveys (€300k)
- Topographical Surveys (€150k – LiDAR Only)

In summary, the overall cost estimate appears to be low, with the possible exception of the estimates for each of the tunnels. It is obvious that a great deal of work has been undertaken in identifying the separate items, quantities and rates for the motorway during the Feasibility Study, however these would require a general review updating both quantities and rates to reflect the current market and changing requirements.

The above comparisons are on the basis of the exchange rate given in the documentation provided i.e. €1.0 equals RON3.7348, dated 2007. The exchange rate used in the original cost estimate is not comparable with the rate today (approximately €1.0 equals RON4.5) and would increase the proposed costs considerably from €2.7bn to €3.3bn. This should be borne in mind for future assessments, as currency exchange markets are likely to vary more than in the recent past. In addition, the cost of basic commodities such as fuel is also likely to have a significant impact on the budget and final construction costs for this scheme over the next 10 years.

The summary of comments on cost estimates are:

Volume 3 includes a comprehensive bill of quantities which is more detailed than expected for a Feasibility Stage. However, due to the poor level of 3D modelling of the design, as well as, a lack of correlation at the interface between various categories of works, such as, the transition from structures to tunnels, the modelling of rest and service areas, design of retaining structures, 3D modelling of all access tracks and the absence of verge or central reservation widening for visibility, the validation of the existing quantities in the Feasibility Study is almost impossible.

The allowance in Chapter 3 for the cost estimate, cost for design and technical assistance seems low compared with the construction value which is estimated at 2.4 billion Euros.

The costs were estimated in RON and exchanged to Euros using a 3.7 exchange rate that was valid on 1st October 2008.

Exchange rate used in the original cost estimate is not comparable with the rate today (approximately €1.0 equals RON4.5) and would therefore increase the proposed costs considerably from €2.7bn to €3.3bn. This should be borne in mind for future assessments, as currency exchange markets are likely to vary more than in the recent past.

In addition, the cost of basic commodities such as fuel is also likely to have a significant impact on the budget and final construction costs for this scheme over the next 10years.

Outline cost estimates developed by Halcrow will be provided within the Procurement Strategy Report which is listed as Task 4 within JASPERS Terms of Reference.

4.1.2.1.10 Volume 4 – Traffic Study

Overview

The traffic study overall is generally of low quality. There are obvious Gaps in the data used, the methodology adopted, and a general lack of supporting information and explanation as to how the forecasting assumptions and the traffic forecast themselves were derived.

The traffic chapter provides information on traffic forecasts for the existing DN7 road between Pitetsi and Sibiu and notes that the capacity for the majority of DN 7 road was exceeded based on 2008 traffic. Based on this, the report confirms the need for a 2 lane motorway and provides traffic forecasts for the opening year (anticipated at the time as 2015) in the region of 20000 – 24000 vehicles day and 34000 – 41000 vehicle day for year 2035. The report comments on the need for a 6 lane motorway (three lanes each way) for the section between Vestem and Sibiu based on the traffic forecasts for year 2035.

With reference to the information received during the official start-up meeting, which took place on the 9th April, the possibility for the implementation of a tolled system in Romania is under review. As discussed with JASPERS during a teleconference, also held on 9th April, the ToR will assume the un-tolled scenario, but may also cover outline requirements for consideration of a tolled scenario.

The Gaps in the existing traffic study, by topic, are described more fully in the following sections.

Data Collection

Only traffic count information for the DN7 is presented, and only for one year (2005).

No traffic count information for any other road is presented, and in particular no information for the DN7C between Pitesti and Curtea de Arges (an important section of the proposed motorway alignment).

No information is provided on historic traffic growth in the corridor.

The report says that origin-destination (O-D) data from the 2005 census was used in the study. No information is provided, however, on the origins and destinations of traffic in the corridor, either in tabular or graphical format.

No information whatsoever is provided on existing travel times in the corridor. The time savings offered by the new motorway over the existing network are the most fundamental benefit of the project.

No background information for the study area is provided – population, employment, car ownership, development plans etc - to give the reader an appreciation of the socio-economic status of the corridor and existing and future traffic drivers.

Base Year Traffic Model

There is mention of a traffic model in the report, but no actual evidence that a model has been used is presented.

There is mention of a zone system, but no zone plan is provided.

No network diagrams (from the traffic model software) are provided either for the base year or future years.

No information on trip origin-destinations is provided, or descriptions as to how the trip matrices were developed.

There is no mention whatsoever of existing travel times in the model.

No details on model calibration are given, apart from the fact that matrix estimation (VFLOWFUZZY in VISUM language) was used. There are no tables comparing modelled to observed traffic flows or travel times for example, which would allow the reader to assess the accuracy of the model.

No assignment plots (traffic flows on links) are provided to give the reader confidence that the model is performing reasonably.

There is no mention of important route choice parameters such as values of time and vehicle operating cost. A limited amount of information is provided in the route alignment assessment report.

Heavy vehicle PCU (passenger car equivalent units) factors are very high on all existing links – leading to very low LOS (E) on every existing link in the Do-Nothing case. This may be valid (due to the mountainous nature of the route), but should be explained further and justified in the light of improved vehicles performance (i.e. trucks) over time.

Future Year Models

Only limited information on future year networks is provided.

Future year traffic growth rates are provided, but no information or explanation as to how they were derived is given.

There is no mention of historic traffic growth in the corridor (only car ownership at the national level).

There is no mention of the future development of socio-economic parameters that will drive future traffic growth (GDP, population, employment, car ownership etc)

No information on how future year matrices were derived is given.

There is no mention of generated (induced) traffic, whether it is included in the forecasts, or how it was calculated if it was.

No information is provided on future year route choice parameters- VOT, VOC, and how they may change over time.

No information on travel time savings offered by the motorway is provided.

No future year assignment plots are provided or any alternative graphical presentation of future traffic in the corridor.

Forecasts

No real explanation on how the traffic forecasts on links were derived is provided, or any commentary on the results given.

No low or high cases or sensitivity test results are provided.

No alternative route options or scenarios are discussed in the main traffic report. Alternative alignments are discussed in the route alignment assessment report for Sections I and II, although the traffic related information provided is very limited. There is no information or discussion provided, for example, on which alignment provides the best access to Ramnicu Valcea.

Looking at the actual traffic forecasts - on comparable sections (e.g. Sector 1, Sibiu-Cornet) forecasted motorway volumes are more than double the Do-Nothing forecasts for the DN7 for 2015 (22,975 versus 9,343). No explanation is given for the differences between the two. This is probably due to re-assignment from other corridors in the wider network, but no assignment plots or assignment difference plots are provided to help understand this.

The numbers in some of the volume tables do not sum correctly.

Conclusion

The existing traffic study has many Gaps and overall is generally of low quality. A completely new traffic study will therefore be required. The primary purpose of any new modelling work would be to produce reliable demand information upon which to base the economic and environmental appraisal of the proposed Sibiu-Pitesti project. The new study would be required to:

- ***incorporate the latest traffic census data collected in 2010***
- ***make use of the national transport model developed in 2011/2012***
- ***incorporate the impacts of the economic downturn since 2008***

The staging of motorway construction - single carriageway in stage 1 followed by dual carriageway in stage 2 – does not seem possible due to high level of traffic flows forecasted for the 2015 opening year. The information related to traffic AADT flows will require further analysis and validation as part of the updated Traffic Study.

The new Feasibility Study shall take account of the potential need for provision of an additional third lane within the sector Vestem to Sibiu and in addition, review the impact on the already constructed Sibiu bypass. Alternatively the use of wider emergency lanes (3.50m wide), which would accommodate a third running lane may be considered as an option for this sub-section.

4.1.2.1.11 Volume 5 - Economic Analysis and Multi Criteria Analysis

Introduction

The purpose of this section is to highlight any Gaps in the Cost Benefit Analysis (CBA) and Multi-Criteria Analysis (MCA) presented as part of the existing Feasibility Study, taking cognisance of EU and national policy, planning processes and standards.

The Gaps in the CBA and MCA presented as part of the existing Feasibility Study, are outlined below. For ease of reference, the documents identified as information sources within the existing CBA report are referred to as follows, within this section:

Document:	Referred to as:
"The Guide to the Cost-Benefit Analysis of Investment Projects"	EU Guidelines
"Guidelines for Cost Benefit Analysis of Transport Projects to be Supported by the Cohesion Fund and the European Regional Development Fund in 2007 – 2013"	JASPERS' Guidelines
"The Paper on the Evaluation and Prioritization of Projects in the Transport Sector"	Louis Berger SAS Paper

Cost Benefit Analysis

The Gaps in the CBA are discussed under the following key headings:

- Economic Analysis
- Sensitivity and Risk Analysis
- Financial Analysis

Economic Analysis

A review of the economic analysis, with regards to existing guidelines, identified the following Gaps:

General

- An economic analysis has not been undertaken for each of the route options being considered as part of the study;
- Details regarding the basis of the economic analysis (such as timeframes, annualisation factors, assessment years, etc.) have not been presented. The report mainly presents details of the data input to the Highway Development and Management (HDM-4) model and it would seem more appropriate for this to be included as an Appendix;
- Project specific assumptions from the traffic forecasting have not been presented. These would normally include traffic volumes, speeds and journey times for the 'without project' scenario and the investment option per type of vehicle and road section, which would be further sub divided into:- traffic remaining on old link; traffic diverting from old link to project link; and traffic generated by the project;
- It is noted that forecast traffic flows for the new motorway include re-assigned traffic from other routes not included in the HDM model and, therefore, the traffic modelled on the existing route in the 'without project' scenario was adjusted to match the total of the flows on the new motorway and existing route in the investment option, thus providing an assessment based on comparable traffic volumes. Details have not been provided to demonstrate that conditions on the existing route in the 'without project' scenario (containing artificially high traffic volumes) reasonably reflect the combined effects of the routes being represented.

Vehicle Operating Costs

- The report outlines the input data for the HDM-4 model, with limited explanation or justification for the assumptions made and values used.

Travel Time Costs

- The values of time provided in the Louis Berger SAS Paper have been adopted rather than the proposed values presented in JASPERS' Guidelines, without any justification;
- The values of time have not been adjusted over time. JASPERS' Guidelines indicates that values should be adjusted over the appraisal period using 70% of the GDP/capita growth rate and no justification has been provided for this not being carried out.

Accident Savings

- The average accident rates (by severity) for 'National Roads' provided in the Louis Berger SAS Paper were adopted for the 'without project' scenario. JASPERS' Guidelines indicate that the base year accident rate should be based on the actual number of road accident occurrences;
- The average accident rates (by severity) for 'Motorways' provided in the Louis Berger SAS Paper were adopted for the investment option. JASPERS' Guidelines recommend that the base year accident rate is based on the actual number of road accident occurrences on existing comparable motorways;
- It is not clear how future year accident numbers for the 'without project' scenario or the investment option have been forecast;
- The values of accidents provided in the EU Guidelines have been used rather than the proposed values presented in JASPERS' Guidelines, without any justification;
- It is not clear whether the values of accidents used have been adjusted over time.

Emission Savings

- The economic impacts of the project in terms of its effects on Air Pollution and Global Warming have not been considered.

Noise Pollution

- The economic impacts of the project in terms of its effects on Noise have not been considered.

Construction Costs

- No breakdown of the construction cost was provided. JASPERS' Guidelines indicate that capital costs should include construction, land purchase and management costs.

Maintenance Costs

- Details of the total work costs and the year in which the works are expected to be undertaken have not been presented for the 'without project' scenario and the investment option.

Economic Assessment Results

- It is not clear how the Net Present Value (NPV) was derived;
- The Present Value of Costs (PVC), including a breakdown, was not presented;
- It is not clear how the residual value was incorporated in to the economic analysis;

- The Present Value year of the costs and benefits have not been presented;
- The results of the economic analysis have not been presented in the table format recommended in JASPERS' Guidelines, which comprises:
    - a summary of general assumptions related to appraisal period, discount rate, unit value of time and unit value of accidents;
    - the CBA grand summary that includes key data such as typical cross section, scheme length, average speed, traffic AADT and level of service, number of accidents. The grand summary also includes information on capital investment cost, maintenance & operation costs and residual value;
    - summary economic analysis of selected alternative (total benefits, net present value, internal rate of return, benefit/cost ratio).
- The share of total economic benefits was not presented nor the highest share item highlighted;
- An interpretation of the economic results was not provided;
- Detailed calculations for the economic analysis were not provided.

Sensitivity and Risk Analysis

A review of the sensitivity and risk analysis, with regard to existing guidelines, identified the following Gaps, which are presented under the following four key headings:

- Sensitivity Testing / Identification of Critical Variables;
- Scenario Analysis;
- Calculation of Switching Values;
- Monte Carlo Analysis

Sensitivity Testing / Identification of Critical Variables

- The feasibility study tests the sensitivity of results to changes of +/- 20% in construction cost, travel time values, accident related costs and vehicle operating costs. This differs from the typical sensitivity testing that is expected to be carried out, which is as follows:

– Traffic - 30%

– Capital costs +30%

– Maintenance costs +30%

– Value of time -40% (if HEATCO derived values are used)

- The project's critical variables have not been identified and justification for the tests undertaken was not provided.

Scenario Analysis

- Scenarios based on combinations of the sensitivity tests undertaken have been presented. There is no evidence that these scenarios represent a combination of extreme values for each of the variables considered.

Calculation of Switching Values

- No assessment was presented to indicate the switching value of critical variables.

Monte Carlo Analysis

- Details of a complex risk analysis (such as Monte Carlo) have not been presented.

Financial Analysis

- No financial analysis was presented.

Multi-Criteria Analysis

The Gaps in the MCA are as follows:

Justification for using the following criteria within the MCA was not presented:

- **Cost** (based on the cost of the alignment being considered relative to the minimum cost of the alignment options);

- **Environmental impact:** no reference was included for the Natura 2000 sites for the section between Pitesti and Cornetu whilst some information is provided for the Cozia National Park area where two Natura 2000 sites coexist;

- **Environmental impact** (based on a score scale from -3 to +3 to quantify the impact of the alignment options in terms of the following:
    - pollution risk;
    - loss of diversity of habitat conditions;
    - avoiding natural preserves or those of high archaeological and historical importance
    - easy access in the area not requiring the achievement of new roads; and
    - existence for the site deployment of water supply and wastewater treatment facilities).
- **Attractiveness and usefulness for traffic** (based on traffic volumes for the alignment being considered relative to the maximum volume of traffic on the alignment options). For example, an improved connection to Ramnicu Valcea is not discussed or considered within the report;
- **Social and economic importance** (based on the population influenced by the alignment being considered relative to the maximum of the alignment options); and
- **Generalised cost for users** (based on the generalised cost of the alignment being considered relative to the minimum of the alignment options, taking into account vehicle operating costs, value of time and road user effects).

The criteria used do not ensure that a wide range of impacts (such as those associated with environment, safety, economy, integration and accessibility & social inclusion) are considered as part of the analysis.

Justification for the weighting applied to each criterion was not presented.

No assessment of the route options' performance against the intended objectives was provided.

No consideration was given to the 'implementability' of the options. For each of the options, for example:

- How straightforward will it be to implement? Are there innovative techniques involved? What are the risks?
- Are there any factors which could result in major operational costs over its life?
- Can the capital cost of the option be funded? Will the on-going operating or maintenance costs be met? What are the associated risks?

- How acceptable is the option to the public? Is there likely to be objections from particular sections of the community or from particular stakeholders?

Conclusion

Whilst, overall, the CBA guidelines appear to have been followed, there are Gaps in the approach adopted, as well as, a lack of information to support some of the assumptions made and parameters used. The environmental aspects are not thoroughly reviewed and analysed. The CBA will need to be updated to take account of the results of the new traffic study, which have been recommended.

The MCA, which seems fairly basic, does not capture the range of impacts attributable to the route options and it is recommended that this be improved.

4.1.2.1.12 Volume 6 - Topographical Studies

The route option stage of the Feasibility Study was based on aerial mapping while the preferred route was designed using a traditional on site survey carried out by the Consultant.

The execution of topographical surveys using traditional on site surveys involves significant resources and time. In addition, it involves access to remote locations and difficult terrain which is seen as a significant health and safety hazard for the work force.

Halcrow initiated discussions with JASPERS, RNCMNR and the national Cadastral Authority (ANCPI) with the view to introduce an advanced LiDAR survey methodology, which will present the following advantages:

- Removes the health and safety risk related to the work force;
- Enables the accurate survey of hardly accessible sites where access is difficult (mountains, rivers etc);
- The technology enables the completion of survey during any season of the year;
- The duration for the completion of such survey is reduced and the corridor surveyed could be 1000m wide measured either side of the future motorway centre line.

The LiDAR surveying method emits laser pulses which provide high precision measurements from a given target (vertical accuracy 50 mm and horizontal resolution of 3 points/sqm). The laser scanning, records time differences between laser pulses sent from the plane and those reflected by the terrain surface. Thus each point surveyed includes the three dimensions required, namely the northing, easting and level. The GPS (Global Positioning System) consists of a GPS receiver located in the aircraft and a GPS station placed on the ground in order to correct any global positioning errors and obtain a best possible global trajectory of the aircraft. The LIDAR technology brings notable advantages compared to traditional methods, the most important advantage being the horizontal and vertical accuracy and the quick completion of the survey.

The opportunity for inclusion of such requirements in the new ToR will be reviewed following receipt of responses from the above consulted parties.

The existing topographical survey is considered outdated and shall require a complete update.

4.1.2.1.13 Volume 7 – Geotechnical Study

The proposed alignment from Sibiu to Pitesti requires 116km of new highway and includes 77.4km of earthworks and 38.6km of structures. The scheme contains many geotechnical challenges including significant sections of cutting, embankment, tunnels and reinforced earth. The topographical and geological conditions along the route, results in areas of difficult engineering, particularly in the Olt Valley, where several river crossings, tunnels and numerous new rock cuttings are proposed.

This section of the report comprises the assessment of the geological, hydro geological and geotechnical aspects of the Feasibility Study.

The following documents have been reviewed as part of this geotechnical assessment:

- Reference 1: The Feasibility Study
- Reference 2: Egis Geotechnical Study, 2008
- Reference 3: Factual Report from the Ground Investigation (commissioned by Egis in 2008)
- Reference 4: Terms of Reference published as part of June 2012 tender

Geotechnical investigation procedures in the EU are governed by the European Standard, Eurocode, EN 1997 Eurocode 7 Part 2: "Ground Investigation and Testing" (EN-1997:2). The Eurocodes were implemented in Romania in 2010. CEN members, including Romania, are bound to comply with this code. However, at the time the Feasibility Study was produced (in 2008), the ground investigation was carried out in accordance with Romanian Standard NP 074-2007. This document does not explicitly state any direct alignment with Eurocode 7 (although it's preceding edition NP 074-2002 is aligned with Eurocode 7). It is considered that the feasibility study should meet the requirements of Section 2.1 of NP074-2007. This is with the view of subsequently achieving the objectives of the "Technical Project" stage (Section 2.2 of NP074-2007) and ultimately the "Detailed Geotechnical Study" stage (Section 2.3 of NP074-2007).

The review carried out by Halcrow, included amongst others, the Terms of Reference published as part of the June 2012 Tender process, referred herein as June 2012 ToR. The relevant section of the June 2012 ToR was the Annex 1 – Specification for ground investigations. Whilst the June 2012 ToR, included a high level specification for ground investigations, details for testing, coordinates for the boreholes to be executed and specified the depth of each borehole, it is noted that such approach to a detailed specification for ground investigation transfers the entire risk for adequacy of GI data to the Employer (RNCMNR), which in our opinion, is not in line with best practice and not desirable.

Also the inclusion of sections of text copied from various norms and standards within the June 2012 ToR does not bring additional value to the document as it simply repeats information that the competent Designers should be aware of.

The main risk with such an approach relates to potential omissions within the ToR aspect that may lead to an incomplete GI report, a risk that according to the June 2012 ToR would have been entirely transferred to the RNCMNR. In our opinion, a robust set of technical terms of reference needs to include the minimum level of investigations required for each category of works such as tunnels, structures, embankment cuttings with the relevant cross references to the Eurocode 7. The ToR should require the Consultant to compile and submit to the Employer the list of applicable standards and norms to be used in the geotechnical design and a detailed proposed specification for ground investigation works. This approach would minimise the risk of commencement of design based on incorrect assumptions, standards or inadequate levels of ground investigations specified.

The geotechnical information presented in the feasibility study is of poor quality. In many instances it is not possible to determine the feasibility of individual solutions or sections of works.

Earthworks

General

Earthworks comprise some 77.4km of the proposed route and include significant sections of embankment and cutting. According to Section 3.1 of the Egis Geotechnical Study, the design of embankments and cuttings are to be informed referencing Romanian State Standard STAS 2914/84. In this report, the applicability of this standard shall be considered and a comparison made with guidelines given within the Eurocode.

As part of the Feasibility Study, a series of long sections have been produced showing the proposed route alignment and a preliminary ground model. In addition, a series of plans and cross-sections have been provided. This information was used to delineate various elements of earthworks and structures.

A ground investigation (ref 3) was undertaken comprising 131 mechanically augured boreholes (FR series) and 158 hand augured boreholes (SR series). The FR series is nominally targeted at structure locations, whilst the SR series is targeted at cuttings and embankments.

Proposed Embankments

A total of 81 sections of embankments have been identified and these are listed in Table 1. These earthworks comprise a total of 52.1km of the proposed route. The proposals are presented on plans and cross-sections contained within Volume 2.1 of the feasibility study.

At feasibility stage an initial assessment of embankment construction is required. This assessment does not require recourse to calculations rather a high level appraisal of the following:

- Adequacy of the ground model to assess global stability of the embankment;
- Adequacy of the ground model to assess settlement of the embankment. This includes immediate and consolidation (long-term) settlements;
- Possibility of re-use of material from cuttings to form the embankments.

Suggested objectives at Feasibility Stage

The objectives at Feasibility Stage should be to obtain geotechnical information to inform preliminary design of each embankment as set out in Section 2.1 of NP074-2007. The information obtained at this stage should then allow progression to the "Technical Project" stage. At the location of each of the proposed embankments the following information (as a minimum) should be obtained:

- Definition of the subsurface ground model. This would typically comprise stratigraphy, structure and principal rock and soil types;
- Determination of rock and soil properties and mass characteristics;
- State of weathering of rock;
- Definition of hydro geological conditions including groundwater levels and presence of aquifers;
- Seismicity;
- Identification of potential construction risks.

The above objectives may be achieved by a number of methods and techniques including:

- Boreholes and trial pits to identify the subsurface stratigraphy, and to obtain disturbed and undisturbed samples for visual classification and laboratory testing. The frequency of boreholes is dependent on the nature and extent of the proposed works and on the variability of ground conditions. Guidelines within Eurocode 7 suggest borehole spacing's of 20m to 200m for linear works such as earthworks and highway structures; however an equivalent recommendation is not given in NP074-2007. At Feasibility Stage, it is considered that a borehole spacing of 200m is acceptable. This spacing should allow the initial assessment to be carried out. The information obtained from these boreholes should then allow determination of the next phase of ground investigation for the preliminary design phase. At detailed design stage it is considered that a nominal borehole spacing of 50m is more appropriate for this scheme.

At any phase of investigation, the ground investigation should provide, as a minimum, the following information:

- In situ tests to obtain engineering and index properties and mass characteristics of soil and rock;
- In-situ groundwater measurements;
- Laboratory testing providing a wide variety of engineering properties and index properties from representative soil samples and rock core retrieved from the borings.

In the context of embankment construction, the subgrade soil requires testing to establish the following:

- Strength characteristics
- Stiffness characteristics
- Consolidation characteristics
- Permeability
- Geochemical characteristics

Review of available information

The desk study and ground investigation are considered generally inadequate for preliminary assessment of embankments.

The ground model shown in the long sections is considered adequately developed for the Feasibility Study at 12 of the 81 embankments. For example, embankment E1 is 400m in length and rises to a maximum height of 3.3m. A preliminary ground model for Embankment E1 can be inferred from boreholes FR1 and FR2 which show the following sequence of strata:

- GHL-0.5m: Topsoil
- 0.5-3.0m: Brown silty CLAY
- 3.0-18.0m: Coarse yellowish sand

From this model, an initial assessment can be made, with the conclusion that the topography and ground conditions are suitable for embankment construction. It is also evident that additional boreholes and testing are required for preliminary design to enable preliminary calculations on stability and settlement.

For the remaining embankments the information is deemed inadequate for a variety of reasons, including:

- No information whatsoever has been provided within the footprint of some of the proposed embankments. For example at embankment E14 (Chainage 14+740-14+920) there is a complete absence of information. The ground model appears to have been inferred from the nearest boreholes. However, this information cannot be relied upon as the nearest borehole (FR19) is 160m from the north end of the embankment whilst borehole FR20 is 260m from the southern end of the embankment.

- In some instances there is an insufficient number of boreholes i.e. borehole spacing is greater than 200m. For example, Embankment E5 is 1790m long. Only 4 boreholes have been provided and therefore the average spacing between boreholes is 448m.

- Insufficient depth of boreholes. At embankment E7 (Ch 7+280 to ch 7+780) the embankment height may be as high as 7.8m. This suggests that embankment construction may cause settlements in strata at depths of up to 20m below ground level. Boreholes SR17 and SR18 only extend to 5.0m below ground level and are therefore inadequate for preliminary assessment.

- No in-situ testing results have been provided whatsoever and it not clear whether any such tests have been carried out. Furthermore, no laboratory test information from the route was provided. Again, it is not known whether any such tests have been undertaken. As a result of this absence of testing, the soil and rock characteristics listed in Section 2.2.1 cannot be defined, even to an approximate degree.

Preliminary design

Cross-sections have been presented in Vol. 2.1 of the Feasibility Study. These show proposed embankment slopes are predominantly at 2:3 (locally at 1:2). Embankment details are shown in Typical Sections 1, 2, 3, 5, 7 and 8 for Class 1 roads (the main carriageway), in Typical Section 9 (Class 2 Roads), Typical Section 10 (Class 3 Roads), Typical Section 11 (Class 4 Roads), Typical Section 12 (Class 5 Roads) and Typical Sections 13 and 14 (slip roads).

At this stage no information has been provided on construction sequence, drainage measures or the classification of allowable earthworks materials.

Embankment Internal Stability

Internal stability of the embankments cannot be assessed at present since no information was provided on the proposed material to be used. Nonetheless, the embankment side slopes have been presented in the typical sections. In accordance with Eurocode 7 guidelines, the following parameters would be required to ensure internal stability where granular fill is proposed:

- Side slopes at 2:3: □ 'k = 400

- Side slopes at 1:2: □'k = 330

where □'k denotes the characteristic internal angle of friction. The values are based on Eurocode 7 guidelines in which a partial factor of 1.25 is applied to the friction angle.

Cohesive soils generally do not exhibit friction angles as high as □'k = 400. It is therefore considered that embankments would generally be constructed from granular fill, unless soil treatment is proposed to improve its frictional properties.

Embankment Global Stability

Global stability of the embankment concerns deep rotational failures occurring through the underlying soils. From laboratory test data presented in Ref 2, parameters have been derived for a general ground model, which is summarised in Table 2. It should be noted that this information was obtained from investigations carried out in Cluj and Ramnicu Valcea. As such, it provides only generic information on materials known to occur regionally. Extensive laboratory testing from samples within the proposed route will be required to confirm the soil and rock properties.

Strata	b (Mg/m3)	'k	cu (kPa)	E (MPa)	k (m/day)
Sandy silty clay	1.8-1.9	12-14	15	15-20	0.3-0.5
Silty Clay	1.9	16-18	20	14-14	2-5
Coarse Alluvium	2.0-2.1	31	10 (c')	50-60	80-250
Sedimentary Rocks	2.0	17	-	50-60	1x10-9
Metamorphic Rocks	2.5	-	-	1500-2000	-

Table 2. Soil and rock parameters derived from investigations at Cluj and Ramnicu Valcea.

It is not known how these parameters have been derived. Nonetheless, layers identified as "sandy silty clay" and "silty clay", appear to be of low strength and therefore may give rise to global instability.

STAS 2914-84 (Table 3) provides guidance on stability for embankments founded on various soils. This suggests embankments slopes can be constructed with slopes at 2:3 up to various heights depending on the type of embankment fill used as follows:

Embankment fill	Maximum allowable height (m)
Silty clay or sandy clay	6
Clayey sand or silty sand	7
Sand	8
Gravel or ballast	10

Table 3 (re-written from Table 3 in STAS 2914-84).

For slope heights up to 12m side slopes should be reduced to 1:2.

STAS 2914-84 does not state the basis for these guidelines. As discussed, internal and global stability will be governed by the strength characteristics of both the embankment fill and the underlying soil. Based on the evidence provided in Table 2, it is considered that embankments constructed at either 1:1.5 or 1:2 would not be stable either internally or globally, even under favourable groundwater conditions.

Seismic impact

The Feasibility Study should make reference to the influence of seismic activity on embankment stability and settlement.

Proposed Cuttings

A total of 76 sections of proposed cuttings have been delineated as shown in Table 4. These earthworks comprise a total of 25.3km of the scheme.

At Feasibility Stage, an initial assessment of cutting construction is required. This does not require recourse to calculations, rather a high level appraisal of the following:

- Adequacy of the ground model to assess stability of the cuttings in both rock and soil;
- Possibility for re-use of material from cuttings to form the embankments.

Suggested objectives at Feasibility Stage

The objectives at Feasibility Stage should be to obtain geotechnical information to inform preliminary design at each cutting. The following information (as a minimum) should be obtained:

- Definition of the subsurface ground model. This would typically comprise stratigraphy, structure and principal rock and soil types;
- Determination of rock and soil properties and mass characteristics;
- State of weathering of soil and rock;

- Definition of hydro geological conditions including groundwater levels and presence of aquifers;
- Seismicity;
- Identification of potential construction risks.

The above objectives may be achieved by a number of methods and techniques including:

- Boreholes and trial pits to identify the subsurface stratigraphy, and to obtain disturbed and undisturbed samples for visual classification and laboratory testing. In-situ tests to obtain engineering and index properties and mass characteristics of soil and rock;
- In-situ groundwater measurements;
- Laboratory testing providing a wide variety of engineering properties and index properties from representative soil samples and rock core retrieved from the borings.

In the context of cutting construction, we require testing to establish the following:

- Strength characteristics;
- Stiffness characteristics;
- Permeability;
- Durability and hardness characteristics of rock.

These preliminary objectives should allow progression to the "Technical Project" stage as defined in Section 2.2 of NP074-2007.

Review of available information

Both the desk study and the ground investigation presented in the feasibility study are considered generally inadequate for preliminary assessment of cuttings.

For the Feasibility Study, it is considered that the ground model is adequately defined at 16 of the proposed cutting locations. For example, cutting C2 (Chainage 2+660-2+920) contains boreholes SR8 and FR4, both of which extend below the base of the cut.

At the remaining locations, there is either excessive spacing of boreholes, boreholes of inadequate depth or a complete absence of boreholes. This is exemplified at the following locations:

- No information whatsoever was provided within footprint of some of the proposed cuttings. For example, at cutting C9 (Ch 12+880-13+100) there is a complete absence of information. The ground model appears to have been inferred from the nearest boreholes. However, this information cannot be relied upon as the nearest borehole SR24 is 160m from the south end of the embankment whilst borehole FR16 is 260m from the northern end of the embankment.

- Insufficient number of boreholes i.e. borehole spacing is greater than 200m. For example, Cutting C1 is 280m long. Only 1 borehole has been provided and therefore the ground model cannot be adequately defined.

- Insufficient depth of boreholes. At cutting C4 (Ch 6100-6220) the cutting depth may be as great as 10.0m. However, borehole SR15 only extends to 5.0m below ground level and is therefore inadequate for preliminary assessment.

No in-situ testing results have been provided whatsoever and it is not clear whether any such tests have been carried out. Furthermore, no laboratory test information from the route has been provided. Again it is not known whether any such tests have been undertaken. As a result of this absence of testing, the soil and rock characteristics listed in Section 2.3.1 cannot be defined, even to an approximate degree. It is therefore not possible to move to the "Technical Project" phase of the scheme.

Preliminary design

Cross-sections have been presented in the Road Works documents ("Vol. 2.1 Lucrari de Drum"). These drawings show proposed cutting slopes at predominantly 2:3 (locally at 1:2) and anchored rock cuttings.

Cutting Stability

Internal stability of cuttings cannot be properly assessed at present due to insufficient information being provided on the strength of the excavated soils. Nonetheless, the cutting slopes have been presented in the typical cross-sections. Based on Eurocode guidelines, the following parameters, in accordance with Eurocode guidelines would be required to ensure internal stability, where granular fill is proposed:

- Slopes at 2:3: □ 'k = 400

- Slopes at 1:2: □ 'k = 330

The values are based on Eurocode 7 guidelines in which a partial factor of 1.25 is applied to the friction angle. These values assume that destabilising water pressures have been sufficiently mitigated. For cuttings through drift deposits, inspection of the parameters in Table 2 indicates that the slopes would not have sufficient strength to remain stable at the proposed slopes.

STAS 2914-84 (Table 5) provides guidance on stability for cuttings formed in various soils. This suggests slopes can be constructed at various inclinations depending on the nature of materials encountered in the cutting:

Cutting slope material	Allowable slope inclination
Clay, sandy clay or silt, clayey or silty sand	2:3
Marl	1:1 to 2:1
Loess	10:1
Rock susceptible to weathering	2:3 to 1:1
Rock not susceptible to weathering	10:1
Rock with stratification favourable to stability	10:1

Table 5, re-written from Table 5 in STAS 2914-84

For slope heights up to 12m, the code recommends side slopes should be reduced to 1:2. It is not known how the recommendations in Table 5 have been derived and clarification is currently being sought on this matter.

Anchored Rock Slopes

Section 3.2 of the Geotechnical Study notes that a number of areas of landslides have been identified and that cutting slopes in these areas are required to be reinforced. As such, rock cuttings with anchors are proposed at 40 distinct locations between ch 11+630 and ch 85+280. These range in height from 5m to 52m. For these cuttings, much greater information is required to inform the feasibility of the route. Additional investigation will be required to establish the following:

- The mass properties of the rock, particularly the shear strength in the materials forming the cutting. The stability of the cutting will be dependent on the occurrence of joints and other planes of weakness and on the amount of friction, asperities and cohesion present within these planes;
- Structure of the rock, particularly how any planes of weakness are oriented relative to a newly exposed face;
- Groundwater conditions. High porewater pressures can lower the strength along planes of weakness;
- In-situ stress variations within rock cuttings;
- State of weathering of rocks forming the cutting. Rock tends to be more weathered along planes of weakness and therefore may have lower strength characteristics than the surrounding rock.

In the Feasibility Study report, there is no reference to the stability of cuttings nor is there any reference to the inadequacy of the information provided so far. No details have been provided on the method of anchoring at this stage. The level of information provided so far means that it is not possible to progress to "Technical Project" stage.

Re-use and disposal of cutting arisings

Inspection of soil strength values in Table 2, suggests that drift materials arising from cuttings would not be suitable for re-use in embankments due to the low friction angles observed. It is possible that excavated rock may be re-used in the earthworks, however its strength characteristics are unknown at this stage.

In the Feasibility Study there is no reference to re-use of materials from cuttings. It is expected that the volume of fill required will greatly outweigh any material won from cuttings. Therefore, large quantities of material will need to be imported to construct the scheme. As such, it is recommended that re-use of cutting materials is addressed within the Feasibility Study as this will have a major influence on the economic and environmental impact of the scheme.

If as-dug materials prove to be unacceptable for re-use and cannot be improved through processing, it will be necessary to dispose of these materials. Movement of unacceptable material can incur significant costs to the scheme. Equally, the environmental impact of moving and depositing large quantities of material may be significant. It is strongly recommended that the Feasibility Study should attempt to identify possible areas of deposition with a view to minimising both financial and environmental problems.

The scheme will require large quantities of structural concrete. Sourcing of local materials could therefore be of great economic and environmental benefit to the scheme. It is recommended that the Feasibility Study should identify not only existing local quarries, but also other potential sources of rock, sand and gravel arising from the proposed works. Cuttings and tunnels may provide large quantities of re-usable stone and it is therefore imperative that the ground investigation provides suitable information from these materials.

In summary, the Feasibility Study does not provide enough information for progression to the "Technical Project" stage.

Reinforced earth and Retaining Walls

Reinforced earth is proposed at 14 locations between ch 11+630 and ch 35+190. The adequacy of GI information can be assessed with reference to Sections 2.2 and 2.3.

Thirteen of these structures have been proposed in areas of cutting. It is not clear why this solution has been adopted. Section 3.2 of the Geotechnical Study does, however, suggest that "several areas with landslides or with instable potential for which reinforcement works must mandatorily be designed". It may be that by introducing reinforced earth it is possible to limit the excavation into rock and thereby reduce potential for landslides. However, this design philosophy needs clarification.

In the 13 areas of cutting it is not clear how much of the reinforced earth can be constructed. The cross-section at ch 16+950 (in cutting C15) is typical of many of the proposals. On the right hand side of this section, part of the carriageway is formed by a 12m high rock cutting. On the left hand side reinforced earth is shown to be embedded within a cutting slope. Evidently, the slope would need to be excavated and then reinstated in order to install the geogrids into the slope. Clarification is required as to how the solution is to be constructed.

At ch 29+600, a section of reinforced earth has been proposed as part of an embankment. It is not known why this solution has been adopted here and clarification is currently being sought on this matter.

Gravity Retaining walls have been proposed at 7 locations between ch 49+520 and ch 76+240. The adequacy of GI information at these locations can be assessed with reference to Sections 2.2 and 2.3. The Feasibility Study should state why this solution has been adopted at these locations and comment on buildability issues.

Structures

There are 117 proposed structures within the site.

Suggested objectives at Feasibility Stage

In the first instance, the following objectives should be addressed within the Feasibility Study:

- Establish a preliminary ground model at each of the proposed structural foundation locations;
- Preliminary assessment of structural foundations e.g. is it feasible to form shallow foundations or will piling be necessary;
- Seismicity.

Review of available information

The desk study and ground investigation are considered inadequate for the Feasibility Stage.

It is considered that for the purposes of a feasibility study, 26 of the proposed structures have adequate ground information. For example, Structure S11 (ch 10+300 to ch 10+460) contains 2 boreholes and it has therefore been possible to establish the preliminary ground model.

For the remaining structures, there is either excessive spacing of boreholes, boreholes of inadequate depth or a complete absence of boreholes. This is exemplified at the following structures:

- At structure S15 (ch12+760 to ch 12+880) there are no boreholes. The ground model appears to have been inferred from the nearest adjacent boreholes. This is inadequate since the nearest information is borehole FR16 (160m north of the north abutment) and borehole SR24 (380m south of the south abutment).

- Structure S29 is proposed to cross the River Olt between ch 20+700 and ch 21+000. The north abutment of the structure is informed by borehole FR27, but there is no coverage for the south abutment.

Therefore a more detailed desk study and further ground investigation is required to complete the Feasibility Study before progression to the "Technical Project" stage.

Preliminary design

Structures have been represented in a series of general arrangement drawings within the Feasibility Study. These drawings provide information on structure location, number of span and span lengths. Adjoining earthworks are also shown indicatively on the drawings.

The Feasibility Report provides no information on the proposed form of structural foundations. There are no preliminary design parameters. It is considered that this information should be included at Feasibility Stage.

Chemical Aggressivity

Structural foundations will be susceptible to chemical attack from both the in-situ soil and groundwater. The Feasibility Study makes no reference to chemical aggressivity. This is a significant Gap, since the structural designer will need to make an assessment of concrete durability prior to detailed design.

Romanian Standard SR EN 206-1 provides guidance on concrete classification. This standard states that concrete must be classified according to in-situ levels of sulphate, pH, CO2, nitrate and Magnesium. As such, the new ground investigation must allow for retrieval of suitable samples for chemical testing in order that this classification can be carried out.

Piling

It is not known where piled foundations are proposed. Nonetheless, given the great magnitude of many of the structures and the fact that soft deposits are likely to preclude spread foundations in these instances, it is likely that piles will be adopted in many cases. It is therefore imperative that ground conditions are established at each structural foundation. Boreholes must be drilled to an appropriate depth in order to allow adequate modelling of piles. Piling will also be affected by seismic activity. It is recommended that the Feasibility Study addresses this issue, with a view to detailed design in accordance with Eurocode 8.

Scour

At several locations in the scheme, it will be necessary to form structural foundations within watercourses. Inevitably, the presence of these foundations will alter the flow regime within these channels and the foundations will be susceptible to hydraulic scour. Therefore, the ground investigation must provide information on soil grading at the location of each of the structural foundations.

Tunnels

Proposed Tunnels

There are 7 tunnels and one section of "open earthworks" (assumed to be "cut and cover" method of tunnelling at shallow depth) proposed, comprising approximately 7.4km of the overall route. The proposals are summarized in Section 2.3 of the Feasibility Study.

Suggested objectives at Feasibility Stage

The objectives at Feasibility Stage should be to obtain geological, hydro-geological and geotechnical information to inform the preliminary design of each tunnel and to derive preliminary design parameter values. At the location of each of the proposed tunnels the following information (as a minimum) should be obtained:

- Definition of the subsurface ground model. This would typically comprise stratigraphy, structure and principal rock and soil types;
- Determination of rock properties, both for intact rock and also for the rock mass, on the alignment of each tunnel;
- State of weathering of rock;
- Definition of hydro-geological conditions including groundwater levels, presence of aquifers and measurement of rock mass permeability.
- Seismicity;
- In-situ stress conditions;
- Identification of potential geotechnical and hydro-geological risks to construction.

The above objectives may be achieved by a number of methods and techniques including:

- Walkover surveys and geological mapping of surface exposures;
- Desk study of available data;
- Vertical or inclined boreholes to identify the subsurface stratigraphy, and to obtain disturbed and undisturbed samples for visual classification and laboratory testing

(although noting that the depth of some tunnels may limit the feasibility of vertical borings);

- Horizontal boreholes (the relatively short lengths of the tunnels provides potential opportunity for continuous horizontal boring along the full length of all tunnels, although this may be limited by poor ground conditions and the stability of boreholes);
- In situ tests to obtain engineering and index properties and rock mass characteristics;
- Geophysical tests to obtain subsurface information (stratigraphy and general engineering characteristics) over a large area to help define stratigraphy and to identify appropriate locations for performing borings (although noting that the depth of the tunnels may limit the effectiveness of some of these techniques in some locations);
- Laboratory testing providing a wide variety of engineering properties and index properties from representative rock cores retrieved from the borings.

In the context of tunnelling through rock the following information should be obtained:

- Unconfined compressive strength of intact rock, intact rock modulus and intact bulk unit weight;
- Triaxial compressive strength and modulus of intact rock;
- Abrasiveness (Cerchar Abrasivity Test);
- Hardness;
- Fracture toughness;
- Punch penetration (to inform excavatability);
- Point Load Index and Brazilian test (tensile strength);
- Petrographic analysis (providing information on microfracture, anisotropy, mineral hardness, grain size and shape);
- Slake durability (in certain weaker rock types only).

Interpretation of the data should be undertaken to provide a preliminary classification of the rock mass quality along the length of each tunnel, together with other design data such as estimated rock mass permeability and groundwater inflow predictions, and the potential for overstressing of the rock around a tunnel (i.e. 'squeezing' potential). This information is typically presented on a longitudinal geological section of a tunnel. It is suggested that rock mass quality is presented in terms of the Norwegian Geotechnical Institute (NGI) Q System, as this is considered to be the most useful classification system for the preliminary design of rock tunnels.

Estimates of the Geological Strength Index (GSI), provides a means of estimating rock mass strength parameters which can then be used for preliminary investigations of squeezing potential.

Best estimates of the rock mass structure should be prepared from consideration of field mapping at the ground surface and joint orientation estimates from borehole cores (possibly using core orientation techniques in the field). The orientations of the principal rock joint sets should be identified for preliminary investigation of rock wedge stability in the hard, blocky rock sections of the tunnels.

The interpreted ground model and associated ground investigation points are represented in the long section drawings. The intrusive investigation comprises boreholes at the proposed entrances of each tunnel. There are no intrusive investigation points within any of the tunnels. The drawings are not accompanied by a narrative and it is therefore not clear as to how the interpretation has been made. However, Section 2 of Volume 2.3 of the Feasibility Study states, that geological maps at scales of 1:200,000 and 1:50,000 have been consulted. It is therefore assumed, that the ground model shown in the drawings has been based on a combination of these maps and the limited intrusive investigation. The Feasibility Study must, however, indicate how the model has been developed.

Table 6 summarizes the available information for each tunnel

Tunnel	Chainage	Length (m)	Intrusive information	Prevailing soil/rock type
Lazaret Nord	19+180 to 20+240	1060	One borehole at each portal only, Nos. FR 25 and FR26	Mica-gneiss
Lazaret Sud	20+370 to 20+700	330	One borehole at each portal only, Nos. FR 26 and FR27	Mica-schist
Caineni A (north)	26+390 to 26+940	550	One borehole at north entrance No. FR35.	Gneiss/amphibolite/marble
Caineni B (open earthworks)	26+940 to 27+080	140	No GI available.	Gneiss/amphibolite/marble
Caineni C (south)	27+080 to 27+980	900	One borehole at south entrance No. FR36.	Gneiss/amphibolite/marble
Robesti	30+550 to 31+450	900	One borehole at each portal only, Nos. FR 39 and FR40	Gneiss
Balota	35+745 to 36+200	455	One borehole at each portal only, Nos. FR 47 and FR48	Gneiss/amphibolite
Poiana	55+135 to 56+835	1700	One borehole at each portal only, Nos. FR 75 and FR76	Possible marl, possible weathered metamorphic.
Curtea de Arges	80+800 to 82+150	1350	One borehole at each portal only, Nos. FR 103 and FR104	Marl, Shale

Table 6, Summary of geotechnical information at tunnel locations.

Review of available information

From the initial geotechnical review, it is considered that the information presented so far does not adequately inform the Feasibility Study. It is considered that the preliminary design of the tunnels could not proceed on the current level of information. The shortcomings are summarized as follows:

- Lack of intrusive investigation within interior of proposed tunnels. Eurocode 7 suggests spacing of boreholes at 20m to 200m for tunnels. For example, the Poiana Tunnel would require an absolute minimum of 8 boreholes. In reality the spacing of boreholes is likely to be much smaller since the Feasibility Study information suggests a complex geological setting where local investigation of faults, fractures and jointing may be required;

- Geological information has been interpreted from large scale maps (1:50,000 and 1:200,000). Whilst this is useful for providing the regional geological setting, more localised information is required for individual tunnels;

- Hydro-geological conditions are poorly defined;

- No in-situ test data was provided to complement the boreholes;

- No laboratory test data was provided to complement the boreholes;

- No geophysical information was obtained – this could greatly enhance the ground model;

- No geotechnical risk register was presented and only minor references to hazards provided.

Conclusion

The Feasibility Study should provide enough information and preliminary interpretation of ground conditions to allow progression to the "Technical Project" stage as defined in NP074-2007 clause 2.2.

The Terms of Reference published as part of June 2012 tender process included a high level specification for ground investigations, detailing testing etc. The June 2012 ToR provided coordinates for the boreholes to be executed and specified the depth of each borehole. It is noted that such an approach to a detailed specification for ground investigation transfers the entire risk for adequacy of GI data to the Employer (RNCMNR) which in our opinion, is not in line with best practice and not desirable. Also, the inclusion of sections of text copied from various norms and standards within the June 2012 does not bring additional value to the document as it simply repeats information that the competent designers should be aware of. The main risk with such an approach relates to potential omissions within the ToR, an aspect, which may lead to an incomplete GI report, a risk that according to June 2012 ToR would have been entirely transferred to the RNCMNR.

In our opinion, a robust set of technical terms of reference needs to include the minimum level of investigation required for each category of works such as tunnels, structures, embankment and cuttings, with relevant cross references to the Eurocode 7. The ToR should require the Consultant to compile and submit to the Employer the list of applicable standards and norms to be used in the geotechnical design and a detailed proposed specification for ground investigation works. This approach would minimise the risk of commencement of the design based on incorrect assumptions, standards or inadequate levels of ground investigation works specified.

At present the Feasibility Study has many Gaps in terms of geotechnical information. A number of issues must be addressed within the study and these are summarised, as follows:

Desk study and survey information

In general, it is concluded that there is insufficient information to properly assess the economic and environmental feasibility of the proposed route. An extensive desk study is required, where geological, hydro-geological and geotechnical information is collated to enable an informed assessment of each element of work. The level of ground investigation is generally poor. Borehole coverage is inadequate and no field or laboratory tests have been made available. Whilst a preliminary ground model can be inferred for some elements of work, it is impossible to deduce any design parameters from the information available.

Embankments

- *Further development of the ground model is required as many of the proposed embankments have insufficient ground information;*
- *Clarification of preliminary soil parameters as set out in Table 2;*
- *Clarification of design philosophy is required particularly with respect to STAS 2914-84, particularly for stability.*

Cuttings

- *Inadequacy of GI info for cuttings, particularly areas of rock cutting;*
- *Preliminary assessment of stability of cuttings (soil and rock);*
- *Clarification of design philosophy particularly with respect to STAS 2914-84;*
- *Re-use of arisings from cuttings to form embankments.*

Reinforced earth

- *Clarification on choice of solution at the 13 cutting locations;*

- *Clarification on buildability of reinforced earth, where geogrids appear to be embedded within slope faces.*

Structures

- *Further development of the ground model as many of the proposed structures have no ground information;*
- *Derivation of preliminary design parameters to allow preliminary foundation design.*

Tunnels

- *A more comprehensive desk study is required with smaller scale geological maps and perhaps historical boreholes;*
- *Intrusive investigation was limited to tunnel portals and therefore provides little insight to the nature of rock within tunnel interior.*

Table 1: Register of GI for Embankments

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E1	0-440	440	3.3	FR1 @ Ch 0 FR2 @ Ch 440	Adequate for preliminary design only.
E2	440-600	160	1.0	FR2 @ Ch 440	Adequate for preliminary design only.
E3	880-1040	160	6.7	SR2	Depth of SR2 is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E4	1560-2660	1100	5.7	SR4, SR5, SR6, SR7	Depth of boreholes is inadequate for preliminary embankment design. Borehole spacing is >200m. Ground model is not fully defined at this location.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E5	3490-5280	1790	6.3	SR10, SR11, SR12, SR13	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E6	6540-7080	540	4.1	SR16, SR16B	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E7	7280-7780	500	7.8	SR17, SR18	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E8	8080-8120	40	3.4	FR9	Adequate for preliminary design only.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E9	8800-9800	1000	7.6	SR20	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E10	10000-10300	300	2.8	SR21, FR11	Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E11	10460-11130	670	7.6	FR12, FR13	Additional boreholes required as spacing is too great to define preliminary ground model. Ground model is not fully defined at this location.
E12	12600-12760	160	2.0	FR16	Adequate for preliminary design only.
E13	13100-13280	180	4.4	SR24	Adequate for preliminary design only.
E14	14740-14920	180	3.8	None	GI needed to enable preliminary design.
E15	15060-15220	160	5.1	FR20	Adequate for preliminary design only.
E16	17100-17240	140	4.6	None	GI needed to enable preliminary design.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E17	21000-21150	150	6.2	SR30	Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E18	21170-21280	110	4.1	SR30	Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E19	21740-21840	100	4.9	None	GI needed to enable preliminary design.
E20	23960-24180	220	4.8	None	GI needed to enable preliminary design.
E21	24300-24440	140	2.6	None	GI needed to enable preliminary design.
E22	24480-24540	60	5.2	None	GI needed to enable preliminary design.
E23	24600-24720	120	1.0	None	GI needed to enable preliminary design.
E24	24800-24980	180	7.6	FR41	Adequate for preliminary design only.
E25	31650-31820	170	1.0	FR33	Adequate for preliminary design only.
E26	32250-32380	130	5.7	None	GI needed to enable preliminary design.
E27	35230-35340	110	3.2	SR43	Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E28	35650-35750	100	7.8	None	GI needed to enable preliminary design.
E29	36900-37730	830	6.8	FR50	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E30	37350-37420 (within structure)	70	5.0	None	GI needed to enable preliminary design.
E31	38620-39340	720	5.5	FR52, FR53, FR54	Adequate for preliminary design only.
E32	39650-40580	930	6.0	FR55, FR56	Additional boreholes required as spacing is too great to define preliminary ground model.
E33	40750-41600	850	6.1	SR45, SR46, SR47	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E34	41700-41800	100	1.7	None	GI needed to enable preliminary design.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E35	41900-42200	300	4.7	SR48	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E36	42250-43800	1550	6.2	SR49, SR50, SR51	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E37	47200-47300	100	4.9	SR56	Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E38	52700-53320	620	6.1	SR63	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E39	53500-53860	360	10.5	SR64, FR74, SR65	Adequate for preliminary design only.
E40	56930-57040	110	2.5	None	GI needed to enable preliminary design.
E41	62100-62150	50	2.9	None	GI needed to enable preliminary design.
E42	62360-62520	160	6.7	SR80	Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E43	63330-63440	110	3.3	SR82	Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E44	63740-63800	60	4.2	None	GI needed to enable preliminary design.
E45	64720-64900	180	5.3	FR86	Adequate for preliminary design only.
E46	65100-65360	260	7.4	SR85	Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E47	65970-67560	1590	7.0	FR88, FR89	Additional boreholes required as spacing is too great to define preliminary ground model. Ground model is not fully defined at this location.
E48	67710-68900	1190	5.5	FR90	Additional boreholes required as spacing is too great to define preliminary ground model.
E49	69080-69780	700	5.7	FR91, FR92	Additional boreholes required as spacing is too great to define preliminary ground model.
E50	69930-70700	770	5.5	SR93, FR93, SR94	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E51	70920-71520	600	6.0	SR95, SR96	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E52	72380-74120	1740	5.1	SR98, SR99, SR100, SR101, FR96	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E53	74320-75470	1150	5.9	SR103, FR97, SR104, SR105	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E54	75600-76240	640	7.0	SR106	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E55	76470-76820	350	8.4	FR99	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E56	77600-78480	880	2.7	SR110, FR101A	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E57	78640-78860	220	7.9	SR103bis, SR104bis	Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E58	78860-79140	280	7.4	none	GI needed to enable preliminary design.
E59 (STR??)	82320-82450	130	6.5	FR104	Adequate for preliminary design only.
E60	82600-82830	230	4.9	none	GI needed to enable preliminary design.
E61	83230-83320	90	3.5	none	GI needed to enable preliminary design.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E62	84000-84100	100	1.4	none	GI needed to enable preliminary design.
E63	84270-84340	70	3.9	SR112	Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E64	84800-84940	140	5.8	none	GI needed to enable preliminary design.
E65	85280-85850	570	7.5	SR113	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E66	86550-87000	450	4.3	none	GI needed to enable preliminary design.
E67	87570-88100	530	4.2	SR118, SR118bis	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E68	88100-91150	3050	6.9	SR119, FR110, Sr120, SR121, FR111, Sr122, Sr123	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E69	91580-92680	1100	6.3	SR124, SR125	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E70	92760-94680	1920	5.3	SR126, SR127, SR129bis	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E71	94700-95050	350	5.7	FR114	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E72	95550-98250	2700	6.3	SR130, FR115, Sr131, SR132, FR115B	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E73	100070-101600	1530	5.5	SR136bis, FR118, Sr137	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E74	101600-104100	2500	6.5	SR138, FR120, SR139, SR139B	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E75	104500-104690	190	6.2	none	GI needed to enable preliminary design.
E76	104720-105400	680	5.0	FR121B, SR140	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E77	105600-105750	150	6.4	none	GI needed to enable preliminary design.
E78	106870-108200	1330	6.4	FR124, SR144, SR145	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E79	108300-108750	450	4.7	none	GI needed to enable preliminary design.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
E80	109200-109750	550	6.9	SR147	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.
E81	109980-116650	6670	3.8	SR148, SR149, SR150, Fr127, SR151, FR128, SR152, Sr153, SR154, SR155, FR129, Sr156, SR157, SR158, FR129, FR130	Additional boreholes required as spacing is too great to define preliminary ground model. Depth of boreholes is inadequate for preliminary embankment design. Ground model is not fully defined at this location.

Table 4 Register GI for cuttings

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
C1	600-880	280	2.0	SR1	Adequate for preliminary design only.
C2	2660-2920	260	4.0	SR8, FR4	Adequate for preliminary design only.
C3	2920-3490	570	2.9	FR4, SR9, SR10	Adequate for preliminary design only.
C4	6100-6220	120	10.0	SR15	A deeper borehole is required to extend below base of proposed cutting and enable definition of ground model.
C5	6320-6540	220	1	SR16	A second borehole is required at the north end to enable definition of the ground model.
C6	7780-8080	300	7.6	SR12, FR9	Both boreholes lie outwith the footprint of the cutting – a further borehole is required within cutting footprint.
C7	11630-11950	320	19m rock cutting with anchors. Reinforced earth structure.	SR22	A second borehole is required at the north end to enable definition of the ground model.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
C8	12100-12260	160	13.4 (TBC)	FR15	A second borehole is required at the south end to enable definition of the ground model.
C9	12880-13100	220	7.0	None	GI needed to enable preliminary design.
C10	13700-14040	340	TBC	FR17, FR18	Adequate for preliminary design only.
C11	14260-14600	340	TBC	SR24bis, FR19	A deeper borehole is required at north end to extend below base of proposed cutting and enable definition of ground model.
C12	15340-15610	270	3.9	SR25	A second borehole is required at the south end to enable definition of the ground model.
C13	15680-15920	240	1.0	FR21	A second borehole is required at the north end to enable definition of the ground model.
C14	16340-16640	300	7.6	FR22	A second borehole is required at the north end to enable definition of the ground model.
C15	16960-17000	40	1.0	None	GI needed to enable preliminary design.
C16	17060-17100	40	2.5	None	GI needed to enable preliminary design.
C17	17240-17440	200	6	FR23	Adequate for preliminary design only.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
C18	17850-18480	630	TBC	SR28, FR24	Both boreholes lie outwith the footprint of the cutting – a further borehole 2 boreholes are required within cutting footprint.
C19	18820-19060	240	TBC	SR29, FR25	Both boreholes lie outwith the footprint of the cutting – a further borehole is required within cutting footprint.
C20	21280-21740	460	5.4	None	GI needed to enable preliminary design.
C21	22140-22770	630	TBC	SR31, FR29	Spacing of boreholes is too great and a further borehole is required to determine preliminary ground model.
C22	22900-23280	380	TBC	None	GI needed to enable preliminary design.
C23	23340-23720	380	TBC	None	GI needed to enable preliminary design.
C24	25300-26000	700	TBC	SR33	Spacing of boreholes is too great and further 3 boreholes of adequate depth are required to determine preliminary ground model.
C25	28580-28810	230	TBC	None	GI needed to enable preliminary design.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
C26	29560-29950	390	TBC	FR38	A second borehole is required at the north end to enable definition of the ground model.
C27	29960-30150	190	7.8	SR37	A deeper borehole is required to extend below base of proposed cutting and enable definition of ground model.
C28	30160-30220	60	7.5	None	GI needed to enable preliminary design.
C29	30230-30540	310	TBC	SR38, FR39	A deeper borehole is required at north end to extend below base of proposed cutting and enable definition of ground model.
C30	31460-31630	170	8.0	FR40	Adequate for preliminary design only.
C31	31380-32050	220	1.0	None	GI needed to enable preliminary design.
C32	32560-32920	360	TBC	FR43, SR39	Adequate for preliminary design, if FR43 is included.
C33	32930-33420	490	6.7	SR40	A deeper borehole is required at north end to extend below base of proposed cutting and enable definition of ground model.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
C34	33580-34240	660	7.9	FR44, SR41	A deeper borehole is required at south end to extend below base of proposed cutting and enable definition of ground model.
C35	34540-34860	320	TBC	SR42	A deeper borehole is required at south end to extend below base of proposed cutting and enable definition of ground model.
C36	34880-35190	310	6.6	FR46	An additional borehole to the north of FR46 is required to allow determination of preliminary ground model.
C37	39340-39630	290	TBC	None	GI needed to enable preliminary design.
C38	44380-44470	90	8.2	FR58	Adequate for preliminary design only.
C39	44570-44620	50	TBC	None	GI needed to enable preliminary design.
C40	44800-44950	150	1.0	FR60	Adequate for preliminary design only.
C41	45150-45330	180	TBC	FR62	Adequate for preliminary design only.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
C42	45420-45860	440	6.6	SR53	A deeper borehole is required at south end to extend below base of proposed cutting and enable definition of ground model.
C43	46270-47200	930	9.2	SR55, SR56	A further 5 boreholes of adequate depth are required to allow determination of the preliminary ground model.
C44	47740-47880	140	1.0	None	GI needed to enable preliminary design.
C45	48320-48520	200	TBC	None	GI needed to enable preliminary design.
C46	48930-49120	190	TBC	None	GI needed to enable preliminary design.
C47	49280-49370	90	TBC	None	GI needed to enable preliminary design.
C48	49520-49840	320	6.1	FR68, FR69	Adequate for preliminary design
C49	50280-50470	190	TBC	None	GI needed to enable preliminary design.
C50	50580-51180	600	TBC	FR71, FR72	A deeper borehole is required at south end to extend below base of proposed cutting and enable definition of ground model.
C51	51180-52700	1520	TBC	SR60, SR61, SR62	A further 8 boreholes of adequate depth are required to allow determination of the preliminary ground model.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
C52	53860-55100	1240	TBC	SR65, SR66, SR67, SR68, FR75	Adequate for preliminary design only.
C53	56830-56930	100	TBC	FR76	Adequate for preliminary design only.
C54	57040-57740	700	2.4	SR69, SR70	Spacing of boreholes is too great and a further borehole is required to determine preliminary ground model.
C55	58230-58290	60	5.5	None	GI needed to enable preliminary design.
C56	58470-58710	240	TBC	SR73	Spacing of boreholes is too great and a further borehole is required to determine preliminary ground model.
C57	58870-58960	90	TBC	None	GI needed to enable preliminary design.
C58	59110-59220	110	6.5	SR75	Adequate for preliminary design only.
C59	59420-59570	150	TBC	None	GI needed to enable preliminary design.
C60	60010-60230	220	6.6	None	GI needed to enable preliminary design.
C61	60650-60780	130	1.0	None	GI needed to enable preliminary design.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
C62	60930-61280	350	TBC	SR79	A deeper borehole is required at south end to extend below base of proposed cutting and enable definition of ground model.
C63	61330-61770	440	TBC	None	GI needed to enable preliminary design.
C64	62320-32360	40	2.7	None	GI needed to enable preliminary design.
C65	62520-63300	780	TBC	SR81, FR84	A deeper borehole is required at south end to extend below base of proposed cutting and enable definition of ground model.
C66	63440-63740	300	7	SR83	Additional 2 boreholes required at to define ground model.
C67	64020-64260	240	4.1	FR85	Additional borehole required at south end to define ground model.
C68	64900-65120	220	2.3	None	GI needed to enable preliminary design.
C69	76940-77240	300	1.9	SR108, SR109	Adequate for preliminary design only.
C70	78480-78640	160	3.5	SR103bis	Adequate for preliminary design only.

Emb No.	Chainages	Length (m)	Hmax (m)	GI info	Comments on ground investigation
C71	79800-80800	1000	TBC	FR102, SR107B, FR103	A further 3 boreholes within the centre of the cutting are required to adequately determine the preliminary ground model.
C72	82140-82320	180	TBC	None	GI needed to enable preliminary design.
C73	82460-82600	140	TBC	None	GI needed to enable preliminary design.
C74	83320-83930	610	TBC	FR105, SR109B	Additional borehole required at south end to define ground model.
C75	84340-84800	460	6.5	FR106, FR107	Adequate for preliminary design
C76	84940-85280	340	9.8	FR108	Additional borehole required at south end to define ground model.

4.1.2.1.14 Volume 8 – Environmental Impact and Volumes Presented as part of the additional/revised environmental studies/documents revision 1/2011

Environmental Impact Assessment (EIA)

Introduction

The Gap Analysis Report on the Environmental Impact Assessment (EIA) for the Sibiu – Pitesti motorway was conducted following a review of the requirements outlined in Order no. 863/2002 on approval of the methodological guidelines applicable to the stages of the environmental impact assessment framework procedure, the control list for report review of the mentioned order, JASPERS European Regions Sectoral EIA Guidelines (Motorway and Road Construction Projects), the Guidelines issued by the National Environmental Protection Agency and established best practice.

The Sibiu – Pitesti motorway is one of the most complex projects in Romania and will include the construction of 7 tunnels (approximately 1700 m cumulative length), over 100 structures representing approximately 27% of the route length, many retaining structures and cuttings in difficult terrain conditions. The motorway route traverses a difficult terrain and follows closely the chain of rivers, Olt, Topolog and Arges. Furthermore the proposed route will meet a number of protected areas, aspect that in addition to the terrain constraints raises the complexity level for this major capital investment project.

The Gap Analysis included a review of the following available data:

- Volume 8.1 – Environmental Impact
- Volume 8.2 – Report of the Environmental Impact Study
- Volume 8.3 – Environmental Impact Assessment Study – Drawings
- Volume 8.4 – Environmental Impact Assessment Study – Annexes
- Volume 8.5 – Environmental Impact Study Non – Technical Report
- Volume 8.6 – Environmental Impact Assessment Study – Public Consultations

Additional/revised Environmental studies/documents revision 1/2011

- Volume 1/7 – Documentation for Environmental Agreement release
- Volume 2/7 – Report of the Environmental Impact Assessment Study – Vol. 1
- Volume 3/7 – Report of the Environmental Impact Assessment Study – Vol. 2
- Volume 4/7 – Report of the Environmental Impact Assessment Study – Vol. 2 Drawings
- Volume 5/7 – Report of the Environmental Impact Assessment Study – Non – Technical Report
- Volume 6/7 – Report of the Environmental Impact Assessment Study – Non – Technical Report
- Volume 7/7 – Relevant Correspondence, permits, Agreements for Environmental Agreement

Findings from EIA Report review

General findings

The information presented in the report is extensive but poorly structured and correlated.

A review of references to legal requirements in line with the latest changes will be necessary.

The EIA Report will require updating in order to include the additional five kilometres between Vestem and the existing Sibiu bypass, as well as other local route realignments.

In order to ensure compliance with the Environmental Protection Agency Order no. 863/2002, Methodology for the development of the EIA report, the revised EIA should include specific maps or location plans to cover key environmental factors as detailed below.

- ***Water:***
  - location plans indicating the water sources and water supply network for:
    - construction stage – site compound;
    - operation stage – service areas, parking and rest areas and maintenance centres;
  - location plans showing the waste water treatment plant for:
    - construction stage – site compound
    - operation stage – service areas, parking and rest areas and maintenance centres;
  - location plans showing the waste water outfall points for:
    - construction stage
    - operation and maintenance stage
  - location plans showing areas of sanitary protection and the perimeters of hydrologic water protection

- ***Air***

  - location plan showing the analyzed perimeter and location of pollution sources and sensitive receptors

  - maps or charts showing the concentration of specific pollutants; group of pollutants and cumulative effects (dispersion study) for:

    - construction stage
    - operation and maintenance stage

The air quality impact will be assessed based on the estimated volumes of works as well as forecasted traffic generated during construction stage and operation stage.

- ***Soil:***

  - diagrams of the area indicating the dominant soil types within the area traversed by the motorway;

  - plans or diagrams showing the areas of top soil removal and or cuttings;

  - plans or diagrams showing the locations for storage sites (storage of reusable materials)

The specific local environmental impacts on water, air, soil, biodiversity and population, as follows:

- During construction stage: impacts relating to site compound and borrow pits proposed in the design;
- During operation stage: impacts relating to service areas and maintenance centres.

The impact of the traffic generated by the transport of construction materials, during the execution of works, from their source to the construction site location was not considered in the Feasibility Study. Also the impact on the existing road network due to construction traffic was not assessed. Due to this the associated impacts were not assessed.

There was no information on the transport of raw materials from source, the consequential increase in traffic and the possible transport routes to be taken, thus, the impact of transporting raw materials (in terms of air, noise and vibration) could not be assessed.

The impact on the population affected by demolition of houses and the number of persons affected was not clarified. Such analysis should include:

- relocation of families affected by the proposed works;
- impact generated by demolition of properties;
- estimates relating to number of jobs created or loss of jobs caused by the project implementation.

The impact on the environment is treated general, with no specific references on sensitive areas (e.g. residential areas, protected areas, etc.). Consequently, there are no local/specific mitigation measures for the impacts generated by the proposed works, specified for each receptor. Such measures would include:

- sensitive areas: residential, protected areas, rivers
- mitigation measures aimed to reduce the specific impacts on each river, stream ground water, protected areas or population.
- Information on baseline environmental conditions (initial situation).

General Information Chapter

There is no information relating to the efficient use of raw materials.

Information relating to the specific activities required to operate the highway (e.g. maintenance and repair) was not provided, although the drawings for facilities such as Maintenance and coordination centres were included.

There was no information on the resettlement of the population or businesses (number or other characteristics of the displaced population).

There are no details relating to riverbed recalibration (diversions), hydro-technical design of culverts, design of torrents (works location, works description, etc.). There is no information on the impact of the mentioned works on surface waters (e.g. where watercourse diversions are required to place a bridge pile in a watercourse, etc.)

There is no information on the location of rainwater discharge points from the road structures or requirements for attenuation and limitation of discharge rates including treatment of surface water before outfall.

Findings regarding noise and vibrations:

The baseline conditions were note established. The impact of the explosives used for construction of the tunnels (noise and vibrations – estimated values) was not considered.

The methods for estimating the noise resulting from different activities on the construction site are not specified.

The method for estimating the noise levels during operation is not described. The report does not include estimated vibration levels and as a consequence does not provide specify mitigation measures for impacts on fauna and population.

The details relating to the impact of vibrations are general and insufficient. No estimation of the vibration levels and no specific impact reduction measures are presented. The report should include noise reduction measures during construction provide maximum allowable noise values, particularly for the protected areas.

There are no details provided which reflect the positive impact of the project (e.g. the positive impact due to traffic diversion from the residential areas, economic growth etc.).

Technological Processes Chapter

Within this chapter the potential impact, nature and extent of environmental impacts estimated for the operation period of the highway are presented in a summarised tabular form. This table includes only the positive aspects of highway operation and overlooks negative impacts on environment, such as:

- Negative impact by blocking access to lands, jobs, etc;
- Accidents;
- Negative impact from air pollution due to traffic;
- Negative impact from high noise levels in the vicinity of the highway; and
- Negative impact on biodiversity by dividing the habitats, etc.

The report mentions that the access to the motorway within Natura 2000 sites will be achieved using existing forest roads. The exact location of the site compounds and the borrow pits are not discussed and as a consequence the actual routes for transport of materials were not presented within the report. As highlighted within the Highways section of this report, no allowance for temporary occupation of land was included in the existing Feasibility Study and no identification of abnormal load transport routes was discussed. Consequently the impacts on biodiversity due to traffic within the designated protected areas were not considered.

Waste Chapter

There are no estimations of volumes/quantities of unsuitable materials resulting from excavations and no details relating to the disposal of these wastes. As confirmed within the Geotechnical section of this report a mass haul diagram was not included within the existing study.

It is expected that a Waste Management Plan would be included within the updated EIA report. This aspect will be clarified within the revised ToR.

Water Chapter

There is no information relating to the current status (baseline conditions) of water streams, the chemical composition and pollutant concentration (chemical analysis reports) of the water table within the are affected by the project.

No specific information relating to the provision of the required volumes of water during construction stage or maintenance and operation stage, was included in the existing EIA.

No information relating to the intended water supply method was described. This could have included wells or connection to an existing water supply network.

The chapter should be updated with specific information relating to the quantitative characteristics of the water sources required for the supply of the service areas or maintenance centres, information on used water quality (chemical analysis), motivation of the proposed method for water supply and improvement measures for water supply for site organisation (proposed locations).

It is mentioned within the report that the project will require no water supply during the operation period. However, within the highway facilities chapter it is specified that the maintenance and coordination centres and the short-term parking will by supplied with water from wells equipped with pumping stations. This aspect is treated as a discrepancy and will require clarification as part of the updated EIA.

Only general information is provided relating to wastewater management during the construction period as well as operation and maintenance. No specific impacts and mitigation measures are presented.

It is recommended that a wastewater management sub-chapter is included within the revised EIA report which should provide as minimum information relating to:

- discharged wastewater quantities;
- physico-chemical characteristics;
- wastewater collection systems;
- location of the treated/untreated wastewater discharge;
- pre-treatment and/or treatment facilities; and
- receptors for the directly discharged or treated wastewater.

The impact on surface water and streams generated by the hydro-technical works was not assessed in accordance with the Water Framework Directive. Based on the information provided within the existing Feasibility Study the following crossings over existing streams were identified:

- approx. Ch.1+000m, crossing over Valea Saraturii (stream);
- between Ch.5+000m and 6+000m, crossing over Sadul River (triple crossing);
- approx. Ch.10+400m, crossing over Olt River;
- approx. Ch.11+000m, crossing over Olt River;
- approx. Ch.17+500m, crossing over Olt River;
- approx. Ch.18+800m, crossing over Olt River;
- approx. Ch.19+200m, crossing over Lotrioara stream;
- approx. Ch.20+700m, crossing over Olt River;
- approx. Ch.21+300m, crossing over two streams;
- approx. Ch.22+000m, crossing over Valea Curpenului stream;

- approx. Ch.23+400m, crossing over stream;
- approx. Ch.26+000m, crossing over Olt River;
- approx. Ch.28+000m, crossing over Olt River;
- approx. Ch.29+000m, crossing over Valea Satului stream;
- from around Ch.40+000m until 45+000m the project crosses several small water courses (possible non-permanent); the project crosses the stream formed in Baiasului Valley several times;
- between Ch.45+000m and 63+000m the project crosses several small water courses (possible non-permanent); no information on the impact of the crossings was identified;
- approx. Ch.64+500m, crossing over Topolog River;
- approx. Ch.65+500m, crossing over the river mouth formed by the stream from the Surlelor Valley;
- between Ch.67+500m and 78+000m the project crosses the Topolog River several times; no information on the impact of the crossings was identified (separately or cumulatively);
- approx. Ch.87+000m, crossing over Arges River;
- approx. Ch.91+100m, crossing over Arges River;
- between Ch.91+500m and ch.100+000m the project crosses the Arges River and an arm of the Arges River several times; no information on the impact of the crossings was identified (separately or cumulatively);
- approx. Ch.104+000m, crossing over Valsanu River;
- approx. Ch.105+500m, crossing over Valsanu River; and
- approx. Ch.106+000m, crossing over channel between Valcele Lake and Budeasa Lake.

Details in the Report relating to the works and structures, which shall affect water streams, are poorly structured and difficult to follow.

The impact of the hydro-technical works (separately and cumulatively) on each surface water stream or river (e.g. Olt River, Arges River, etc.) and any associated mitigation measures, were not presented.

The EIA should assess hydro-technical works and their impact on existing rivers or streams, and should also consider the cumulative impacts in accordance with the article 4 (7) of the Water Directive.

Air Chapter

There are no methods provided to determine the levels of pollutants discharged into the atmosphere (e.g. US EPA/AP-42 methodology, EEA/EMEP/CORINAIR methodology).

Soil Chapter

There is no information relating to the baseline conditions for the soils (no chemical analysis reports), biological activity or levels of pollution in the project area. Such requirements shall be captured within the Ground Investigation section of the revised ToR.

No pollutant quantities/concentrations were estimated. Particular reference should have been included to the settlement of pollutants from air (SO2, NOx and heavy metals). These pollutants are to be assessed for both construction stage and maintenance and operation stage.

No information is provided on the quantities of top soil or other materials resulting from cuttings required to be removed during the various stages of project implementation or the re-use or disposal of this material.

Geology Chapter

The estimated impact on geology is generally discussed. It should include information on direct impact on geological components and the impact of the changes in the geological environment on the environmental elements i.e. hydro geological conditions.

The chapter does not include specific impact mitigation measures for existing ground.

Biodiversity Chapter

The data related to mammal species is generic and was derived from data available within literature only. No data obtained through site surveys or monitoring was included. Furthermore, the data presented relates to Natura 2000 sites only.

This chapter should be finalised in conjunction with the Appropriate Assessment summary/conclusions.

No information is provided on the number and density of fauna, level of isolation, age structures, habitats dynamic and the species from the impacted natural areas dynamic.

The impact on biodiversity due to water sources and water quality changes covers the Natura 2000 sites only.

There are discrepancies related to the areas of forest land to be removed. More details are discussed within section 4.1.2.1.15 of this report.

Monitoring Chapter

No specific details were provided on sampling/observation locations and monitoring frequency of the environmental aspects such as noise, air, soil and biodiversity, during construction and motorway operation.

Risks Chapter

No information on risks resulting from the handling and use of substances with a high risk of explosion and fire (explosives and fuel).

It is recommended this chapter should include a risk analysis relating to the potential for accidents, plans for risk situations, accidents response procedures and a comparative risk analysis summary for each project alternative.

The revised EIA report shall include but not limited to the following:

- the additional five kilometres link to the existing Sibiu bypass, as well as any other local route re-alignments.
- references to the latest relevant legal requirements.
- maps and diagrams for each key environmental impact category.

The EIA report should include an evaluation matrix for both positive and negative impacts generated by the Sibiu – Pitesti project implementation. The matrix should propose the specific mitigation measures.

Conclusions and recommendations

Generally the report follows the structure imposed by the Order no. 863/2002. However the information presented in the report is too generic and poorly structured and correlated.

The EIA report will require a complete update in order to incorporate the latest version of the motorway alignment that will include the additional five kilometres link to the existing Sibiu bypass.

The report assessment was conducted following the recommendations of the JASPERS European Regions Sectoral EIA Guidelines (Motorway and Road Construction Projects) and the Guidelines issued by the National Environmental Protection Agency.

The updated EIA report shall include graphical elements such as maps, layout drawings and charts in accordance with the current legal requirements.

The EIA report should address as minimum the gaps identified within this report.

It is important that informed decision is being made by the Environmental Agency. In order to enable this, the revised EIA should identify impacts and mitigation measures that are as specific as possible. Thus, the updated EIA should include an evaluation matrix for both positive and negative impacts generated by the construction of Sibiu – Pitetsi motorway.

It is recommended that the final version of the EIA Report is completed after issuance of the Natura 2000 permit. This approach will enable the capturing of the results and recommendations included within the Appropriate Assessment report.

Appropriate Assessment

Introduction

Introduction to the Gap Analysis

This report aims to show the data Gaps in the existing Appropriate Assessment (AA), also known as Habitats Directive Assessment (HDA) for the construction of the Sibiu-Pitesti motorway in Romania. The Appropriate Assessment report reviewed was downloaded from the web link below which was provided within JASPERS Terms of Reference.

http://www.anpm.ro/upload/62753_StudiulEA_AutostradaSB_Pitesti.pdf

Some omissions apply to the AA report as a whole. These are as follows:

- A table of contents would help the reader to see the contents of the report and check the inclusion of all necessary elements for quality assurance purposes;
- The overall length of the report is too long. Detailed background information on species, habitats and Natura 2000 sites could be moved to an appendix and summarised in the main report. The impact matrices could also be moved to an appendix and summarised in the main report.
- Greater use of mapping to show route alignment options, Natura 2000 sites and predicted impacts would be beneficial;
- There should be a more robust methodology of the impact assessment itself, which refers to EC and Romanian HDA guidance – not just the methodology for collection of information on species and habitats (Chapter F);
- The current methodology in Chapter F should describe in greater detail the requirements for collection of data on all relevant qualifying interest habitats and species, e.g. carnivores and provide recommendations for further survey where Gaps exist;
- References to the positive or negative aspects of the development that do not specifically relate to the qualifying interests of Natura 2000 sites are not necessary to include in the AA;
- Other Natura 2000 sites may need to be included for consideration, e.g. Piemontul Făgăraş (ROSPA0098) and Platforma Cotmeana SCI (ROSCI0354)
- Details of formal or informal consultation in the development of the AA need to be provided;

- Further description regarding the next steps in the HDA process, including further ecological survey requirements, need to be provided; and

- The references at the end of the document are incomplete (some references in the body text are not repeated in the references);

There are also omissions that apply to each of the key stages of HDA. This Gap analysis report has taken an example structure of an HDA report and included tables in each sub-section to show data Gaps and provide corresponding recommendations. The sub-sections of Chapters 4 and 5 of this report, showing the key HDA stages, are based on European Commission (2001) guidance, which is described in Section 3.2. Gaps in the data requirements have also been identified by cross reference to Romanian Order 19, issued by the Ministry of Environment and Forests. This Order transposes the requirements of the EC Habitats and Birds Directives into Romanian law and is also described in Section 3.2.

Project background

Requirement for this section	Provided in existing Appropriate Assessment?
This section should describe the need for the road, the general characteristics of the design and build phases and all work undertaken to date, including the Feasibility Study	Yes
There should be a brief description of the location related to the protected areas of community interest (Natura 2000 sites), including STEREO 70 coordinates and a link to an appendix showing maps of the protected areas in relation to the proposed road.	Yes
The section should also include some very general background comments on Habitats Directive Assessment (HDA), e.g. HDAs are required under the Habitats Directive (Directive 92/43/EEC on the Conservation of Natural Habitats and Wild Fauna and Flora) and the Birds Directive (Codified Directive 2009/147/EC on the Conservation of Wild Birds), which apply to proposed plans or projects that may have a 'likely significant effect' (LSE) on a Natura 2000.	Yes but currently in Section 10 of the document; would be better to provide this general background in Section 1

Consultation with the Environmental Protection Agency (EPA) on the method and scope of the HDA

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
As best practice in line with EC (2001), a summary description of all consultation with the EPA could be provided to show that the EPA has agreed with the list of Natura 2000 sites to be included in the screening and AA stages and are content with the general scope and methodology of the assessments. However, this is not a requirement of the Romanian legislation.	No	This description could be included to comply with best practice.
Records of written correspondence from consultation should be provided as an Appendix.	No	This description could be included as best practice.

The Sibiu-Pitesti Motorway - Overview and purpose of motorway construction

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
This section should provide an overview of the existing physical environment of the area, including geology, hydrology and topography of the three road sectors.	Yes	Report could be improved by providing more background information on these physical factors
A reference to an appendix map showing the route alignment options could be included here.	No	The report would benefit from providing a map that shows all of the alignment options in one map

Proposals

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
Description of the length, width and location of the proposed route options (i.e. construction footprint), including access roads, ditches, retaining walls	The existing AA does not provide sufficient detail in this description.	The report would benefit from providing a map that shows all access roads and additional infrastructure required, plus additional description of the route options.
Description of additional services necessary to implement the project (decommissioning/relocating the pipes, high voltage lines, etc), respectively the way accessing these additional services may affect the integrity of Natura 2000 sites	The existing AA does not provide sufficient detail in this description.	Further information regarding additional services and access arrangements to these additional services is required.
Description of the location and basic design details of all proposed bridges, tunnels and culverts	The existing AA does not provide sufficient detail in this description.	The report includes a list of tunnels required but could include more general information on them and a map showing location of bridges and tunnels in relation to Natura 2000 sites
Description of the construction materials and chemicals proposed to be used in the project, including location of any quarries used to source the construction materials	Yes – Section 1.6.12 in Chapter A	More information on quarry locations may need to be provided
Description of natural resources needed during project construction, including location and volume of any water resources required	The existing AA does not provide sufficient detail in this description.	Further detail is required that shows the relation between natural resources requirements and specific Natura 2000 sites.
Description of expected emissions and wastes to air and water during construction	The existing AA does not provide sufficient detail in this description.	Further detail is required that shows the relation between natural resources requirements and specific Natura 2000 sites.

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
Provision of estimates of traffic numbers expected to use the road during construction (in relation to atmospheric dust and subsequent deposition caused by construction vehicles)	No	Include estimates of traffic numbers from modelling done to date
Provision of a broad estimate of traffic numbers expected to use the road during operation (in relation to production of NOx from vehicle emissions)	No	Include estimates of traffic numbers from modelling done to date

Phases of activity considered

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
The expected phases of activity should be described, including the proposed timing of each phase (construction, operation and decommissioning, plus sub-phases of these). The typical 'on-the-ground' activities related to motorway construction should be described	Partially	Include a simple breakdown of activities by phase that can later be used to determine which phase impacts are likely to occur – see examples in Table 2.1 below

Examples of activities in the different phases that are not fully described in the AA report are shown in Table 2.1.

Table 4.1 Example activities to inform HDA considerations

Activity Phase	Examples of likely activities
Construction* (and pre-construction)	Seismic survey; Hydrology survey; Earthworks, including drilling, piling, road surface planning and milling, excavation and filling; Construction vehicle movements; Concrete batching, road pavement layer installation and asphalt laying; Installation of roadside equipment and services, including buried cables, lighting, signs, gantries and signals

Activity Phase	Examples of likely activities
Routine maintenance	Verge cutting; Painting; Pothole filling; Clearing gullies and drains to maintain road drainage**; Repairing equipment and services
Structural maintenance	Surface planning and treatment; Crack and seat; Overlays/ Inlays/ Replacements of road surface and sub-structure
Operational	Use of the road by commuters, freight and other traffic
*The term 'construction' encompasses all on-line, off-line, ancillary and associated works ** 'Road drainage' is a term often used to encompass drainage channels, gullies, interceptors, catch pits, manholes, piped grips, piped drainage, ditches, filter drains, counter fort drains and balancing ponds.	

Habitats Directive Assessment - Requirements of the Habitats and Birds Directives

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
This section should provide details of the general requirements under Articles 6(3) and 6 (4) of the Habitats Directive. HDA is required where any plan, alone or 'in combination' with other plans, could have an LSE on internationally designated sites. These sites comprise: Special Protection Areas (SPAs), designated under the Birds Directive. Potential Special Protection Areas (pSPAs) are also included; Special Areas of Conservation (SACs) and candidate SACs designated under the Habitats Directive;	No	There needs to be a description of the process of HDA, including the results of the first stage – screening for likely significant effects

HDA guidance

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
The regulations and guidance documents used to inform the methodology should be listed. For example, the regulations and guidance listed below: Relevant Romanian Regulations Ministry of Environment and Forests. Order No. 19 (13th January 2010), regarding the approval of the methodological guide on appropriate assessment of potential effects of plans or projects upon the community interest protected natural areas	Yes	There is a long list of orders in section 1 of the report – suggest shortening the list to priority orders
EC HDA Guidance European Commission (2001). Assessment of plans and projects significantly affecting Natura 2000 sites; EC, 2000. Managing Natura 2000 Sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC. EC, 2007. Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC; Clarification of the concepts of alternative solutions, imperative reasons of overriding public interest, compensatory measures, overall coherence, opinion of the commission	No	Suggest referring to EC guidance on HDA and also HDA guidance that is specific to roads (if not included in the Romanian guidance list), Design Manual for Roads and Bridges (DMRB) Volume 11, Section 4, Part I (HD 44/09).

Stage 1: Screening for LSE - Introduction to the screening stage

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
The background to the first (screening) stage of the HDA should be described. The screening stage determines whether there will be a 'likely significant effect' (LSE) on a Natura 2000 site. Figure 4.1 below shows the principal requirements for the screening stage	No	Background to the screening process needs to be provided in full, with clear conclusions provided on the Natura 2000 sites screened in for the Appropriate Assessment The full meaning of the term LSE, in relation to the European Court of Justice's 'Waddenzee' judgment, on how to determine LSE, should be described here or in a glossary at the end of the report.
This section needs to show that any conclusions of the screening assessment have been agreed with the EPA. If the screening assessment determined that the project is likely to cause a LSE on any Natura 2000 site, and avoidance measures cannot be agreed with EPA, then a strategic level Appropriate Assessment (AA) will need to be carried out for those sites.	No	Evidence of early discussions with EPA need to be provided to determine their agreement with the findings of the screening stage and the list of Natura 2000 sites that need to be considered in the AA stage. Decisions of Romanian Technical Approval Committee need to be documented. Other Natura 2000 sites may need to be included for consideration, e.g. Piemontul Făgăraș (ROSPA0098) and Platforma Cotmeana SCI (ROSCI0354)
The project should aim to avoid impacts on Natura 2000 sites by identifying the potential for impacts early in the decision-making process, and embedding avoidance measures through design guidance and specifications.	No	Evidence of early avoidance measures through design guidance and specifications needs to be provided

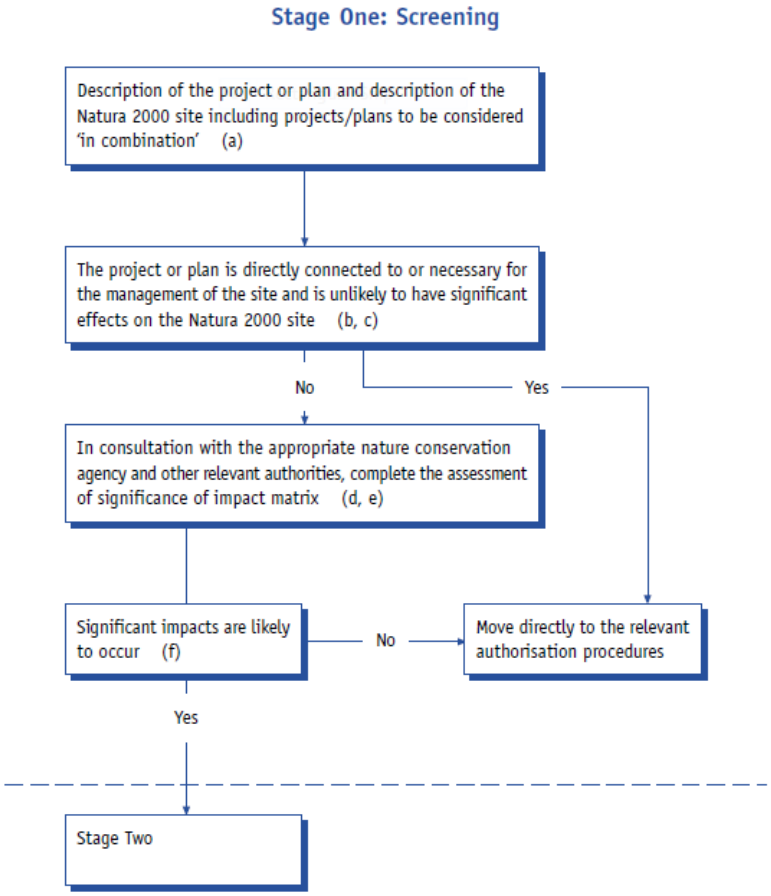


Figure 4.1 Screening for Likely Significant Effects. Source: EC (2001) Assessment of Plans and Projects significantly affecting Natura 2000 sites.

Screening Step 1: Management of the Natura 2000 sites

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
A short description to show that the project is in no way necessary for the management of any Natura 2000 sites should be provided	No	This description needs to be included

Screening Step 2: Description of the project

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
Description of the project The requirements for description of the project are shown in Chapter 2 of this Gap Analysis report.		
Identification of cumulative effects (see below)		
Identify all projects/plans which might act in combination with motorway construction	No	A list of other plans or projects that may cause cumulative effects with Sibiu-Pitesti project needs to be provided
Identify the types of impacts (e.g. noise, water resource reduction, chemical emissions, etc.) that are likely to affect aspects of the structure and functions of the site vulnerable to change	Partially	Include consideration of cumulative effects with other plans or projects
Define boundaries for examination of cumulative effects; note these will be different for different types of impact (e.g. effects upon water resources, noise) and may include remote (off-site) locations	Partially	The report should list cumulative effects that are likely and those that are unlikely for each qualifying interest – and provide the rationale for these decisions
Identify potential cumulative pathways (e.g. via water, air, etc.; accumulation of effects in time or space). Examine site conditions to identify where vulnerable aspects of the structure and function of the site are at risk	Partially	More detail is required to show how cumulative effects relate to the most vulnerable aspects of the qualifying interests
Prediction of magnitude/extent of identified likely cumulative effects	Partially	More detail is required on the magnitude and extent of cumulative effects

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
Comment on whether or not the potential cumulative effects are likely to be significant	Partially	A ranking of significance for each identified cumulative effect should be provided

Screening Step 3: Characteristics of the Natura 2000 sites to be considered in the HDA

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
This section should provide a list of the Natura 2000 sites agreed with the EPA as either being directly or indirectly affected by the route alignment options. The distance between the Natura 2000 sites and the route options should be listed.	No	Although a list of sites is included in Section B, there is no discussion of agreement with the EPA on this list or information on how far the Natura 2000 sites are from the proposed route alignments (distance measurements). This information needs to be provided.
This section should include a map or reference to an appendix map showing all of the Natura 200 sites on one map, to provide overview and context of project	No	The report would benefit from providing a map that shows all of the Natura 2000 sites in one map – either at the beginning of the report or a reference in the introduction to an appendix map.
Inclusion of the Natura 2000 standard data form for each site	No	These forms should be included as an appendix for reference purposes

Screening Step 4: Assessment of significance

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
A description of a robust methodology to be employed to identify impacts that could cause LSE	Partially	The impact assessment methodology should follow EC and other guidance. The current methodology at the start of Chapter C is insufficient and not specific enough for the qualifying interest habitats and species.
A description of all construction, maintenance and operation activities with no potential impacts on Natura 2000 sites should be provided	No	This description needs to be included
A list of Natura 2000 sites unlikely to be significantly affected by the project should be provided (i.e. sites that have been 'screened out')	No	This description needs to be included. A rationale for the decision for screening sites in or out of further assessment should be included.
A description of all construction, maintenance and operation activities which could cause potential impacts on Natura 2000 sites should be provided	No	This description needs to be included
A list of cumulative impacts that could cause LSE should be provided. This should include cumulative impacts from the project alone and also cumulative impacts from other plans or projects	Yes Section 10 on page 68 refers to cumulative impacts. Impact matrices for individual Natura 2000 sites appear to include consideration of cumulative impacts, e.g. Section D1.10 (page 152)	This description may need to be provide greater detail on cumulative impacts, including names of other plans or projects where relevant

Stage 2: Appropriate Assessment

Introduction to the AA stage

All Natura 2000 sites for which LSE was predicted as a result of the construction of the Sibiu-Pitesti motorway must progress to the next stage in Habitats Directive Assessment. The key elements of this second stage, the AA, are shown in Figure 2.

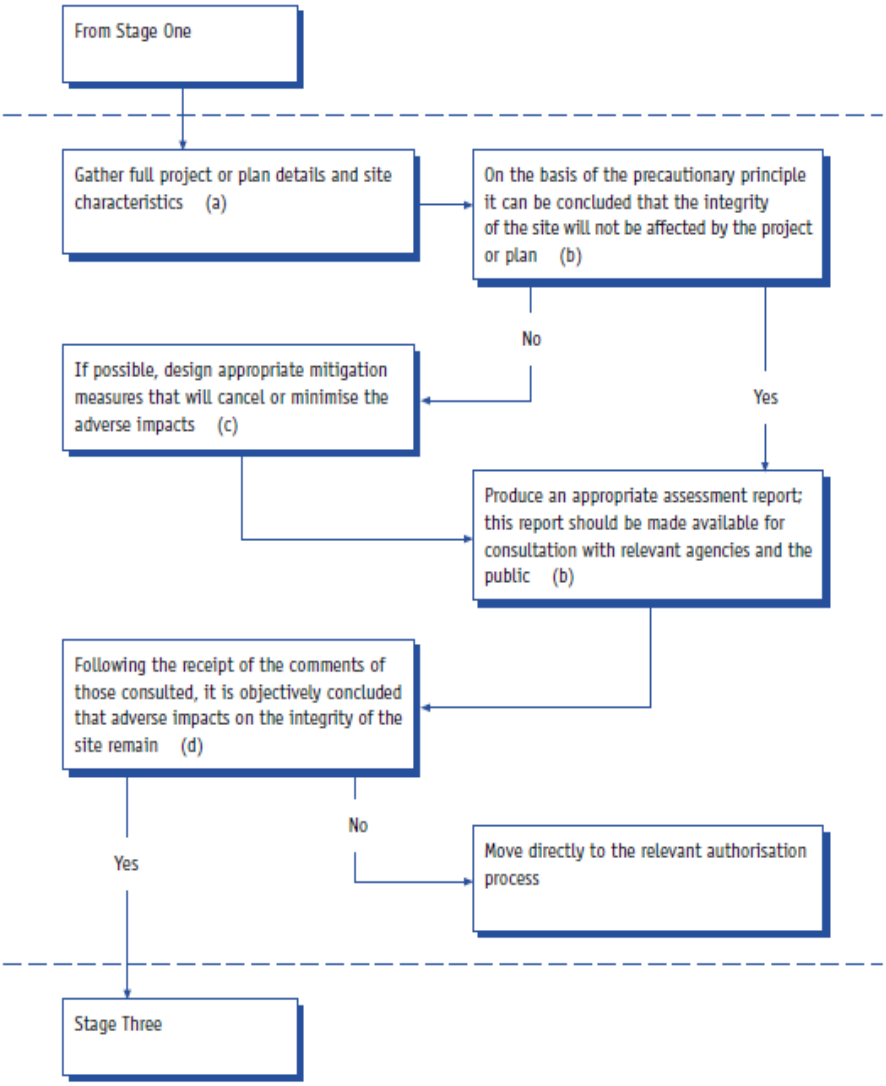


Figure 5.1 Source: EC (2001) Assessment of Plans and Projects significantly affecting Natura 2000 sites.

AA Step 1: Gathering information

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
The following checklist is taken from the EC (2000) guidance. It repeats some of the information that should have already been collected at the screening stage.		
Information about the project (see below)		
Full characteristics of the project which may affect the site	Partially	Further description of the project should be added, as described in Chapter 2
The total range or area the project will cover	Yes	
Size and other specifications of the project	Yes	
The characteristics of existing, proposed or other approved projects or plans which may cause interactive or cumulative impacts with the project being assessed and which may affect the site	No	The AA may need to be provide greater detail on cumulative impacts, including names of other projects where relevant
Planned or contemplated nature conservation initiatives likely to affect the status of the Natura 2000 sites in the future	The existing AA does not provide sufficient detail in this description.	The AA may need to include a description of such initiatives
The relationship (e.g. key distances etc.) between the project and the Natura 2000 sites	No	Distances between the proposed route alignments and all Natura 2000 sites need to be provided. The precise area of any land-take required from any Natura 2000 site needs to be specified
The information requirements (e.g. EIA/SEA) of the authorisation body or agency (EPA)	No	Further information on the requirements of the EPA for all HDAs needs to be provided – for example, by including Romanian Order 19 (2010) from the Ministry of Environment and Forests as an Appendix.
Information about the Natura 2000 sites (see below)		

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
The reasons for the designation of the Natura 2000 sites	The existing AA does not provide sufficient detail in this description.	Further information on the reasons for the designation of each Natura 2000 site may need to be provided
The conservation objectives of the Natura 2000 sites and the factors that contribute to the conservation value of the site	Sections D.2.7 and D.2.8 contain some general information on conservation objectives.	Further, specific details regarding conservation objectives and management plans will need to be provided for all qualifying interest species
Description of the current conservation status of the Natura 2000 protected area (favourable or otherwise), including development/changes that may occur in future	The existing AA does not provide sufficient detail in this description.	It will be necessary to provide additional and updated information regarding site condition and ecological trends observed at the relevant Natura 2000 sites.
The existing baseline condition of the sites	Partially	More information on existing population and abundance of habitats and species, including recent trends, should be provided
The key attributes of any Annex I habitats or Annex II species on the sites	Partially	Description of key attributes of fauna species appears to be provided in Section D, but further detail may be required – in particular, the key attributes of Annex I habitats
The physical and chemical composition of the sites	No	This information needs to be provided
The dynamics of the habitats, species and their ecology	Partially	More information on ecological and hydrological connections between habitats and species should be provided
Those aspects of the sites that are sensitive to change	No	This information needs to be provided

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
The seasonal influences on the key Annex I habitats or Annex II species on the sites	No	This information needs to be provided
Other conservation issues relevant to the sites, including likely future natural changes taking place	No	This information needs to be provided
Data on the Natura 2000 sites: surface, types of ecosystems, types of habitats and species which may be affected by the implementation of the project	Yes	
Description of the ecological functions of the affected Natura 2000 species and habitats (surface, location, characteristic species) and description of their connection/relation with the neighbouring Natura 2000 protected natural areas and their distribution (relevant to understanding the requirement to maintain coherence of the Natura 2000 network) Identify the key structural and functional relationships that create and maintain the integrity of the Natura 2000 sites	The existing AA does not provide sufficient detail in this description	It will be necessary to provide additional information regarding any hydrological or ecological links and migration routes between the different Natura 2000 sites
Data regarding the structure and the dynamics of the affected species populations, including; population abundance and distribution trends within the Natura 2000 site (using existing survey data for the relevant habitats and species); estimated percentage of the national and European species population within the Natura 2000 site; estimated number of species affected by the implementation of the project	The existing AA does not provide sufficient detail in this description.	It will be necessary to provide additional information
Other relevant information regarding the conservation of the Natura 2000 protected area, including possible changes to the natural evolution of the Natura 2000 site, e.g. Environmental Statements from EIAs for similar projects or plans elsewhere, existing data on hydrogeology	The existing AA does not provide sufficient detail in this description.	It will be necessary to provide additional information

AA Step 2: Impact prediction

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
Predicting impacts should be done within a structured and systematic framework and completed as objectively as possible. The types of impact should be identified, i.e. direct and indirect effects; short- and long-term effects; construction, operational and decommissioning effects; and isolated, interactive and cumulative effects.	No	The impacts in the report should be listed alongside all the qualifying interest habitats and species that they relate to
Methods for categorising impacts could include; Direct measurements; Flow charts, networks and systems diagrams Quantitative predictive models; Geographical information systems (GIS) (to produce models of spatial relationships); Information from previous similar projects; Expert opinion	No	All of these methods for categorising impacts need to be considered for potential use – at present the categorisation is simplistic and non-specific C Other impacts may need to be described in more detail, e.g. NOx deposition during the operation phase. There may also be additional impacts to consider, e.g. new motorway leading to increased public access (from lay-bys, access roads) and recreation disturbance to some species.

AA Step 3: Conservation objectives

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
This section should show how the project could adversely affect the integrity of Natura 2000 sites. The key questions are; Does the project have the potential to: cause delays in progress towards achieving the conservation objectives of the site? interrupt progress towards achieving the conservation objectives of the site? disrupt those factors that help to maintain the favourable conditions of the site? interfere with the balance, distribution and density of key species that are the indicators of the favourable condition of the site?	No	Each of these questions needs to be answered individually

AA Step 4: Mitigation measures

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
To assess mitigation measures, the following tasks must be completed:		
list each of the measures to be introduced (e.g. noise bunds, tree planting);	Yes	
explain how the measures will avoid the adverse impacts on the site;	Partially	Mitigation measures should be applied to the specific habitats and species that are qualifying interests of the relevant Natura 2000 sites. The report needs to make the distinction between mitigation measures that may be effective for a species at one location but not another. Specific mitigation for carnivore and invertebrate species needs to be provided A detailed description of when the mitigation measures are to be applied should be included (e.g. outside bird breeding seasons etc) Mitigation should be species specific and location specific, e.g. mitigation provided in areas traversed most commonly by carnivores
explain how the measures will reduce the adverse impacts on the site.	Partially	As above

Overall conclusion of AA stage

Requirement for this section	Provided in existing Appropriate Assessment?	Recommendation
The AA report should;		
describe the project or plan in sufficient detail for members of the public to understand its size, scale and objective	No	Further description of the route alignment, including maps showing the distance to the Natura 2000 sites should be provided
describe the site baseline conditions of the Natura 2000 sites	Partially	More information on existing population and abundance of habitats and species, including recent trends, should be provided. Recommendations for further survey work should be described.
identify the adverse effect(s) of the project on Natura 2000 sites	Partially	A summary of adverse effects needs to be made for the specific qualifying interests of the Natura 2000 sites
explain how those effects will be avoided through mitigation	Partially	Mitigation measures should be provided for the specific qualifying interests of the Natura 2000 sites
sets out a timescale and identifies the mechanisms through which the mitigation measures will be secured, implemented and monitored.	Partially	The existing report sets out general mitigation measures for the construction and operation phases but further detail is required. Some mitigation measures described may not be achievable.

Remaining Stages of HDA

In the conclusions of the existing AA, a discussion of mitigation measures of provided. There is no discussion of where residual adverse effects on site integrity will remain after the mitigation measures are applied. Therefore the remaining stages of HDA are not included in the report, i.e. Stage 3 (Assessment of Alternative Solutions) and Stage 4 (Assessment where no alternative solutions exist and where adverse impacts remain).

A description of the next steps in the HDA process and any further ecological survey and consultation requirements needs to be provided.

Conclusions

This Gap Analysis report has identified the following principal Gaps in the existing AA;

Chapter of Gap Analysis Report	Gap identified
1. Introduction	General background on HDA Details of consultation with the EPA, including the outcomes of the consultation
2. Sibiu-Pitesti Motorway	Maps showing the route alignment options Specific design details of motorway construction relevant to potential impacts on Natura 2000 sites, including mapping Further information on projected traffic numbers during construction and operation Information on construction activities required for the project and the expected phasing of them Description of natural resources needed during project construction, including location and volume of any water resources required Description of expected emissions and wastes to air and water during construction
3. Habitats Directive Assessment	Details of the general requirements under Articles 6(3) and 6 (4) of the Habitats Directive, with regard to the consecutive stages of HDA and when it is necessary to proceed to the next stage Details of EC guidance on HDA (e.g. EC 2001) and references to specific sections of this guidance that are relevant to the project, for example the assessment of alternative solutions (in relation to Article 6 (4) of the Habitats Directive) and the different route alignment or design options available.

Chapter of Gap Analysis Report	Gap identified
4. Stage 1: Screening for LSE	Description of the screening process undertaken before the AA stage, including; A list of all Natura 2000 sites and qualifying interests screened in or out of further assessment and the rationale for these screening decisions (some additional sites may need to be added); A description of a robust methodology to be employed to identify impacts that could cause LSE; Decisions by EPA regarding the Presentation Memo of the screening stage
5. Stage 2: Appropriate Assessment Step 1: Gathering information	**Project details** Full characteristics of the project which may affect the site The relationship (e.g. key distances etc.) between the project and the Natura 2000 sites The characteristics of existing, proposed or other approved projects or plans which may cause interactive or cumulative impacts with the Sibiu-Pitesti project Planned or contemplated nature conservation initiatives likely to affect the status of the Natura 2000 sites in the future Details of the information requirements (e.g. EIA/SEA) of the authorisation body or agency (EPA)and how the AA has fulfilled these requirements **Natura 2000 site details** The reasons for the designation of the Natura 2000 sites Full details of the conservation objectives and management plans for the sites Description of the current conservation status of the sites Adequate detail on the existing baseline condition of the sites Description of the key attributes of any Annex I habitats or Annex II species on the sites Description of the key physical and chemical characteristics of the sites Description of the dynamics of the habitats, species and their ecology Description of those aspects of the sites that are sensitive to change Description of the seasonal influences on the key Annex I habitats or Annex II species on the sites Description of other conservation issues relevant to the sites, including likely future natural changes taking place Description of the ecological functions of the affected Natura 2000 species and habitats and description of their connection with neighbouring Natura 2000 sites (relevant to understanding the requirement to maintain coherence of the Natura 2000 network) Data regarding the structure and the dynamics of the affected species populations, including; Other relevant information regarding the conservation of the Natura 2000 sites, including possible changes to the natural evolution of the sites

Chapter of Gap Analysis Report	Gap identified
5. Stage 2: Appropriate Assessment Step 2: Impact prediction	Structured and systematic framework for impact prediction Clear description of impact categorisation A description of a robust methodology to be employed to identify impacts that could cause adverse effects, using EC and other internationally recognized HDA guidance
5. Stage 2: Appropriate Assessment Step 3: Conservation objectives	Detailed information on how the project could adversely affect the integrity of Natura 2000 sites
5. Stage 2: Appropriate Assessment Step 4: Mitigation measures	A description of how the measures will avoid the adverse impacts on the site A description of how the measures will reduce the adverse impacts on the site A detailed description of the mitigation measures required for the qualifying interests, e.g. carnivores, invertebrates A detailed description of the timing requirements for the proposed mitigation measures (e.g. outside bird breeding seasons etc)
5. Overall conclusions of the AA	Description of the project in sufficient detail for members of the public to understand its size, scale and objectives Adequate description of the site baseline conditions of the Natura 2000 sites Adequate identification of the adverse effect(s) of the project on Natura 2000 sites Adequate explanation of how those effects will be avoided through mitigation A description of the timescale and mechanisms through which the mitigation measures will be secured, implemented and monitored Recommendations for further survey work required
6. Remaining stages of HDA	Description of the next stages to be followed in the HDA process, including any further ecological survey and consultation requirements

4.1.2.1.15 Volume 9 – Documentation for Identification of Land Owners

Volume 9 of the existing Feasibility Study provides information on the total area of land to be acquired for the project. The report includes details related to area of land classified by category of use. The following summary data is provided:

Agricultural land total area 4,895,975.73 sqm comprised of:

- Sibiu County: 804,376.90 sqm
- Valcea County: 1,162,181.40 sqm
- Arges County: 2,929,417.43 sqm

Non - agricultural land total area 766,848.21 sqm comprised of:

- Sibiu County: 88,107.83 sqm
- Valcea County: 261,563.79 sqm
- Arges County: 417,176.59 sqm

Forest land total area 2,904,026.78 sqm comprised of:

- Sibiu County: 419,144.44 sqm
- Valcea County: 1,339,291.35 sqm
- Arges County: 1,145,590.99 sqm

The overall area of land to be acquired was estimated as 8,566,850.71 sqm.

It is noted that in the Volume 1 Synthesis, chapter 5.17 explains that approximately 620 ha (6,200,000 sqm) of land is required for the project.

Additionally, the Environmental Impact Statement report makes reference to the area of land required for the project as 2,217,256.79 sqm (220 ha) forest land with a total of 7,952,477.36 sqm (795 ha).

The apparent inconsistencies in the total area of land required for the project will necessitate a detailed review as part of the updated Feasibility Study. The information regarding area of forest land to be acquired is of particular importance in relation to the environmental report, as proposed mitigation measures will be a function of the impact of the area of land acquired.

The documentation provided as part of Volume 9 suggests that an allowance for the land required for services areas was included. However, a review of the road works design volume indicates that 3D modelling of rest and service areas was not performed.

This aspect may lead to inaccuracies in the total area of land required. Additionally, possible omission of retaining structure works or similar, required to accommodate the rest and service areas at the locations indicated on the land owner identification drawings may lead to further inaccuracies in the total area of land required.

Value of land in Deviz General was estimated at €46 million. This may be underestimated and may have been calculated used the 620 ha instead of 857 ha area of land for the project required according to Volume 9.

The insufficient 3D modelling of the project may have resulted in underestimation of the area of land to be acquired and magnitude of works at some locations. Furthermore it is not clear if the land required for the relocation and protection of public utilities was included in the documentation.

Land acquisition and identification of land owners is a task that may carry a high level of risk and will require adequate consideration as part of the future Feasibility Study. The acquisition of land required for the project is essential to the successful delivery of this major highway scheme, and the risks associated with it are to be captured as part of the comprehensive risk assessment process that is to be undertaken by the designer of the updated Feasibility Study. Law 250/2010 outlines the requirements for the acquisition of land and provides detailed methodology for the completion of such a process. The main issues which may arise during the land acquisition process relate to unidentified land owners, disputes between land owners and a lack of land ownership titles in the areas which were not subject to nationalisation prior to 1989.

Responsibility for Expropriation is to be shared between the Consultant for the updated Feasibility Study (who will undertake most of the tasks required in Law 255/2010) and the RNCMNR who will check the documents.

The existing Feasibility Study does not include allowance for temporary occupation of the land required for the motorway construction. This is seen as a significant risk that could lead to delays in the completion of the construction works.

4.1.2.1.16 Volume 10 – Motorway communication and Traffic Control

Motorway communication, operation and maintenance plan

A report on operation and maintenance of the motorway is provided in the Feasibility Design. This includes the main requirements for the maintenance centres. The document also provides a schedule of regular inspections that are to be carried out for the key category of works. It is considered that this document could be used in an initial discussion regarding motorway maintenance strategy which for an objective of this size is likely to be tendered under a contract for private maintenance and operation. However the strategy for motorway communication and maintenance is to be further discussed with the Client.

Volume 10 of the Feasibility Study includes details related to motorway communication installations. The comments related to the information provided are:

- Variable message signs are described and proposed to be installed near junctions and tunnels;
- Matrix signs providing live data on traffic, weather etc are described;
- Traffic loops acting as automatic traffic counters are described;
- CCTV equipment is described and an indicative schedule of locations provided. No information is included on the number of CCTV units based on coverage. This is regarded as a gap;
- Emergency phone systems are described but no typical detail is provided for access platforms near the equipment. This is regarded as a gap;
- The cost estimates provided do not include quantities and unit rates used. This is regarded as a gap;
- Description of radio communication includes radio coverage maps for the route;
- Typical drawings show the number of ducts required for the motorway communication system included but the highway design drawings do not correlate the data or allow sufficient soft verge width for the installation of these ducts. The typical section does not cover the physical segregation of optical cable ducting and power ducting which is required due to health & safety reason. This is regarded as a gap; and
- The schedule of ITS equipment provided is to be reviewed and updated as part of the Feasibility Stage and correlation including integration of the ITS equipment locations within the Design is to be considered. This is regarded as a gap

Comments relating to the provision for maintenance and operations centres as well as the spacing between these centres are provided within chapter 4.1.2.1.8 of this report.

The maintenance plan provides outline requirements for the provision of inspection and maintenance for the main category of works. The maintenance and operation plan report will require updating in line with the most recent Romanian norms. The maintenance strategy for Sibiu – Pitesti motorway will require further consideration by the RNCMNR, as well as, Ministry of Transport and Infrastructure, with the view to secure a robust strategy for this major motorway scheme.

4.1.2.1.17 Volumes 11 - Projects for the relocation and protection of public utilities affected by the works.

It is envisaged that the data included as part of these projects is outdated and will most likely require to be brought up to date as part of the new Feasibility Study.

The information relating to existing Public Utilities (PU), including the projects for protection and relocation of the PU's, is outdated and will require a complete update to take account of the most recent site conditions and current relevant legislation with regard to such specialised projects. Our review shows that the majority of the Permits obtained for the relocation and protection of utilities have expired. One aspect which the ToR will clarify is the requirement for the validity of the newly issued Permits to be granted for the duration of project implementation in compliance with law 255/2010.

Utilities investigations should use, in addition to intrusive investigations, ground penetrating radar which is a method that makes use of radar signals in order to create an image of the foundation soil. This non-intrusive method uses radio spectre microwave length electromagnetic radiations (UHF/VHF frequencies), by detecting signals reflected by bodies or underground structures. Such recommendations will be considered for inclusion in the new ToR.

The proposed relocation and protection of public utilities is presented within Volume 11 of the Feasibility Study. The main comments on Volume 11 are:

- The projects were completed at Feasibility Study stage and the design was undertaken by licensed designers;
- It is not clear if the land to be acquired includes areas of land needed for the relocation of public utilities; and
- A public utilities co-ordination plan was not identified within the documentation provided. Such a plan is particularly useful for identification of specific hazards and for verification of interfaces between proposed works and public utilities.

The projects for protection and relocation of public utilities were completed in 2008 and are considered outdated due to possible changes to site conditions and modifications in the relevant legislation. As such, the projects will require a complete update and it is expected that the new ToR will require completion of both Feasibility Stage and Technical Project Stage in order to enable the receipt of the relevant third party permits.

4.1.2.1.18 Volume 12 – Permits & Agreements

The existing Urbanisation Certificates for the three counties Sibiu, Valcea and Arges, as well as, the other permits are out of date and will need to be reapplied for as part of the updated Feasibility Study.

The third party permits system is lengthy and quite often the process leads to delays in completion of the design either due to non-response from third parties or due to conditions imposed through the permitting system. The validity of permits is in many cases given as 12 or 24 months which could be restrictive and may require renewal of permits in some cases before the design is completed. It is acknowledged that a system for third party consultation and approval is needed.

The validity of all permits should be set to the duration of the construction contract which would comply with the requirements of Law 255/2010.

The permits for temporary access to site for ground investigations and other site investigations were not considered within the existing Feasibility Study. The June 2012 ToR explained that for archaeological investigations the access to site would be granted in accordance with Law 255/2010, and will be enabled through a power of attorney that was to be issued by the RNCMNR. In our opinion, such an approach may be feasible for non-intrusive surveys such as noise surveys, topographical surveys or biodiversity surveys. It is envisaged that the intrusive surveys such as ground investigations and archaeological investigations will require third party permits including, but not limited to, permits from the Forestry Authority (known as Ocolul Silvic), the Environmental Protection Agency (particularly for access to Natura 2000 sites), from public utilities owners or administrators and others.

5 Conclusion

The information presented within this Gap Analysis report provides details on the following aspects:

- Findings, conclusions and recommendations regarding omissions and discrepancies identified within the existing documentation;
- Outline proposals for local route alignment options consolidated with data gathered following the site visit attended by Halcrow's team during 3rd to 5th June 2013; and
- Comments on key dates related to project implementation.

Halcrow's team of key experts have completed the analysis of the existing Feasibility Study and a draft report was made available to JASPERS on 24th May 2013. Halcrow's team led by Alan Guthrie and Bogdan Fodor also delivered a presentation to representatives of JASPERS, RNCMNR and Ministry of European Funds on 28th May 2013. The presentation outlining the Gap findings was structured as follows:

1. Road works
2. Structures
3. Hydrology and Hydraulic Assessment
4. Tunnels
5. Service /rest areas and maintenance centres and maintenance strategy
6. General bill of quantities and cost estimates
7. Traffic and Traffic Modelling
8. Cost Benefit Analysis and Multi Criteria Analysis
9. Topographical Study
10. Geotechnical Investigation
11. Environmental Impact Statement
12. Habitats Directive Assessment
13. Land acquisition
14. Motorway communication system
15. Public utilities
16. Permits and Agreements
17. Maintenance and operation plan
18. Outline Procurement strategy

The existing Feasibility Study includes a significant amount of information and generally the proposed Sibiu – Pitetsi corridor follows the most feasible route along the Olt valley, Topolog River and Arges River. Due to time elapsed between the completion of the existing Feasibility Study (2008) and the present, many parts of the study are considered outdated either due to possible variations to the situation on site or due to changes in legislation or design parameters (see traffic census). For these reasons, the recommendation of this report is for a complete update of the existing Feasibility Study with retention of the currently proposed corridor, but inclusion of an enhanced route options report with associated traffic data, cost benefit analysis and multi criteria analysis. Although it is generally acknowledged that the exiting corridor is adequate, a thorough route options report is required to provide robust justification for the rejection of any other proposals studied. In addition, the route options report shall include, but not be limited to, the proposals outlined within section 4.1.2.1.5 of this report.

The summary of findings for each of the categories highlighted in the presentation on 28th May 2013, are outlined below:

1. **Road works**

Pre-feasibility study dated 1994 for section Pitesti – Curtea de Arges - Cornetu L= 90km:

- route studied included one main corridor with small local alignment variations;
- Earthworks quantities estimated to 8.3 million cubic metres;
- Spacing between grade separated junctions is close to the minimum recommended of 10km; and
- No connection to Ramnicu. Valcea.

Pre-feasibility study dated 1997 for section Cornetu – Sibiu L=57km

- Section heavily constrained by existing terrain; and
- Two options were studied and agreement was for the option closer to river Olt in favour of the option developed into the mountain.

Feasibility Study completed in 2008, length L= 116km

- Routes studied close to the pre-feasibility options;
- Current preferred corridor is sensible and may require small local alignment variations;
- Route options report would have benefitted from a concise list of constraints and advantages and disadvantages;
- The lack of suitable connection to Rm. Valcea not captured within route options;

- Mass haul diagram not available and location of borrow pits not identified;
- Calculations for the provision of climbing lanes not available;
- Typical cross section complies with TEM but more clarity is required for applicability of each type;
- Verge width not wide enough to accommodate motorway communication ducting and ducting for lighting;
- The lack of 3D modelling of the highway design results in risks related to land acquisition and estimate of works;
- Topographical survey – move to LiDAR survey requires OCPI approval;
- No emergency exits from motorway between Vestem and Cornetu, section with 5 tunnels (the longest being 1700m long);
- Vestem junction not required at this stage but re-configuration of the as built Sibiu bypass junction required;
- Section Vestem – Sibiu may require 3 lane motorway due to traffic levels;
- No clear provision for public lighting at grade separated junctions (recommended) – impact on land to be acquired and cost; and
- Interface at the tie in to tunnels not considered (distance between twin tunnels recommended as 20m or 35m);

Alignment options:

- Option 1: 5km missing link between Vestem and Sibiu bypass;
- Option 2: ch 5+500m to ch 11+500m option west of Boita to be studied;
- Option 3: ch 25+000m to ch 29+000m alignment option east of Caineni to be studied with the view to remove Caineni tunnel;
- Option 4: ch 65+000m to ch 68+500m alignment option situated further east to be studied in order to remove the motorway from what may be a marchland area;
- Option 5: ch 78+800m link road between Tigveni interchange and DN73C to be considered;
- Option 6: ch 91+000m to ch 99+000m translation of the alignment further west in order to minimise the impact on the existing river;
- Option 7: ch 109+000m near Budeasca reservoir – raise vertical alignment and bring the horizontal alignment closer to the reservoir dam in order to minimise the impact on the existing rail. The future bridge soffit level to be above the top

of the reservoir dam (level and impact to be agreed with the reservoir administrator); and

- Option 8: ch 116+200m reconfiguration of the Bascov interchange to a diamond shape junction, combined with relocation of the proposed maintenance centre.

More generic observations in relation to the alignment:

- Alignment bifurcation in approach to tunnels to be considered;
- No information on buildability aspects particularly along river Olt valley; and
- Review of alignment with the areas where river diversions are proposed to be considered with the view to minimise the impact on the existing natural river bed and habitats within these areas.

Road safety features:

- Alignment does not include widening of verge or central reservation for visibility;
- The width of the soft verge is insufficient to enable the installation of the safety barrier – impact on land acquisition;
- No information of surface course roughness value or provision for high friction surfacing at junctions;
- All at grade T junctions to have visibility and traffic capacity checks carried out;
- Clear identifications of departures from Standards not included;
- Surface water drainage at changeovers – aquaplaning;
- Road safety audit is to be commissioned by RNCMNR as part of the updated Feasibility Design – cost for RSA to be budgeted for; and
- Allowance for devices for protection against snowdrifts or avalanches not discussed.

Highways recommendations summary:

- Updated Feasibility Design to include full 3D modelling and analysis of interface between various elements of design;
- Local route options to be reviewed;
- CBA and Traffic to be carried out for route options and Route Options report updated to include robust justification for rejection of various options;
- Junctions traffic capacity analysis and visibility checks;

- Clear identification of departures from Standards to be included as separate chapter in the Technical Report to the Feasibility Study in order to enable Employer's Approval; and

- Buildability aspects to be reviewed.

The revised Feasibility Study shall include a robust route option analysis backed up by enhanced cost benefit analysis, traffic data and multicriteria assessment.

A clear identification of all proposed departure from standards shall be presented in a separate report to the revised Feasibility Study.

The revised Feasibility Study may include the analysis of removal of the Vestem junction which is currently proposed at ch 0+000m.

The inclusion of the rehabilitation of the section of DN73C between Tigveni and Ramnicu Valcea within the scope of works for Sibiu – Pitesti motorway may require higher level decision by RNCMNR and Ministry of Transport and may be conditioned by the Romanian Government capital expenditure strategy. Following discussions between Halcrow's team and JASPERS specialist Mr. Fergal Trace it was outlined that the potential inclusion of the approximately 20 km of DN73C road within the scope of works for Sibiu – Pitesti motorway project, may positively contribute to the scheme Internal Rate of Return and would enhance the connectivity to Ramnicu Valcea, the only major city (located almost halfway along the scheme) between Sibiu and Pitesti.

2. **Structures**

- Level of ground investigation not sufficient;

- Buildability reviews to be considered as part of the updated study;

- Width of carriageway on bridge at locations where diverge and merge tapers extend on bridge not considered;

- Lighting on structures where required;

- Standardisation of type of structures used to be considered in order to enable increased efficiency during construction stage;

- Skew angle for some of the structures to be further reviewed and optimised where possible; and

- Provision for footbridges at locations where any existing communication paths are discontinued by the motorway alignment (this may include passageways for local farm animals if any)

The structures are to be designed to Eurocodes and consideration for standardisation of the type of proposed structures should be reviewed. A detailed analysis of buildability issues including the requirements for temporary access to the site should be considered.

3. **Tunnels**

- Buildability review to be considered;
- No clear details for cross passages between tunnels tubes;
- Consideration for restrictions on use of the tunnels by vehicles transporting dangerous goods;
- Not clear whether allowance has been made for fan redundancy and fans destroyed by fire. Without access to the detailed calculations it is not possible to check the number of fans, but the overall approach is as expected;
- The safety systems listed include the major systems which would be expected in this type of tunnel, however, there is not much detail on the performance requirements for each of these systems; and
- Risks and procedures for Dangerous Goods Vehicles (DGV) are not considered in this report. The risks from DGV and mitigations should be considered at an early stage.

The buildability and provision of safety equipment including driver advanced information systems (VMS, matrix signal etc) shall be considered as part of the revised Feasibility Study.

4. **Hydrology and Hydraulic Assessment**

- No access to hydraulic calculations or hydraulic modelling were available;
- Acknowledged that Romanian standards do not cover requirements for increase in rainfall intensity as allowance for climate change – adoption of international best practice to be included in ToR which usually include 20% increase in rainfall intensity allowed for in the calculations;
- Statistical assessments based on data sets of river flows, water management, subsurface flows, precipitation, land use, soil mapping were not available; and
- No information available regarding project integration with high flow management schemes required to agree structure design/ class of importance with the specific requirements in the hydraulic scheme of flood alleviation and flood hazard/risk management plans (FRMP)

A thorough review of hydraulic and hydrological impacts shall be analysed as part of the updated Feasibility Study with focus on minimisation of environmental impacts and allowance for sustainable drainage systems, as well as, provisions for prevention of flooding including effects generated by climate change.

5. **Service /rest areas and maintenance centres and maintenance strategy**

- Volume 2B includes proposed locations for the service areas, short stay parking and maintenance centres. However, the design for these motorway services was not developed in the 3D model and in many cases this results in works not being captured and or significant buildability issues;

- At some locations, the service area merge and diverge lanes extend over bridges with no allowance for widened bridge deck included;

- Requirement for provision of public lighting does not feature in the existing study. This would impact on the soft verge width and the potential need for visual screening (i.e. plantation of poplars); and

- Maintenance plan included in the existing Feasibility Study provides description for regular maintenance and inspection of principal category of Works. Future maintenance strategy should also be considered.

The maintenance strategy for Sibiu – Pitesti motorway will require further consideration by the RNCMNR, as well as, Ministry of Transport and Infrastructure, with the view to secure a robust strategy for this major motorway scheme.

6. **General bill of quantities and cost estimates**

- Volume 3 includes a comprehensive bill of quantities which is more detailed than expected for a Feasibility Stage. There is limited 3D modelling of the design as well as a lack of correlation at the interface between various categories of works. These include:

  - transition from structures to tunnels;
  - modelling of rest and service areas;
  - deign of retaining structures;
  - lack of 3D modelling of access tracks; and
  - absence of verge or central reservation widening for visibility.

  Due to the above limitations, the validation of the existing quantities was not feasible.

- The costs allowed for design and technical assistance (Chapter 3 of the cost estimate) are relatively low compared with the construction value estimated at €2.4 billion;

- The costs were estimated in Romanian Leu (RON) and exchanged to Euros using a 3.7 exchange rate that was valid on 1st October 2008; and

- Exchange rate used in the original cost estimate is not comparable with the rate today (approximately €1.0 equals RON4.5) and would increase the proposed costs considerably from €2.7 billion to €3.3 billion. This should be borne in mind for future assessments as currency exchange markets are likely to vary more than in the recent past. In addition the cost of basic commodities such as fuel is also likely to have a significant impact on the budget and final construction costs for this scheme over the next 10 years.

Outline cost estimates developed by Halcrow will be provided within the Procurement Strategy Report which is listed as Task 4 within JASPERS Terms of Reference.

7. Traffic and Traffic Modelling

Data Collection

- No background information on the study area is given;
- Only traffic information for the DN7 is given;
- Origin & Destination information from 2005 survey is missing;
- No historic traffic growth data;

Base Year Traffic Model

- No evidence a model has been used;
- No network diagrams;
- No model calibration data;
- No assignment plots;
- No information on VOT or VOC parameters;

Future Year Models

- Traffic growth figures given but not how they were derived;
- No mention of future development or generated traffic;
- No information on travel time savings;

Forecasts

- No sensitivity test results (high and low growth);
- General lack of discussion on how various parameters were derived; and

- A new study would be necessary in order to:
  - make use of the latest traffic census data collected in 2010;
  - make use of the national transport model developed in 2011/2012; and
  - incorporate the impacts of the economic downturn since 2008.

A new traffic study will be required. It is envisaged that the recent economic downturn may lead to a reduction in traffic volumes generated within the Sibiu – Pitesti corridor and this is confirmed by the data available on International Monetary Fund (IMF) web pages which show a cumulative drop in the Gross Domestic Product (GDP) for Romania of 24% for the period 2008 – 2011.

8. Cost Benefit Analysis (CBA) and Multi Criteria Analysis (MCA)

Economic Analysis

- Separate route option analysis not undertaken;
- No information on the basis of the analysis given;
- Project specific assumptions not presented;
- Forecast traffic flows do not match HDM model;
- Sensitivity and Risk Analysis;
- Sensitivity range is too narrow;
- No evidence of complex risk analysis (Monte Carlo);
- Financial Analysis; and
- No assessment to establish the most suitable financing structure has been presented.

Multi-Criteria Analysis

- No justification on cost or environmental impact and no in depth consideration of environmental impact;
- Inadequate review of environmental impacts related to Natura 2000 sites;
- Attractiveness and usefulness for traffic;
- Social and economic importance;
- Justification for weighting of criteria not given;
- No assessment of performance against objectives;

- No discussion on implementation or risks;
- No discussion on capital or maintenance costs; and
- No discussion on likely objections.

Whilst, overall, the CBA guidelines appear to have been followed, there are Gaps in the approach adopted, as well as, a lack of information to support some of the assumptions made and parameters used. The CBA will need to be updated to take account of the results of the new traffic study that has been recommended.

The MCA, which seems fairly basic, does not capture the range of impacts attributable to the route options including aspects relating to Natura 2000 sites and it is recommended that a new MCA is carried out. The requirements for the new MCA will be outlined within the revised ToR.

9. **Topographical study:**

The route option assessment of the feasibility study was based on aerial mapping while the preferred route was designed using a traditional on site survey carried out by the Consultant. This information is considered outdated.

Halcrow initiated discussions with JASPERS, RNCMNR and the national Cadastral Authority – ANCPI (a letter was sent to ANCPI on 30th May 2013 outlining the requirements and seeking comments) with the view to employ an advanced LiDAR (light detection and ranging) survey methodology.

10. Geotechnical Investigation

- General lack of information provided by ground investigation;
- No evidence of investigation into material re-use or borrow pit locations – impact on scheme cost;
- No mass haul diagram was provided;
- In some areas borehole spacing is too large or non-existent;
- Insufficient depth to boreholes;
- No in-situ test results have been provided;
- No site specific laboratory test results have been provided;
- No reference to the stability of rock cuttings or proposed anchoring methodology;
- Inadequate information for tunnel assessments;
- No risk registers; and
- Acceptability of existing ground investigation report may be seen as high risk.

Generally the geotechnical information presented in the Feasibility Study is of insufficient detail and the absence of laboratory test results does not enable the validation of the existing data. In many instances it is not possible to determine the feasibility of individual solutions or sections of works.

The Terms of Reference published as part of June 2012 tender process included a high level specification for ground investigations, detailing testing etc. The June 2012 ToR provided coordinates for the boreholes to be executed and specified the depth of each borehole. It is noted that such approach to a detailed specification for ground investigation transfers the entire risk for adequacy of GI data to the Employer (RNCMNR) which, in our opinion, is not in line with best practice and not desirable.

Also, the inclusion of sections of text copied from various norms and standards within the June 2012 does not bring additional value to the document as it simply repeats information that the competent designers should be aware of. The main risk with such an approach is related to potential omissions within the ToR aspect that may lead to an incomplete GI report, a risk that according to June 2012 ToR would have been entirely transferred to the RNCMNR. In our opinion, a robust set of technical terms of reference needs to include the minimum level of investigations required for each category of works such as tunnels, structures, embankment cuttings with the relevant cross references to the Eurocode 7. The ToR should require the Consultant to compile and submit to the Employer the list of applicable standards and norms to be used in the geotechnical design and a detailed proposed specification for ground investigation works. This approach would minimise the risk of commencement of design based on incorrect assumptions, standards or inadequate levels of ground investigations specified.

Due to large amount of boreholes required for this project, it is envisaged that a phasing of the GI investigations will be proposed as part of the Procurement Strategy report.

11. **Environmental Impact Statement:**

- Information is too generic and poorly structured and correlated;
- The mitigation measures are too generic;
- The 5 kilometres link between Vestem and the as built Sibiu bypass is to be included in the new EIA;
- No indicative location for site organisation and borrow pits were presented;
- Impact generated by traffic during construction stage not considered;
- No information regarding number of people affected by demolition of properties is presented;
- The report does not include information on the correlation between different forms of impact;

- Impact on the environment is treated generally, with no specific references on sensitive areas (residential areas, protected areas, use of explosives, etc); and

- No information on disposal of any hazardous materials including unsuitable material resulted from excavations is presented. A Waste Management plan will be required to be included within the updated EIA.

The main Gap indentified in relation to the environmental study is the lack of discussions about specific impacts and mitigation measures and absence of information relating to impacts such as, temporary construction traffic, use of explosives, river realignments or demolition of any properties. No thorough reviews of impacts relating to Natura 2000 sites were included.

The updated EIA shall include the additional 5 kilometres extension between Vestem and the existing Sibiu bypass and any other local route realignments. Also, the potential inclusion of the rehabilitation of the DN 73C (approximately 20 km long) road between Tigveni grade separated junction and Ramnicu Valcea, shall be considered as part of the updated EIA.

12. Habitats Directive Assessment

- Lack of details of consultation with Environmental Protection Agency;

- Maps showing options do not correlate with the results of the biodiversity survey;

- Natural resources requirements are not captured;

- Lack of site details for Natura 2000 sites and no information on how the Project affects these sites;

- No details of mitigation measures; and

- No recommendations for further survey work.

No clear evidence of correlation of data resulting from biodiversity surveys with the design and no discussion of whether residual adverse effects on site integrity will remain after the mitigation measures are applied.

13. Land acquisition

- Volume 9 Land Acquisition confirms that 857 ha are needed for the motorway;

- Volume 1 Synthesis calculates that 620 ha are needed;

- Environmental Impact Statement calculates that 795 ha are needed;

- The apparent inconsistency in total area of land will require a detailed review as part of the updated Feasibility Study. The information regarding area of forest land to be acquired is of particular importance for the environmental report as mitigation measures proposed would be a function of impact.

- Area of land required (permanent and temporary occupation of land) may not be accurate due to Gaps in the 3D modelling of the design; and

- Value of land in Deviz General was estimated at €46 million. This may be underestimated and may have been calculated used the 620 ha instead of 857 ha area of land for the project required according to Volume 9.

Responsibility for Expropriation to be shared between Consultant for updated Feasibility Study (who will undertake most of the task required in Law 255/2010) and the RNCMNR, who will check the documents.

Based on our review of the land acquisition documentation, it became apparent that a large number of unknown land owners exist. Also the documentation does not seem to include areas of land to be acquired for borrow pits or land to be occupied for the construction of access tracks along the motorway route, where required. Furthermore, the widening of the verge or central reservation in order to ensure adequate visibility, or verge widening required for the provision of safety barriers and ITS ducting, as well as other services, does not feature in the current design and this aspect would need to be addressed in the new ToR.

The existing Feasibility Study does not include allowance of temporary occupation of land required for the motorway construction. This is seen as a significant risk that could lead to delays in the completion of the construction works.

14. Motorway communication system

- Volume 10 of the Feasibility Study includes details related to motorway communication installations;

- Variable message signs are described and proposed to be installed near junctions and tunnels;

- Matrix signs providing live data on traffic, weather are described;

- Traffic loops acting as automatic traffic counters are described;

- CCTV equipment is described and indicative schedule of locations provided but no information included on no. of CCTV units based on coverage. This is regarded as a gap;

- Emergency phone system is described but no typical detail for access platform for this equipment was provided. This is regarded as a gap;

- The Cost estimates provided do not include quantities and unit rates used. This is regarded as a gap;

- Description of radio communication includes radio coverage maps for the route;

- Typical drawing showing the number of ducts required for the motorway system is included but the highway design drawings do not seem to correlate the data and allow sufficient soft verge width for the installation of these ducts. The typical section doesn't cover the physical segregation of optical cable ducting and power ducting which is required for health & safety considerations. This is regarded as a gap;

- The schedule of ITS equipment provided is to be reviewed and updated as part of the Feasibility Stage and correlation including integration of ITS equipment locations within the Design to be considered. This is regarded as a gap;

Confirmation of motorway communication strategy from RNCMNR is needed.

15. Public utilities

The proposed relocation and protection of public utilities is presented within Volume 11 of the Feasibility Study. The main comments are:

- The projects were completed at the Feasibility Study stage and the design was undertaken by licensed designers;

- It is not clear if the land to be acquired includes areas of land needed for the relocation of public utilities; and

- A public utilities co-ordination plan was not identified within the documentation provided. Such a plan is particularly useful for identification of specific hazards and for verification of interfaces between proposed works and public utilities.

The projects for protection and relocation of public utilities were completed in 2008 and are considered to be out of date due to possible changes in site conditions and modifications of the relevant legislation. As such, the projects will require a complete update and it is expected that the new ToR will require completion of both Feasibility Stage and Technical Project Stage in order to enable the receipt of the relevant third parties permits.

16. Permits and agreements

The existing Urbanisation Certificates issued by the three counties Sibiu, Valcea and Arges, as well as the other permits, are out of date and will need to be reapplied as part of the updated Feasibility Study.

The third party permits system is lengthy and quite often the process leads to delays in completion of the design either due to non-response from third parties or due to conditions imposed through the permitting system. The validity of permits is in many cases given as 12 or 24 months which could be restrictive and may require renewal of permits in some cases before the design is completed. It is acknowledged that a system for third party consultation and approval is needed.

The validity of all permits should be set to the duration of the construction contract. This would be in compliance with the requirements of Law 255/2010.

An important aspect that needs to be considered as part of the planned ground investigations (GI), archaeology and other site investigations, is the need for the future Consultant to apply for various third party permits in order to gain legal access to the site. Attention is drawn particularly to the intrusive investigations (GI and archaeology) and to their potential impact on Natura 2000 sites. The duration for application and receipt of such permits will be considered within the project implementation programme (minimum three months). This duration may be shorter or longer depending on the impacts identified (construction of temporary access road, removal of trees etc).

17. Outline Procurement strategy

The procurement strategy will be discussed in detail as part of the report that is to be delivered on 28th June in compliance with Task 4 of the Client's Terms of Reference. The procurement strategy related to project preparation and execution of works has to be adapted to the constraints of the financing source(s). In advance of this deadline Halcrow presented the initial outline considerations and the proposed approach to procurement. The presentation was delivered on 28th May 2013 to representatives of RNCMNR and JASPERS. The key aspects presented are summarised below.

Outline Procurement plan

If RNCMNR wish to procure services for updating the Feasibility Study using 2007 – 2013 EU budgets, an application form has to be completed and submitted to the Managing Authority. These EU funds are available for commitment until 31st December 2013. In the procurement report to be issued on 28th June we shall include proposals for both criteria for award allowed by Romanian law:

1. Lowest price; and
2. Economically most advantageous bid.

In the draft report to JASPERS we will recommend the latter option and propose evaluation factors.. In advance of the formal submission of the procurement report on 28th June **we would like to highlight the importance of having the entire tender documents finalised for upload onto SEAP** (Electronic System for Public Acquisitions) **on 12th August 2013,** with the aim of having the procurement notice published in the Official Journal of the EU (OJEU) by 7th September 2013 at the latest. This could create the basis for the services contract to be signed by 31st December 2013.

It is essential that a working relationship with ANRMAP (National Procurement Agency) is established during this period and JASPERS support for the materialisation of this objective is required.

Critical path for implementation of the Sibiu – Pitesti project

Any delay in the completion of the Feasibility Study will likely have a significant concomitant impact on the implementation of the contract (completion of construction and defect notification period – 24 months) within the time constraints of the 2014 – 2020 programming period.

With regard to project implementation programme it is envisaged that the following key dates require consideration:

- Commencement of tender procedures for the award of the Feasibility Study contract and Technical Advisor contract on 12th August 2013;
- Completion of the tender process and award of Consultancy Services contracts by the end of December 2013;
- Completion of the Feasibility Design by December 2015;
- Tender for the award of the Construction Works Contracts during 2016 (Land acquisition process to be completed by December 2016);
- Award of the construction Contract January 2017;
- Completion of Technical Project by the Contractors (including addition ground Investigation), receipt of Construction Permit by autumn 2017;
- Completion of Execution Designs by the Contractors autumn 2017 to spring 2018 with start of Construction on-site Spring 2018;
- Construction start on-site spring 2018 with duration of construction estimated to four years minimum; and
- Completion of construction autumn 2022 with the 24 months defects liability period extending into the year 2024.

The above represents a more realistic project implementation scenario which relies heavily on a key task – completion of tender documents for upload on SEAP on 12th August 2013, with the aim of having the procurement notice published in the OJEU by 7th September 2013 and award of the Consultancy Services Contracts by 31st December 2013. It is noted that the award of the Feasibility Study contract may be delayed beyond 31st December 2013 due to various risks that are difficult to quantify, for example tender claims and objections.

A high level review may be carried out by the Romanian Government through the Ministry of Transport and Infrastructure of the overall strategy for implementation of major motorway projects in Romania within the next programming period. The purpose of such review would be to establish potential impacts on available resources (financial, plant, equipment, materials and labour) required for the implementation of such projects.

The conclusions and recommendations of such a review are related to the feasibility and opportunity for the adoption of a staged implementation of the Sibiu – Pitesti motorway project and indeed staging and phasing of any of the other major motorway projects in order to ensure correlation with their implementation programme and available resources.

An optimistic works implementation scenario would involve the completion of the construction works by 2020, which in theory could be achieved through compression of the construction programme to three years and reduction of time allowance for the Contractor's Design to 6 months in order to enable a start of construction on site summer 2017. Due to various constraints relating to the complex approval process (including third party approvals), weather in the area traversed by the motorway route as well as terrain constrains, the requirement for additional ground investigation and completion of an adequate independent verification of the Execution Design, such a scenario would prove less feasible and should be treated with the appropriate due diligence and caution.

6 Final considerations

Halcrow's assignment started on 18th March 2013 with the official start-up meeting, organised by JASPERS, taking place at the Ministry of Transport headquarters on 9th April 2013.

The meeting was attended by a large number of representatives from Romanian National Company of Motorways and National Roads, Ministry of Transport and Ministry of European Funds, as well as members of the JASPERS management team. All participants were provided with information on the scope of the assignment, programme, key objectives and risks.

Following the completion and delivery to JASPERS of the DRAFT Gap Analysis Report on 24th May 2013, Halcrow's team represented by Alan Guthrie, Bogdan Fodor, Jeni Ionita and Kevin McGinty delivered a presentation on Tuesday 28th May to the representatives of JASPERS, RNCMNR and the Ministry of European Funds. The presentation outlined the main findings of the Gap Analysis review and provided preliminary proposals related to the procurement strategy. The meeting took place at the RNCMNR headquarters in Bucharest.

The frequent meetings and teleconferences already organised between JASPERS and Halcrow's key experts demonstrates not only a very good understanding of the project environment but also the task team determination to deliver the assignment on time, within budget and to the expected quality.

The existing Feasibility Study has been prepared under certain time constraints and limitations which have had an impact on the level of detail provided. The Gaps identified within this report are seen as a direct consequence of the very short time allocated for the completion of the existing study and by no means are suggested as a criticism towards the Consultant involved in the delivery of the existing Study. The main recommendation is for adequate time allocation for the update of the existing study within the scheme implementation programme in order to address gaps identified within this report. The estimate of time needed for the update of the existing Feasibility Study is twenty four months and this duration is based on the assumption that the award of the Feasibility Study will take place in either December 2013 or January 2014. Any delays to the award of the Feasibility Study contract may have a negative impact on the timeline required for the completion of the Feasibility Study. Negative impacts will be due to risks related to the winter season and subsequent impact on the ground investigation, archaeology and other similar site investigations contracts.

As mentioned above the project implementation timescale is very tight and risk of delays exist – this could be mitigated through early "buy in" from key stake holders (MoT – RNCMNR, ANRMAP, and MAEUR).

The Feasibility Study is to include a buildability review section for major works including proposals for temporary occupation of land required for temporary access tracks as well as considerations to transport of abnormal loads using the existing road network.

Procurement of the consultancy services for the update of the Feasibility Study by 31st December 2013 is imperative to the successful implementation of the project.

The outlined range of costs related to the project implementation task as well as construction works will be presented within the Procurement report which is detailed as Task 4 of JASPERS Terms of Reference. Based on the preliminary information the scheme implementation costs excluding VAT are estimated in the range of €2.2 billion to €2.9 billion.

The Gaps identified within this report will constitute the basis for the update of the technical Terms of Reference (ToR). Amongst the many technical aspects, the ToR will include a mandatory requirement for all the detailed specifications (known in Romanian as Tema de Proiectare) for all site and ground investigations to be submitted to RNCMNR for review and approval prior to commencement of works on site. In addition the ToR will require the future Consultant to deliver a Design Statement Report soon after the award of the contract (possibly 45 days). The purpose of the Design Statement will be to ensure that the methodology adopted by the future Consultant will include and address as a minimum the Gaps identified within this report. Amongst other elements the Design Statement shall include the list of applicable standards proposed by the Consultant for use in the design development. It is therefore recommended that a copy of this Gap Analysis report is made available to the successful tenderer (Consultant).

The structure of the revised ToR will be based on the document already published as part of the June 2012 tender process. It will aim to fill the Gaps indentified in this report and shall provide clear requirements for successful completion of the Feasibility Study. A Feasibility Study which shall be to the level of quality expected by the Romanian Authorities and the European Commission for such a major motorway investment project.