Technical Explanation

Introduction

Local population of Volkovo and Orman has objected through their authorised representatives about the location of the North Bypass of Skopje route.
The objections are mainly about the adverse impact of the route on the environment and the exact reasons are: the reservoir, the churches and burial ground of Volkovo, acquisition of agricultural land in Lepenec valley, the impact of the road on the crops, damage to biotopes, severance of Orman etc.
The objectors are recommending a new route north of Orman and north of Stenkovec airfield.
The objections on the route are submitted to the European Bank for Reconstruction and Development (EBRD) London as an interested creditor for realisation of the project.
The project is prepared by "Granitproekt" Skopje (now Balkan Consulting), and it is financed by The Fund for National and Regional Roads (FNNR) of the Republic of Macedonia.
For establishing the justifiability and the weight of the objections, EBRD has contracted the independent consultant Mr. Chris Holland from London, an expert in the field of transport planning.
Based on the detail study of the project relating to the above mentioned objections of the objectors, the Consultant is preparing a report.
In his detailed report from the overview of the technical documentation and from field inspection, the Consultant has taken the objector's objections mainly as justified. The revealed stand is mainly based on the fact that roads, besides the economical and social benefits, always have a negative impact on the environment, not that Planner has given an inadequate technical solution.
In his analytical approach to the consideration of the possibility for mitigating the negative impacts of the road on the environment, the Consultant is giving the following recommendations:
a) Investigation of a new route suggested by the objectors, north of Volkovo and Orman and north of the Stenkovec airfield and
b) Local changes of the current route with which negative impacts of the road on the environment would be mitigated.
The recommendation for an investigation of a new route north of Orman and Stenkovec airfield is forced by the objectors, while an investigation of new alignment in the micro corridor of the current route is a Consultant's idea.
Based on the available data from the Main Project and from the field investigation, the Consultant is making an analysis of the effects caused by the changes of the route according to the abovementioned recommendations. Based on the investigations he performed, he is mainly concluding that the current route, in the this terrain conditions, is a very successful solution.
Still, in order not to leave that conclusion in verbal form, through the FNRP, he is ordering the elaboration of this technical documentation through which, with technical and economical indicators, separate solutions will be analysed and compared.
For the elaboration of this technical documentation, the recommendations of the Consultant's report are taken as project conditions directed in two direction as:

- Elaboration of a Draft Solution in the Corridor as directed by the objectors, it's technical and economical evaluation and a comparison with the route from the Main Project (current route). The comparison should be made according to the recommendations from the Annex A from the report.
- Elaboration of an ameliorated technical solution with local horizontal and vertical adjustment of the current route near the churches in Volkovo according to the stated recommendations in the report and an economical comparison of the route.

1. North of Orman and Stenkovec airfield variant (Objector's route)

1.1 Project conditions

We have mentioned above that the Consultant's report is representing a project goal. It is referring to the quantity of works that has to be executed as well as the stage of elaboration (The Draft Solution). In order to make the project goal complete, the project conditions has to be known as well, which in this case we have taken from the "North Bypass" project goal:

Base project conditions

- Terrain: flat, hilly
- Planning period: 25 years
- Traffic load: over 12.000 vehicles AADT
- Road class: highway

Program conditions

- Calculation speed: V=120kmph
- Base speed: V=100kmph

  Planned level of service "D"

Exploitation conditions

- Traffic regime: Uninterrupted flows
- Crossroads level: lowered

Constructive elements

- Lanes ..... 2x (2x3 , 75) = 15,00m^1
- Edge lanes ..... 2x0 , 50+2x0 , 25 = 1,50m^1
- Stop lanes..... 2x2, 50 = 5,00m'
- Road profile ..... 2x10 , 75 = 21,50m^1
- Split lane ..... = 4,00m^1
- Rigolaberme ..... 0 , 75+1 , 00 = 1,75m^1
- Road shoulders ..... 2x1 , 00 = 2,00m^1
- Planum ..... = 27,50m^1
- Maximum along inclination ..... = 4%
- Maximum transversal inclination ..... = 6 %

1.2 Base for elaboration of the Project

For elaboration of the topical technical documentation, beside the Main Project for the Bypass of Skopje (current route), maps from the Army Headquarters were used in R=l: 25.000, as well as detail inspection of the terrain.

1.3 Topographic characteristics of the terrain

The indicated Corridor for locating the route north of the Stenkovec airfield and north of

the Orman village, from topographic aspect, can be characterised as the following:
On the first part, north of the Stenkovec airfield, from the road Skopje - Banjani to the river Lepenec, the terrain is characterised as very favourable for terracing, characterised with a mild along and transversal inclinations of the natural terrain.
The second part of the indicated Corridor is characterised with very much expressed morphology which is consisted of the valley of river Lepenec and river Kuckovska reka as well as the hills Stenkovec, Gniliste, Krastavac, Panzirkovo, Bela Glava etc. which are characterised with steep slopes in along as well as transversal direction. In conditions of the mentioned topography, during the lining of the highway route, significant cuts in the terrain are expected on this part, as well as usage of artificial objects for bridging, as bridges, viaducts and tunnels.

1.4 Existing and planned infrastructure

Beside the natural topographic characteristics, during the lining, the existing and planned infrastructure in the indicated Corridor also have a significant influence, as follows: villages Gorno Orizari, Orman and Nikistane, burial ground in Nikistane, Stenkovec airfield, M-3 highway and larger number of local roads, railroad Skopje - Kacanik, as well as the planned highway Skopje -Blace.

1.5 Horizontal solution

In the conditions of the mentioned topography of the terrain and the existing and planned infrastructure, and after detailed inspection of the terrain on Military Headquarters maps in R=l: 25.000, a horizontal draft of the objector's route has been elaborated.
The start of the route as a part of the current route through Volkovo is on km 12+686.09 north of Suto Orizari. The end of this variant with km 23+475.36 = km 21+120 (according to the current variant through Volkovo) is on southwest of Volkovo.
The route is shaped with five horizontal curves which are securing the project speed of V=120 kmph. This route in relation to the Volkovo route is longer for 2.35 km.
During the defining of the horizontal draft, the position and the angle of the intersection with the planned highway Skopje - Blace has been particularly considered, in order to define a lowered road junction Stenkovec. Every realization is pointing to the fact that that the new location for the road junction Stenkovec is less favorable in relation to the current variant through Volkovo, in relation to the morphology of the terrain as well as in relation to the fitting. In the broader area where the junction Stenkovec is planned, there are a dozen households built, one gas station and one asphalt base. It is expected that the junction will seize several of this buildings, and a deviation of the existing M - 3 road with length of 1 km will be needed.

1.6 Vertical solution

The mentioned topography of the terrain along the route also has repercussions on the leveling solution. On the first part from km 13 to the river Lepenec, the leveling is characterized with mild along inclinations and small earthworks. On the second part of the route, the expressive topography of the terrain, manifested through steep slopes and transversal inclinations of the terrain, has conditioned the usage of limits of 4% along inclination as well as significant cuts of the terrain, usage of bridges and tunnels on one part of the route with length of 1=1.25 km.

1.7 Normal transversal profiles

The profile of the highway is defined with the project goal and the current legislative and technical regulative and it is constant along the whole length of the route, as stated:
- Roadway 2 x (2x3, 75) ..... = 15,00m^1

- Edge lanes 2x0, 50+2x0, 25 ..... = 1,50m^1
- Stop lanes 2x2, 50 ..... = 5,00m^1
- Split lane ..... = 21,50m^1
- Rigola berme 0, 75+1, 00 ..... = 4,00m^1
- Road shoulders 2x1, 00 ..... = 1,75m^1
- Planum ..... = 2,00m^1

In the scope of the Corridor K-8 East-West where this route belongs, a reducing of the transversal profile in the tunnels on the expense of the stop lane of 1.5 m^1 has been performed. In other words, the profile of one lane in the tunnel is 2x3.50+2x0.35 = 7.70 m^1.

1.8 Applied constructive solutions

In accordance with the elaborated horizontal and vertical drafts in conditions of the current topography and the infrastructure along the objector's route, following constructive solutions are foreseen:
Road crossings as overpasses on km 14+310, km 15+300, km 16+280 and 17+780
Underpasses on km 19+600 and km 20+762.53
Overpass on km 6+900 on the existing M-3 road over the planned highway Skopje - Blace
Bridge on km 18+320 over the river Lepenec and the railroad Skopje - Kacanik
Viaduct on km 22+335 over the river Kuceviska reka and the road Volkovo - Kuceviste
Tunnel through the Pancirkovo hill with length of 1250 m
Smaller excavations and embankments north of the Stenkovec airfield as well as important excavations and embankments after the river Lepenec.

1.9 Preliminary estimation of the works

An approximate preliminary estimation has been made for all kinds of construction works with calculations of the works. Total value of the works according to the preliminary estimation is:
- Current route ..... = 41.037.296, 00 EUR
- Objector's route ..... = 72.689.669, 00 EUR

difference ..... =31.652.373,00 EUR

Explanation of the calculations

The comparison of the variants is made from km 12+686.08 to km 21 + 120.00 (according to the current route) which is identical to km 23+475.36 on the objector's route. The objector's route is longer for 2.35 km in relation to the current route.
The quantities of works for the current route are taken from the Main Project, which presents great accuracy for this stage of planning. The quantities of works for the objector's route are mainly estimated in relation to the current route which also gives assurance for greater accuracy.
As a result of the less favorable terrain conditions on the location for the junction Stenkovec on the objector's route, its price is increased for 10% in relation to the price for the current route.
The price for the traffic signalization and equipment, illumination and drainage is accepted as 30% higher because of the 30% increased length of the route.
The price for the tunnel comprises the construction works, illumination and ventilation and it is accepted as average value from the Planner's value of majority of tunnels planned on the Corridor 8, for the part passing through Macedonia. In the Project according to the normal transversal profile, a reduced profile of the highway has been foreseen in the tunnel, i.e. without stop lane.

From the submitted calculation of the works, it's obvious that the current route has a significant advantage in relation to the objector's route.

1.10 Comparison of the variants

In the annex A from the report, the consultant, beside the economical comparison, is recommending an appraisal and comparison according to the criteria stated in the Table on the pages 39 and 40. Based on the recommended principals of apprising of the expropriation, residential quality, quality at places of assembly, flora and fauna, landscape and pollution, a appraisal has been made on the routes and it's given in the following table:

Characteristic/Impact	**Current (moved) route**		**Objector's route**	
	quantity/ subjective value	**impact rating**	**quantity/ subjective value**	**impact rating**
Length (km)	8.43 km	minor	10.79	major
Cost incl. ameliorating measures €	41.037.296,00	minor	72.689.669,00	major
EXPROPRIATION Houses acquired Total land (first category) taken (ha)	9 5	minor minor	10 6	minor minor
RESIDENTIAL QUALITY houses subject to over 50 dB(A) night - at Przini (east of the river) - at Volkovo / Orman - at Nikistane	 10 20 -	 minor medium -	 - 5 50	 - minor major
visual quality/character - at Przini / Gorno Orizari - at Volkovo / Orman	 medium medium	 medium medium	 good -	 good -
quality at places of assembly - church at Volkovo / burial ground - at Nikistane - school at Orman (Volkovo)	 High - low	 major - minor	 High -	 major -
flora and fauna **-** loss of biotopes categories 3 and 5	low	minor	low	minor
landscape **-** east of river - west of river / zone S and Z from Orman - hills north and west of Volkovo	 low high high	 minor medium major	 low high minor	 minor medium minor
pollution (worst case of vehicle standards) Total CO2 tons per year Total NO2 tons per year	 11.500 195	 medium medium	 14.000 240	 medium medium

It is in the Planners conclusion that the current route has an advantage over the objector's route.

2. Local movement of the current route variant (Consultant's route)

The consultant in principle is considering all of the objections from the objectors on the current route as justified. Talking about the objections, he is giving the following explanations:

- Regarding the reservoir and the school, it is in his opinion that the Planner has considered the consequences from the construction of the highway.
- Regarding the acquisition of the agricultural land, the impact of the road on the crops quality, the endangerment of the biotopes, the pollution etc., it is in his

opinion that those impacts will be present in any route.
- He is considering the objection about the impact of the road on the churches and the burial ground in Volkovo as serious as well as the residential conditions in the vicinity of the highway in the weekend settlement by the river Lepenec near Przini.

In order to ameliorate the impact of the road over the churches, burial ground and the weekend settlement in Przini, he is suggesting a change of the technical solution even if it demands increasing of the construction costs.
The subject of this part of the project is a variant with local displacement of the current route. The elaborated technical documentation on a Draft level, as a second alternative, has the following technical characteristics in plan and profile.

2.1 Horizontal solution

As an elaborator of the Main Project for the current route, the Planner is expressing full support that there is always a better route for increased investments and that increasing the quality of road's impacts over one subject on other's expense is always possible. Having in mind the aforementioned stand, the Planner is making a correction of the current route according the stated recommendations from the Consultant as follows:
- Bypassing the weekend settlement in Przini and
- Displacing the current route in the vicinity of the churches and the burial ground in Volkovo for about 70 m west from the current route

On previously reonbulirani situation bases in R = 1:1.000 with applied existing infrastructure, a technical solution has been elaborated on the displaced route.
The start of the change is at km 16+512.75, while the end is on km 20+964.13, identical to the 20+800 on the current route and it is longer for 164.13 m. The horizontal solution is formed with elements on the curves that are securing the planned speed of V = 120 kmph.
Minimal applied radius on the horizontal solution on the change is R = 1.050 m. In relation to the current and planned infrastructure, the new route has the following characteristics:
- Favorable angle of intersection with the route of the planned highway Skopje - Blace with which the junction Stenkovec is planned is kept.
- The angle of intersection with the river Lepenec is somewhat less favorable in relation with the current route.
- The intersection with the railroad Skopje - Kacanik is under angle of 90°.
- Weekend houses in the settlement of Przini are completely bypassed from their north side.
- In the area of the churches and the burial grounds, 6 (4) individual residential buildings are affected.
- The part north of Volkovo from the road to Orman to the burial grounds is solved with a
- tunnel 1 = 1.100m.

On this part, if eventually this variant is accepted, during the elaboration of the Drafts and Main projects, separated roadways will have to be considered with min 3d between the axes of the roadways while "d" is the width of the roadway for !/2 highway.
The separation of the roadways will condition increased expropriation in the area of Volkovo burial grounds.

2.2 Vertical solution

The vertical solution for the current route on the part where the transition from the plane of the river Lepenec's valley to the hilly region north of Volkovo is, is solved with an

inclination of 4% as a limit inclination.
Maximum excavations on the point around km 19 are approximately 20 m. With the new solution, with displaced axis towards a hill for around 70 m horizontal, in height perspective the peak elevations on the terrain are raised for 10 m average, and the excavations from 20 to 30 m, so the need for applying a tunnel solution is imposed.
But the tunnel solution, from it's side, according to the current technical and legal legislation, is imposing a need for using a maximum along inclination of 2.5% and maximum transversal inclination of the road of 5%.
Sublimating the aforementioned conditions, the vertical solution in the displaced route is drawn on the following way:
The peak elevation of the route intersection with the railroad Skopje - Kacanik has been taken as a fixed point, with what a free profile for the railroad has been secured.
From the intersection with the railroad with inclination of 2.5% as "imax" in tunnels, the level of this part of the changed route has been drawn. On that way drawn level has conditioned an usage of tunneling solution with length of 1.1 km on the part north of Volkovo. On the remaining part, the level is adjusted to the current terrain conditions, and at the same time is included in the current trace level.
Formed with one vertical direction with inclination of 2.5% and two vertical circle curves, from which one is with R_{mJn} = 12.500 m, the vertical solution of the displaced route is in harmony with the project conditions and it is representing a very successful solution.

2.3 Normal transversal profiles

In the scope of the Corridor K-8 East-West where this section belongs, a reducing of the transversal profile in the tunnels on the expense of the stop lane of 1.5 ml has been performed. In other words, the profile of one lane in the tunnel is 2x3.50+2x0.35 = 7.70 ml.

2.4 Applied constructive solutions

On the part outside of the change made with this project, the current route is still valid. On the part with the change, following construction solutions are foreseen:

- The junction Stenkovec is accepted as it is in the current route in all of the calculation indicators.
- On the part from river Lepenec to the local road Volkovo - Orman, the applied construction solutions for the current route are accepted for the displaced route too, as follows: a bridge on river Lepenec, viaduct Orman, retained embankment between river Lepenec and the railroad as well as crossings (underpasses) on km 17+433.33 and 17+929.42.
- The excavation on the current route from the road Volkovo - Orman to the burial grounds in Volkovo according to the displaced route is provided with tunneling, because of the increase of the excavations from approximately 20m to 30m.
- The viaduct Volkovo is planned on the displaced route, but this time very shorter.
- The excavation on km20+600, (20+500) (at the reservoir) is kept as an excavation on the displaced route.

A very significant difference in the applied construction solutions on the displaced route in relation to the current route is the 1.1 km tunnel.

2.5 Preliminary estimation of the works

To establish the value of the costs of the routes, an approximate preliminary estimation is elaborated in order to calculate the works.
The preliminary elaboration with calculation of the works is elaborated in the boundaries of the objectors variant, in other words from km 12+686.00 to km 23+475 = 21+120 according to the current route.

It is done in order to make all three variants (the current route, the micro displaced route and the objector's route) comparable.

According to the calculations, total value of the works by variant is:

- Current route ..... 41.037.296.00 €
- Micro displaced route ..... 61.112.491.00 €
- Objector's route ..... 72.689.669.00 €

The value of the works for the current route for the line from km 21 + 120 to km 25+289 (Saraj) according to the Main project is 17.357.010.00 € and it the same for all three variants. If we add this value separately to each of the variants, we'll get the total value by variant for the section Orizari - Saraj from km 12+686 to km 25+289, which is:

- Current route ..... 58.394.306.00 €
- Micro displaced route ..... 78.469.502.00 €
- Objector's route ..... 90.689.669.00 €

Summary of the results

From the aspect of needed investments for realization of the project, current route is the most acceptable one. Moreover, from the aspect of the impact of the road over the environment, no significant improvements have been achieved with the displaced route and the objector's route in relation to the current route.
Objector's route is 2.35 km longer.
Current route, which is a result of displacing Novo Selo route, is 2.5 km longer in relation to the same.
Total extension of the objector's route is 5km that has a strong influence on the construction and exploitation costs.
Above stated stands on the planner are without any conclusion or suggestion.
Having in mind the purpose of this technical documentation, the final opinion is left to the one who ordered it.

Elaborated by:
dipl. civil engineer Cekov Kiro
dipl. civil engineer Ristovski Riste