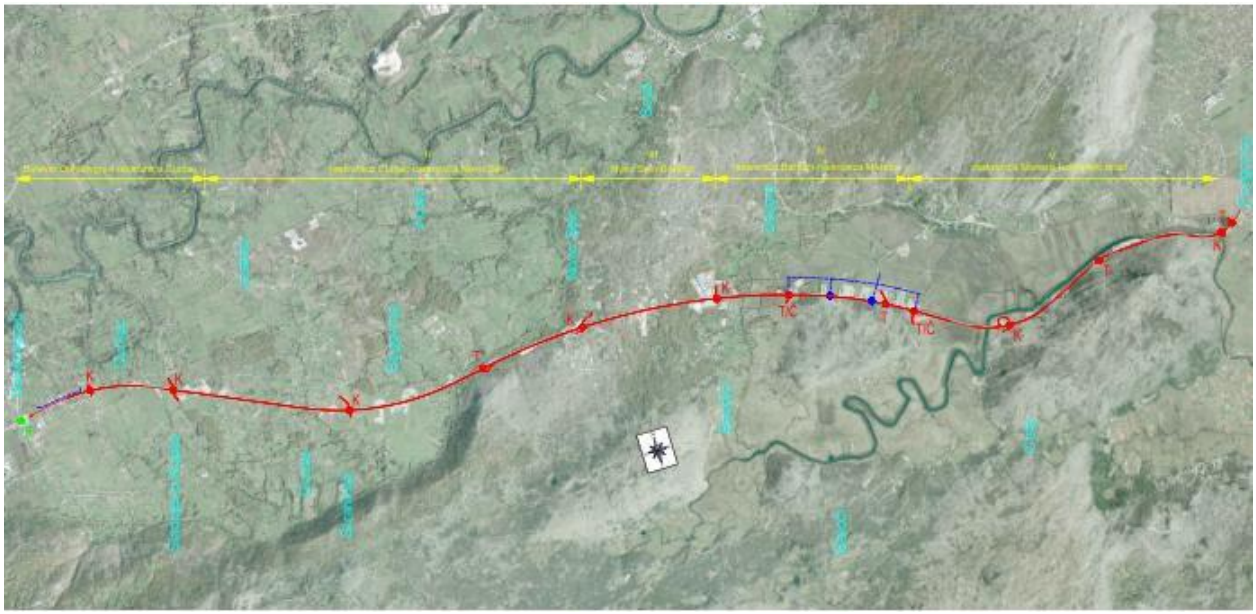
MEDIX d.o.o.
PODGORICA
SLOVAČKA 27

PIB: 02280175
PDV: 30/31-00238-8
Ž.R.: 530-1679-20

GENERAL CONTRACTOR: GOVERNMENT OF MONTENEGRO –– TRAFFIC DIRECTORATE

ENVIRONMENTAL IMPACT ASSESSMENT OF RECONSTRUCTION THE MAIN ROAD M-18 SECTION PODGORICA - DANILOVGRAD (EIA Study)



Podgorica, july 2019.

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1. GENERAL INFORMATION

- Information about the project developer
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- *Information about the project developer*

PROJECT DEVELOPER: THE GOVERNMENT OF MONTENEGRO – MONTENEGRIN TRANSPORT ADMINISTRATION

AUTHORISED PERSON: SAVO PARAČA

CONTACT PERSON: NIKOLA ARNAUT

ADDRESS: IV PROLETERSKE 19, PODGORICA

COMPANY REGISTRATION NUMBER (CRN): 02420970

PROJECT LEADER REGISTRATION NUMBER: 02420970

PHONE NUMBER: 020/655-084

FAX: 020/655-359

e-mail: nikola.arnaut@dzs.gov.me

- Main information about the project

b) PROJECT TITLE: "RECONSTRUCTION AND UPGRADE OF THE MAIN ROAD M-18 SECTION PODGORICA-DANILOVGRAD"

LOCATION: BOULEVARD DANILOVGRAD – INTERSECTION NOVO SELO-KOMANSKI BRIDGE, FROM ch. km 114+500 UP TO km 129+500

ADDRESS: Danilovgrad-Podgorica section

Pursuant to Article 19 of the Law on Environmental Impact Assessment ("Official Gazette of Montenegro", no. 75/18) I hereby adopt the

DECISION

On forming a multidisciplinary team for the purpose of assessing the impact of reconstruction of the Main Road M-18, section Podgorica Danilovgrad on the environment. The team will be as follows:

1. Prof. dr Darko Vuksanović, metallurgical engineer
2. Prof. dr Mihailo Burić, geological engineer
3. Mr Dragan Radonjić, technological engineer
4. Dr Snežana Vuksanović, biologist
5. Dr Miloje Šundić, biologist
6. Ivana Raičević, environmental protection specialist
7. Dr Milenko Petrović, mining industry

Associates:

8. Milan Maraš, specialist of chemical technology
9. Miljana Vuković, specialist of biology

During the course of development of the Environmental Impact Assessment Study, the multidisciplinary team must comply with the Law on Environment ("Official Gazette of Montenegro, no. 52/16), the Law on Environmental Impact Assessment and other legal provisions and delegated legislation which are applicable in regard to environment.

The designated team members fulfil the conditions which are stipulated by Article 19 of the Law on Environmental Impact Assessment.

The team member I am hereby appointing as the coordinator of the process of development of the environmental impact assessment study is Ivana Raičević, the environmental protection specialist.

Company "MEDIX"
CEO
Ljiljana Vuksanović, economist

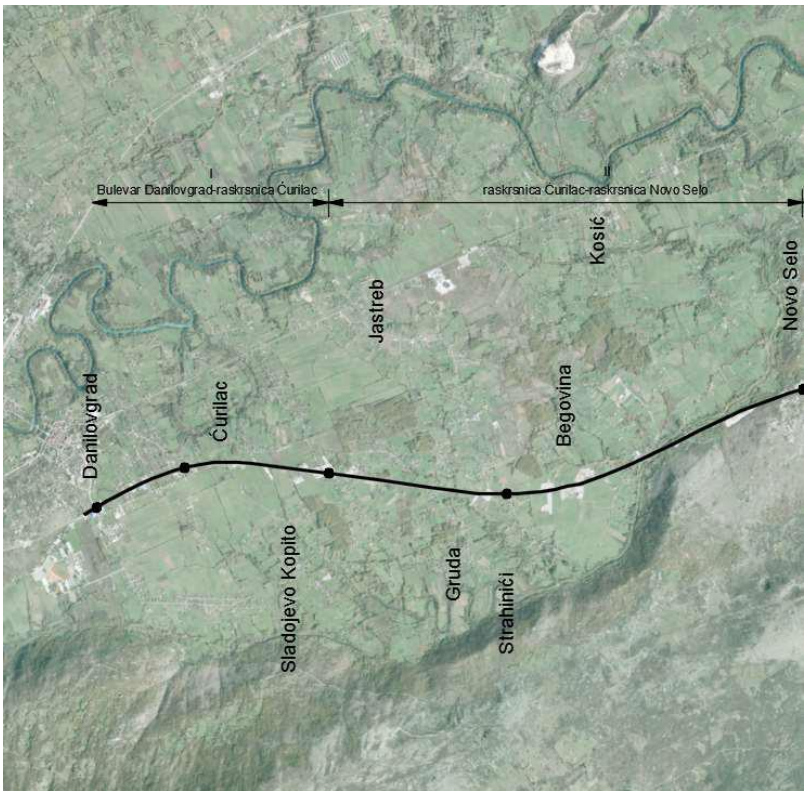
Stamp

2. LOCATION DESCRIPTION

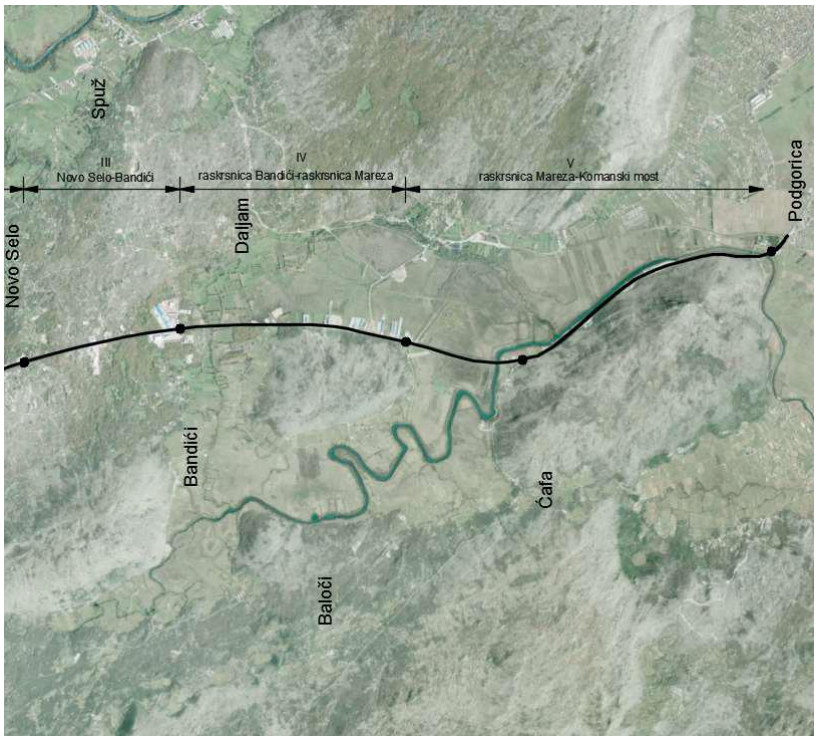
Direction of the Main road Podgorica-Danilovgrad is south-southwest. The total length of the road section from Danilovgrad to Podgorica is 15.132 km. The starting point of the road section is located at the exit from the roundabout in Danilovgrad (the starting section of the Danilovgrad boulevard), while the end point is located at the entrance to Podgorica and it encompasses the area after the Komanski ski Bridge and entrance to the suburban settlement Gornja Gorica.

An overview map of the project area is shown in Figure 1, while the Figure 2 provides an overview map which includes the project implementation phases.

Figure 1. *Overview map of the project area*



a)



b)

Figure 2. *Overview map with project implementation phases*

2.1. Cadastral parcels which are planned to be used for the purpose of project implementation

It is planned to build a boulevard along the entire road section from Podgorica to Danilovgrad. The planned reconstruction of the road is in line with the provisions defined in the Spatial Plan of Montenegro until 2020 and the guidelines provided in the Spatial-Urban Plan for the Capital Podgorica until 2025.

As it has been defined in the Spatial Plan of Montenegro until 2020, the subject road section should be upgraded to a motorway for fast traffic. Taking into account the configuration of the terrain, as well as the spatial limitations imposed by the traffic-technical design conditions, it was defined that the speed limit should be 80km/h.

The road section passes through several cadastral municipalities in the project area, and it includes the following cadastral parcels:

Previous condition:

Danilovgrad

CM GRLIĆ
CP 551/4,551/3,552,556/2,582, 581, 662/2, 662/1, 652, 751/2, 750, 749, 634, 660/1, 660/2, 654, 653, 656/1, 655/1, 639/2, 657, 655/2, 656/2, 579/4, 579/2, 635/1, 633, 631/1, 631/2, 632, 627/1, 627/4, 627//3, 625/1, 613/2, 613/1, 629/2, 556/1, 625/2, 627/2, 626/1, 635/2, 636, 662/2, 624/1, 708/6, 756/1, 663/3,748/1

CM GLAVICA
CP 2089/2, 2089/1, 2085/3, 2085/1, 2077/1, 2085/2, 2082, 2081/2, 2080/1, 2080/2, 2079/2, 2079/1, 2077/2, 2068/2, 2068/1, 2067/2, 1968, 1969/2, 1994/2, 2065, 2066, 2073/1, 2064/1, 2055/3, 2055/6, 2086

CM BANDIĆI
CP 714/90, 714/5, 714/1, 714//2, 714/1, 865/1, 867/3, 865/3, 867/1, 867/5, 864/2, 870/5, 870/4, 864/1, 863/7, 871/1, 855/3, 3472/3, 3472/1, 855/1, 854/1, 843/6, 810/2, 809/1, 809/11, 809/12, 845/2, 810/1, 812/4, 812/2, 812/1, 814/1, 803/1, 796/1, 714/56, 867/4, 868/1, 870/1, 871/3, 842, 813/5, 813/2, 813/2, 813/2, 813/1, 814/3, 818/1, 802/3, 797/1, 3480/1, 714/60

CM DONJI ZAGARAČ
CP 864, 865/1, 866, 867/1, 869, 867/2, 872, 871, 876/2, 875/2, 875/1, 876/1, 879, 881, 882

CM NOVO SELO
CP 1246, 1218, 1244/22, 1244/10, 1244/1, 1309/2, 1311, 1315/9, 1313, 1066, 1353/1, 1356, 1372/3, 1342, 1341, 1540/1, 1540/110, 1486/2, 1153/1, 1309/4, 1242/1, 1245/1, 1244/11, 1275, 1310, 1314, 1399, 1357, 1338, 1353/15, 1374, 1435, 1443, 1485, 1219, 1221, 1220, 1222, 1227, 1229, 1060, 1062, 1228, 1059/1, 1061, 1226, 1234, 1240/1, 1063, 1236, 1064, 1240/2, 1241/2, 1243/1, 1244/8, 1315/8, 1318/2, 1334/1, 1067/4, 1067/3, 1067/1, 1068/1, 1069, 1070, 1071, 1153/6, 1153/10, 1153/5, 1153/9, 1153/11, 1120, 1121, 1355, 1354, 1358/1, 1365, 1367, 1339, 1340, 1353/13, 1353/3, 1353/16, 1353/11, 1353/12, 1373, 1436, 1540/23, 1540/31, 1540/7, 1486/1, 1388, 1213, 1216, 1360, 1368

CM JASTREB
CP 110, 111, 109, 102/3, 688, 112, 659, 106, 107, 117/1, 113, 117/2, 125, 122, 124, 123, 119, 937, 577, 629/1, 130, 129/6, 126, 128, 127, 129/3, 129/4, 129/5, 129/2, 133/3, 220, 221/6, 221/5, 227/5, 227/1, 227/2, 227/3, 227/4, 227/6, 228, 229/1, 229/2, 252, 255, 256, 259, 260, 261, 262/1, 529/1, 263, 262/2, 427, 426, 428, 424/1, 425/2, 424/2, 407, 396, 406, 423, 422, 421, 417, 283, 664, 601, 420/1, 418, 1909, 419, 397, 411, 410, 403, 402, 399, 398, 1912, 1914, 1911, 1910, 529/2, 529/3, 575, 604/4, 663, 661/1,
661/2, 660, 666, 657, 608, 656, 687, 655,668, 665, 696, 698, 700, 701, 702, 72, 607, 674

CM ĆURILAC
CP 959, 960, 961/1, 962/2, 955/2, 956/1, 962/4, 954, 962/3, 2323/1, 2320/1, 2321/1, 2322/1, 2324/1, 2324/2, 2323/2, 2322/2, 2321/2, 1604/2, 2319/1, 943/3, 943/1, 943/2, 949/27, 949/28, 949/29, 949/26, 949/57, 949/23, 949/19, 949/18, 949/16, 949/53, 949/15, 949/14, 948, 945/3, 946/14, 946/12, 946/13, 947/1, 1291/35, 1291/48, 1291/34, 1291/50, 1291/51, 1291/33, 1291/32, 1291/31, 1291/30, 1291/54, 1372/1, 1373/1, 1378, 1291/29, 1377, 1341/1, 1340, 1339, 1376/2, 1352/2, 1396/2, 1397/4, 1397/2, 1401/2, 1653, 1652, 1651/2, 1649, 1630/2, 1634, 1611/9, 1611/1, 1610/7, 1606/2., 1586, 1584, 1537, 1610/1, 1373/3, 1389, 1387/4, 1291/27, 1291/26, 946/11, 946/9, 946/8, 946/18, 946/10, 949/74, 949/17, 949/7, 949/64, 949/6, 949/5, 949/22, 949/21, 1351/1, 1376/1, 1378/1, 1390/2, 1385/5, 1387/2, 1401/4, 1400, 16667777, 1678, 1605, 1613/2, 1594, 1593, 1600, 1585, 1535, 1536, 1588, 1528, 1538, 1604/1, 1532, 1650, 1630/1, 1401/1,

1291/28, 1372/2, 1341/2, 1291/21, 1291/14, 1291/20, 1291/13, 1291/12, 1291/11, 946/4, 946/3, 946/2, 940/1, 949/2, 941/3, 941/2, 942, 1402, 1292/1, 1349/1
Podgorica

CM BERI
CP 1608/3, 1608/1, 1609/1

CM BALOČI
CP 3146/2, 3147/1, 3164/1, 3165/1, 3175, 3165/1, 3175, 3165/2, 3151/1, 3191/2, 3195, 3151/3, 3191/1, 3156, 3152/2, 3153, 3193, 3166, 3174/4, 374/3, 3189, 3190, 3192, 3194/1, 3196/1, 3188/2, 3204/3, 3204/2, 3203/4, 3155, 364/2, 3164/3, 3163/2, 3163/1, 3162/1, 3162/2, 3181, 388/1, 3188/3, 3225, 3204/1, 3206/3, 3203/2, 3206/1, 3205, 3203/1, 3207/1, 3207/3, 3213/1, 3214/1, 3208/1, 3208/2, 3209, 3212, 3219/1, 3221/2, 3221/5, 3221/6, 3227/1, 3227/2, 3213/2, 3213/3, 3218, 3217, 3578/1, 3578/3, 3578/3, 3578/4, 3218, 3217, 3578/1, 3578/3, 3578/3, 3578/4, 3578/5, 3578/6, 3578/10,3578/11

CM DONJA GORICA
CP 732/1, 4085/2, 726, 725, 4184, 759/1, 4188, 4215, 4190, 4186, 4076/1, 4191/3, 4187, 4185, 760/2, 785, 787, 720/1, 722, 728, 729, 730, 731

CM TOLOŠI
CP 3756, 4123, 3754, 3755, 3759, 4637, 4146, 5054, 4122/2, 4122/4, 4130/2, 4130/3, 4129/3, 4131, 4135, 4137, 4138, 4139, 4140, 4142/3, 4142/2, 4143, 4144/1, 4144/2, 4145, 4147, 4291/1, 4148/1, 4148/2, 4291/3, 4201, 5130, 5131, 5143/1, 76, 4657/2, 4660, 4661/2, 4664, 4666, 4667, 4668, 4669, 5182/2, 5182/2, 5182/1, 5181/1, 5180, 5179, 5178, 5133, 5134, 5135, 6143/2, 5148/1, 5147, 5148, 4170, 5185/2, 4749/2, 5185/3, 4749/1, 4295/3, 4553, 4167, 4172, 4171, 5183, 5177, 5184, 5192/1, 4141, 4169, 4142/1, 4168/4

Current condition (parcels to be acquired):

Danilovgrad

CM GRLIĆ
CP 551/7,551/8,552,556/4,582, 581/2, 662/3, 662/1, 652/2, 751/3, 750/2, 749/2, 634/1, 660/3, 660/3, 654/1, 653/1, 656/1, 655/1, 639/3, 657/2, 655/3, 656/2, 579/4, 579/7, 635/7, 633/, 631/1, 631/2, 632, 627/7, 627/6, 627/5, 625/5, 613/6, 613/4, 629/4, 556/4, 625/4, 627/8, 626/3, 635/3, 636/2, 662/8, 624/5, 708/50, 756/5, 663/4,748/3

CM GLAVICA
CP 2089/3, 2089/4, 2085/3, 2085/4, 2077/6, 2085/5, 2082/2, 2081/3, 2080/3, 2080/4, 2079/3, 2079/4, 2077/6, 2068/3, 2068/4, 2067/2, 1968/2, 1969/3, 1994/3, 2065/2, 2066/2, 2073/2, 2064/2, 2055/8, 2055/7, 2086/2

CM BANDIĆI
CP 714/97, 714/98, 714/101, 714//100, 714/102, 714/103, 865/5, 865/7, 867/7,865/3, 867/8,867/9, 864/4, 870/5, 870/7, 864/3, 863/17,863/18, 871/4, 855/4, 3472/5, 3472/4, 855/4, 854/2, 843/11, 810/4, 809/16, 809/13, 809/15, 809/14, 845/11, 810/3, 812/4, 812/5, 812/6, 814/6, 803/2, 796/4, 714/104, 867/7, 868/2, 870/6, 871/4, 842/2, 813/6, 813/7, 813/8, 814/8, 814/7, 818/2, 802/4, 797/5, 3480/2, 714/105

CM DONJI ZAGARAČ
CP 864/2, 865/4, 866/2, 867/4, 869/2, 867/2, 872/2, 871/2, 876/3 ,876/4, 875/2, 875/3, 876/5, 879/2, 881/2, 881/4, 882/4,882/2

CM NOVO SELO
CP 1246/2, 1218/2, 1244/16, 1244/12, 1244/14, 1244/15, 1309/5,1309/6, 1311/1, 1315/15, 1313/1, 1066/2, 1353/21, 1356/2, 1372/4, 134/22, 1341/2, 1540/125,1540/126,1540/126, 1540/124, 1486/3,1486/4, 1153/27,1153/28, 1309/7, 1242/2, 1245/7, 1244/13, 1275/4,1275/2, 1310/1, 1314/2,1314/4,1314/5, 1399/2,1399/4, 1357/2,1357/3, 1338/3,1338/2, 1353/28, 1374/2,1374/4, 1435/2, 1443/2, 1485/2, 1219/2, 1221/2, 1220, 1222/2, 1227/2, 1229/2, 1060/2, 1062/2, 1228/2, 1059/3,1059/4, 1061/2, 1226/2, 1234/2, 1240/3, 1063/2, 1236/2, 1064/2, 1240/4, 1241/3, 1243/4, 1244/17, 1315/11,1315/14, 1318/2, 1334/3, 1067/5,1067/6, 1067/7, 1067/1, 1068/5,1068/6, 1069/2, 1070/2,1070/4, 1071/2, 1153/13, 1153/12, 1153/14, 1153/15, 1153/16, 1120/2, 1121/2, 1355/2,1355/3, 1354/2, 1358/3, 1365/2, 1367/2, 1339/2, 1340/2, 1353/25, 1353/26, 1353/22, 1353/24, 1353/23, 1373/2, 1436/2, 1540/27, 1540/28, 1540/29, 1486/4, 1388/2,1388/3, 1213/2 1216/2, 1360/2, 1368/2

CM JASTREB
CP 110/2, 111/2, 109/2, 102/5, 688/2,688/3, 112/2, 659/2, 106/2, 107/2, 117/4, 113/2, 117/3, 125/2, 122/2, 124/2, 123/2,123/1, 119/2, 937/2, 577/2, 629/3, 130/2, 129/9, 126/2, 128/2, 127/2, 129/6, 129/7, 129/8, 129/10, 133/4, 220/2,221/8, 221/7, 227/7, 227/8, 227/9, 227/10, 227/11, 227/12, 228/2, 229/4, 229/3, 252/2, 255/2, 256/2, 259/2, 260/2, 261/2, 262/4, 529/3, 263/2, 262/2, 427/2, 426/2, 428/2, 424/3, 425/3, 424/4, 407/2, 396/2, 406/2, 423/2, 422/2, 421/2, 417/2, 283/2, 664/2,664/3, 601/2, 420/2, 418, 1909/2, 419/2, 397/2, 411/2, 410/2, 403/2, 402/2, 399/2, 398/2,

1912/2, 1914/2, 1911/2, 1910/2, 529/6, 529/5, 575/2, 604/5, 663/2, 661/4, 661/5, 660/2 666/2, 657/2, 608/2, 656/2, 687/2, 655/2,668/2, 665/2, 696/2, 698/2, 700/2, 701/2, 702/2, 72/2, 607/2, 674/2

CM ĆURILAC

CP 959/2, 960/2, 961/3, 962/5, 955/3, 956/4, 962/6, 954/2, 962/5, 2323/3,2323/5, 2320/3, 2321/3,2321/5, 2322/3, 2324/3, 2324/4, 2323/6, 2322/5, 2321/7, 1604/3, 2319/3, 943/5,943/6, 943/6, , 949/75, 949/76, 949/77, 949/78, 949/79, 949/80, 949/81, 949/82, 949/83, 949/84, 949/85, 949/86, 948/2, 945/4, 946/21, 946/12, 946/22, 947/6, 1291/65, 1291/66, 1291/67, 1291/68, 1291/69, 1291/70, 1291/32, 1291/71, 1291/72, 1291/73, 1372/3, 1373/5, 1378/2,1378/3, 1291/74, 1377/2, 1341/3, 1340/2 1339/2, 1376/3, 1352/2,1352/4, 1396/3, 1397/5, 1397/6, 1401/3, 1653/2, 1652/2, 1651/3, 1649/2, 1630/3, 1634/2, 1611/9, 1611/10, 1610/12, 1606/4., 1586/2, 1584/2, 1537/2, 1610/3, 1373/6, 1389/2, 1387/6, 1291/75, 1291/76, 946/24, 946/25, 946/26, 946/27, 946/31, 949/87, 949/88, 949/89,949/90, 949/91, 949/92, 949/93, 949/94, 949/95, 1351/1, 1376/3, 1378/3, 1390/3, 1385/6, 1387/7, 1401/5, 1400/2, 1677/2, 1678/2,1678/3,1678/4, 1605/2,1605/3, 1613/3, 1594/2, 1593/2,1593/4, 1600/2, 1585/2, 1535/2, 1536/2, 1588/2, 1528/2, 1538/2, 1604/4,1604/5, 1532/2, 1650/2, 1630/4,1630/5, 1401/6, 1291/81, 1372/4,1372/5, 1341/3, 1291/75, 1291/76, 1291/77, 1291/78, 1291/79, 1291/80, 946/28, 946/29, 946/30, 940/3, 949//96,949/97, 941/7,
941/6, 942/2, 942/3, 1402/2, 1292/3, 1349/2

Podgorica

CM BERI

CP 1608/24,1608/25, 1608/19,1608/21, 1609/3,1609/4

CM BALOČI

CP 3146/3, 3147/3, 3164/4, 3165/3, 3175/2, 3165/3, 3175/2, 3165/2, 3151/1, 3191/3, 3195/2, 3151/5, 3191/4, 3156/2, 3152/2, 3153/2, 3193/2, 3166/2, 3174/8, 374/9, 3189/2, 3190/2, 3192/2, 3194/4, 3196/4, 3188/2, 3204/5, 3204/6,3204/7,3204/8, 3203/4, 3155/2, 3164/5, 3164/6, 3163/3, 3163/4, 3162/3, 3162/4, 3181/2, 3188/4, 3188/5, 3225/2,3225/3, 3204/9, 3206/4, 3203/2, 3206/6,3206/5,3206/7, 3205, 3203/8, 3207/1,3207/4, 3207/3, 3213/5, 3214/3, 3208/3, 3208/4, 3209/2, 3212/2, 3219/3, 3221/7, 3221/8,
3221/10, 3221/11, 3227/4,3227/5,3227/6,3227/8, 3213/6, 3213/4, 3218/2, 3217/2, 3578/15, 3578/14, 3578/16, 3578/4, 3218/2, 3217/2, 3578/15, 3578/14, 3578/3, 3578/4, 3578/16, 3578/13, 3578/10,3578/12

CM DONJA GORICA
CP 732/6, 4085/4, 726/2, 725/2, 4184, 759/2, 4188, 4215/2, 4190/2, 4186/2, 4076/2, 4191/4,4191/5, 4187/2, 4185/2,4185/3, 760/3, 785/2, 787/2, 720/3, 722/2, 728/2, 729/2, 730/2, 731/2

CM TOLOŠI
CP 3756/2, 4123/2, 3754/2, 3755/2, 3759/2,3759/4, 4637/2, 4146, 5054/2, 4122/3, 4122/4, 4130/5, 4130/4, 4129/4, 4131/2, 4135/2, 4137/2, 4138/2, 4139/2, 4140/2, 4142/4, 4142/4, 4143/2, 4144/4, 4144/3, 4145/2, 4147/2, 4291/9,4291/8,4291/6,4291/5, 4148/4, 4148/3, 4291/7, 4201, 5130/2, 5131/2, 5143/4,5143/5, 76/2, 4657/3, 4660/2, 4661/2, 4664/2, 4666/2, 4667/2, 4668/2, 4669, 5182/4, 5182/3, 5182/2, 5181/2, 5180/2, 5179/2 5178/2, 5133/2, 5134/2, 5135/2, 6143/3, 5148/3, 5147/2, 5148/3, 4170/2,
5185/4, 4749/4, 5185/5, 4749/3, 4295/4, 4553/2, 4167/2, 4172/2, 4171/2, 5183/2, 5177/2, 5184/2, 5192/3,5192/4, 4141/2, 4169/2, 4142/4, 4168/6

As it has already been mentioned, it is planned to carry out a reconstruction of the Main Road M-18, section Podgorica Danilovgrad, which stretches from Komanski ski Bridge to the Danilovgrad roundabout. Locations of Komanski ski (Sitnica) Bridge are shown in Figures 3 and 4, and this location represents the starting point of reconstruction of the existing main road, and it stretches up to the restaurant Ognjište. This section may also be seen in the form of a satellite image obtained from Google Earth, which is shown in Figure 4f.

Figure 3. *Location of the Komanski ski-Sitnica Bridge*

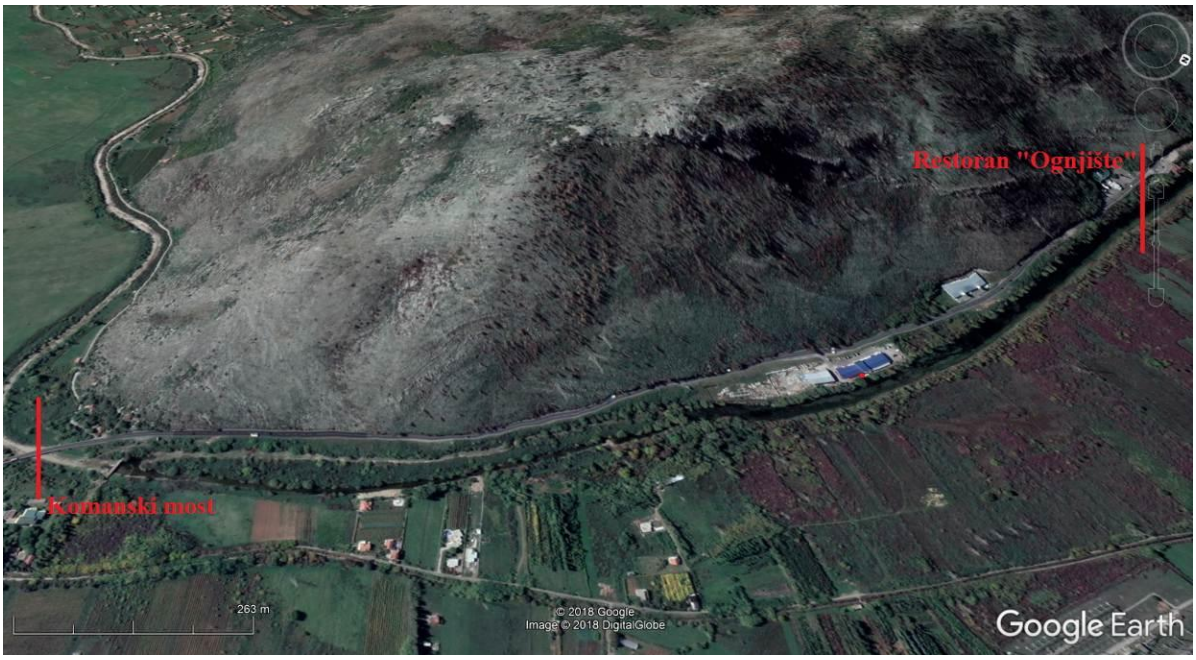
a)

b)

c)

d)

e)



f)

Figure 4. *Road section from Komanski ski-Sitnica Bridge to restaurant "Ognjište"*

Figure 4 shows that there are several individual residential objects in the immediate surrounding of Komanski ski Bridge (Figure 4 a, f). Apart from these individual residential objects which have been identified, a certain number of business premises is located along both sides of the subject section of the existing main road.

The road section from the restaurant "Ognjište" to the locality Mareza is shown in Figure 5.

a)

b)

c)

d)

e)

Figure 5. *Road section from the restaurant "Ognjište" to locality Mareza*

As it may be seen in Figure 5, only one residential object is located on the right side of this part of the road section, while more business premises have been identified along the right side of the existing Main Road Podgorica-Danilovgrad.

The road section from the locality Mareza to the Novo Selo intersection is shown in Figure 6.

a)

b)

c)

d)

e)

f)

g)

h)

i)

j)

k)

l)

m)

n)

Figure 6. *Overview of the section of the main road which stretches from Mareza to the Novo Selo intersection*

Figure 6 shows that, individual residential objects and business premises have been identified along this part of the road section, whereby the residential objects are located along the left side of the main road, while the business premises are located along both sides of the road.

The part of the road section which stretches from the Novo Selo intersection to the Iveco business premises is shown in Figure 7.

a)

b)

c)

d)

e)

f)

g)

Figure 7. *Overview of the road section from the Novo Selo intersection to the Iveco business premises*

The overview provided in Figure 7 shows that a certain number of residential objects and business premises is located along this part of the road section.

The part of the road section which stretches from the Iveco business premises to the “Eko“ gas station is shown in Figure 8.

a)

b)

c)

d)

e)

f)

g)

h)

i)

j)

k)

l)

Figure 8. *Overview of the part of the road section from the Iveco business premises to the "Eko" gas station*

As it may be seen in the Figure 8, this part of the road section is mostly marked by a higher number of business premises and individual residential objects which are located along both sides of the main road.

The part of the main road which stretches from the “Eko“ gas station to the Danilovgrad roundabout is shown in Figure 9.

a)

b)

c)

d)

e)

f)

g)

h)

Figure 9. *Overview of the road section from "Eko" gas station to the Danilovgrad roundabout*

Just as it has been shown in the previous figures, the Figure 9 shows that this section is characterised by a higher number of business and residential objects which are located along both sides of the Main Road Podgorica-Danilovgrad.

2.2. Overview of geographical, geomorphological, geological, hydrological, hydrological, seismic and traffic conditions

(The data was obtained from the Geotechnical study which was carried out by the company „"MI" LLC, Podgorica. The Study was done in the period from February to June 2017)

2.2.1. Geographic position

The subject road section represents a part of the Main Road M-18 Šćepan Polje-Nikšić-Danilovgrad-Podgorica, and it stretches from the Danilovgrad roundabout (the beginning of the Danilovgrad boulevard) to the entrance to Podgorica, i.e. the section after crossing the Komanski ski Bridge and reaching the suburban settlement Gornja Gorica.

When it comes to level of the terrain, the part of the road section which stretches from the starting point of the route in Danilovgrad up to km 120+500 (L=6.0km) is located in a plateau (cca 50 m asl). Along the next 1.2km (km 121+700), the road reaches altitude of 84 m asl. Starting from this section, the road level decreases up to the point of 34 m asl over the next 2.0 km. From this point onwards, up to the final point of the road route, elevation of the road ranges from 33 m asl to 38 m asl. The section of the road which represents the point of entrance to Podgorica is located at the elevation level of 34 m asl.

2.2.2. Geomorphological characteristics of the terrain

Sediments that cover the periglacial karst field, i.e. today's Zetsko-Bjelopavlicka plain, have glacial fluvial (glf) and lake-puddle (Q) origin, where the terraced sediments of the gravelly-sandy composition are predominant in the Zeta valley. These sediments are locally bound in the form of conglomerates, while lake-puddle sediments are predominant in the Bjelopavlici plain, and they are marked by high content of clay. This intensive sedimentation has brought the sub-horizontal inclination of the terrain, thus, from the morphological aspect, the terrain is mostly

marked by slight inclination - less than 5°, whereby it is marked by declination towards the South. Carbonate-dolomite hills rise from the part of the terrain which is located in a plain: Zelenika, Luznica, Sancevi and Plana reach the height of about 200 m asl, whereby their slopes are characterised by a relatively mild tilt.

2.2.3. Geological composition of the terrain

The explored terrain belongs to the geotectonic unit of the Old-Montenegrin heave. The oldest stratigraphic series of formations date back to the upper Triassic period, while the most recent sediments date back to the Eocene period.

In the vicinity of the explored area, the oldest sediments date back to the upper Cretaceous, whereby they have the NW-SE direction and they were formed in the limestone-dolomite facies.

Turonian age sediments (K22) are represented by yellow-whitish banked and massive, often saccharide dolomites, dolomite limestone and banked, rarely layered, massive limestone. This section is characterised by predominance of dolomite and dolomite limestone, which cover layers of limestone.

These sediments make up a part of the Zelenika hill.

Terrain in the Komani area is comprised of Xenon age sediments (K23), which occur in the form of grey-whitish to grey-yellow limestones, as well as dolomite limestones and dolomites. These sediments are usually banked and layered, they are rarely massive.

Quaternary sediments are represented by quaternary clays (Q) and fluvioglacial sediments (fgl).

Quaternary clay (Q) is present in the largest part of the Zeta river valley in Bjelopavlici. The colour of this type of clay ranges from green and yellow to whitish, while the thickness of its layers reaches up to 80 m. This type of clay is characterised by dark brown humus soil, with thickness of around 1-2 m.

Fluvioglation sediments (fgl) are represented by gravel-sandy alluvium. Terraced sediments (t2 and t3) may be found in the field of Project area.

2.2.4. Engineering-geological characteristics

According to the engineering-geological composition, geotechnical characteristics of the terrain, i.e. the interaction of the terrain and the objects, the following geotechnical areas have been marked as significant:

1. Embankment;
2. Clay, glacial-liminal origins, ochre-grey (G_q);
3. Clay, diluvial origin, dark brown black (G_{dl});
4. Sandy gravel;
5. Clayey gravel;
6. Limestone, dolomite limestone and dolomite;

Area 1 – embankment

Embankments are located along the entire road section, but they are isolated as a separate complex in the part of the road where its thickness exceeds 2 m.

In the embankment area, the following components may be distinguished: the upper layers of the roadway, the 1a area and the lower layer, the 1b area.

The 1a area is represented by sandy-dusty gravel from which the buffer and the final layer of the roadway were built. Compaction test (Proctor test) and CBR test were carried out in this area, and it had the following characteristics:

Geotechnical area	Properties				
	γ (kN/m^3) compacted	**w (%)**	Proctor test		**CBR (%)**
Area 1a			**W (%)** optimum	**γ max (kN/m^3)**	
	20,2-21,0	**4,0-5,1**	**6,1-6,9**	**21,7-22,0**	**75-85**

The 1b area is represented by clayey debris, along with intermittent occurrence of gravel and clay with debris. Compaction test (Proctor test) and CBR test were carried out in this area, and it had the following characteristics:

Geotechnical area	Properties				
	γ (kN/m^3) compacted	**w (%)**	Proctor test		**CBR (%)**
Area 1b			**w (%)** optimum	**γ max (kN/m^3)**	
	19,9-21,0	**3,9-5,1**	**4,5-8,2**	**20,1-21,8**	**60-75**

The observed thickness of the area 1a ranges from 0.9 to 1.6m, while the area 1b is characterised by thickness which ranges from 1.0 to 2.2m, i.e. it reaches the depth of 3.1m.

As it has previously been mentioned, the geotechnical environment 1 (1a + 1b) is isolated as a special complex in the part of the terrain with thickness over 2.0 m, and it spreads along the following chainages: km 115+405 – 119+780 (bridge on the river Susica), km 123+175 – 123+980, km 125+160 – 126+120 (bridge on the river Matica), km 126+160 (bridge on the river Matica), km126+390 and km 129+770- 129+931 km (bridge on the river Mareza), whereby clayey gravel represents the predominant component of its composition.

According to the GN200 categorisation, the material from the area 1 belongs to the excavation category II and III.

Area 2 (Gq) Clay, glacial-liminal origins, ochre-grey

Clay sediments are predominant in the explored area. Clay in the area 2 is characterised by variable dust-sandy composition, which has medium to high plasticity. Sand occurs in the form of interlayers, which usually has mm-dimensions, and has unequal distribution.

Sandy areas which are characterised by thickness of interlayers which may reach cm values of thickness occur on chainage km 123+175+123+980, which has an impact on decreasing the compaction of terrain. In deeper layers of the terrain, at the depth of more than 8-10m, interlayers of sand, i.e. layers of sand reach dm dimensions.

Surface of the area 2 is comprised of humified clay, which is most commonly characterised by thickness ranging from around 0.2m up to maxium defined thickness od 0.4m.

Parameters of physical-mechanical properties, in cases where compaction module was measured for loads from 100 to 400 kPa, are:

Geotechnical area	***Properties***			
	γ (kN/m^3)	**φ (^{0})**	**c (kN/m^2)**	**Mv (kN/m^2)**
Area 2	**18,0-19,0**	**17-25**	**11-18**	**2,1-9,5x10^3**

Compaction test (Proctor test) and CBR test were carried out in this area, and it had the following characteristics:

Geotechnical area	Properties				
	γ (kN/m^3) compacted	**w (%)**	Proctor test		**CBR (%)**
Area 2			**w (%)** optimum	**γ max (kN/m^3)**	
	16,5-17,0	**18,5-19,5**	**16-17**	**17,5-18,0**	**7,5-8,5**

Geotechnical area 2 represents the surveyed terrain which is located in the area from the first chainage up to the Susica river bridge km 119+780, but it should be noted that the embankment for the existing roadway is was built at this location, and it is isolated as a separate complex at the following sections: after chainage km 115+405 and from chainage km123+175-123+980, which also represents the location of the foot of the embankment on the existing roadway.

According to the GN200 categorisation, the material from the area 2 belongs to the excavation category I and II.

Area 3 (Gdl)- clay, diluvial origin, dark brown black

Clay characterised by dark brown to black colour also has dusty-sandy attributes, whereby it may also be characterised by medium to high sandiness. It makes up the surface area of the terrain, which reaches thickness up to 2.5 m, beneath which the area 2 is spread out, and thus is significantly determines the conditions for carrying out the works regarding construction of the road due to its position and properties.

According to the compaction test (Proctor test) and CBR test, this area is characterised by lower values of properties, as CBR of the embankment which is made from carbonate debris and area 3 is <70%:

Geotechnical area	*Properties*				
	γ (kN/m^3) compacted	**w (%)**	Proctor test		**CBR (%)**
Area 3			**w (%)** optimum	**γ max (kN/m^3)**	
	13,2-13,5	**28,0-29,0**	**21,0**	**14,5-15,0**	**2,0-3,0**

The part of the terrain that makes up this area is occasionally flooded, it is characterised by high degree of flooding, and it partially overlaps the road. Thus,

its elevation level is designed accordingly. This area makes up the foot of the embankment at the chainage: km: 125+160 - 126+350.
According to the GN200 categorisation, the material from the area 3 belongs to the excavation category I and II.

Area 4 (– Sandy gravel, glacio-fluvial origin

Glacio-fluvial gravel is sandy, intermittently dusty and poorly clayey on the surface part of the terrain, and it reaches the depth up to 1.0 m.

The sediments are well granulated and partially less to more strongly connected into conglomerates by carbonate binder.

The estimated parameters of physical-mechanical properties of the area are:

Geotechnical area	***Properties***			
	γ (kN/m^3)	**φ (^{0})**	**c (kN/m^2)**	**Mv (kN/m^2)**
Area 4	**24,5-26,5**	**32-35**	**0-20**	**25-40x10^3**

Area 4 makes up the terrain from the chainage km 129+210 up to the end of the road route.

According to the GN200 categorisation, the material from the area 4 belongs to the excavation category II-IV.

Area 5 - Clayey sandy gravel, alluvial origin

Compared to gravel of glacio- fluvial origin sediments of alluvial origin are heavily clayey and poorly compressed in relation to gravel of glacio- fluvial origin. They are also dusty-sandy, but unevenly granulated.

When it comes to the subject site, these sediments were found in the Sitnica riverbed, (at the institute "Komanski most"), the borehole Bkm-2, up to the chainage km 129+210.

The estimated parameters of physical-mechanical properties of the area are:

Geotechnical area	***Properties***			
	γ (kN/m^3)	**φ (^{0})**	**c (kN/m^2)**	**Mv (kN/m^2)**
Area 5	**24,0-26,0**	**25-30**	**1-3**	**2-10x10^3**

According to the GN200 categorisation, the material from the area 5 belongs to the excavation category II-III.

Area 6 – limestone, dolomite limestone and dolomites

The complex of carbonate rocks is represented by limestone and dolomite limestone, characterised by rare stratification with dolomites and marlstone limestone.

The degree of presence of cracks in rocks is the main characteristic which predetermines the engineering-geological properties, as well as the geotechnical conditions for carrying out the works.

According to frequency of their occurrence, stratification cracks are predominant, and they are followed by tectonic and relaxation cracks.

Carbonate rocks are characterised by prominent stratification cracks, whereby visual aspect of rocky areas ranges from layered to banked, depending on frequency of their occurrence.

Stratification cracks are mostly compressed, but the gap reduces quickly 0.5-1m. They are most commonly characterised by inclination of 30-40^o, with a 20^o, i.e. 60^o deviation.

Cracks which are characterised by steep declination 60-90^o havet the highest impact on conditions for making the slopes on the roadway.

The degree to which the terrain is cracked, comparted was expressed via RQD and GSI.

The degree to which the rocky area is cracked predetermines conditions of construction of the roadway, and it was provided in the chapter Analysis of geological conditions of construction.

Based on site surveys, laboratory tests and a comparative analysis with terrains which have a similar engineering-geological composition, average physical-chemical properties of intact rocks are:

Geotechnical area	***Properties***		
	γ (kN/m^3)	**φ (^{0})**	**δc (MPa)**
Area 6	**26,0-28,0**	**23-50**	**130-140**

Predicted properties of the cracked environment are:

Parameter / **Area**	g kN/m^3	φ ^{o}	c MPa	RQD %	Md GPa	Edyn GPa
Area 6	**25,5-27,5**	**23-41**	**3-13**	**30-80**	**0,7-11**	**2-6**

According to the GN 200 categorisation, it belongs to the excavation category V-VI, whereby the excavation will be carried out mechanically, by the mandatory use of explosives. Terrain surface in the subject area has characteristics of the terrain category IV, where excavation also can be done using heavy construction machines, e.g. concrete breaker.

Limestone and dolomitic limestone are characterised by properties which make them favourable to construction of embankments, whereby the required granulation should be fist achieved by all means.

These materials make up the terrain on the following chainages: after the bridge on the Susica River km119+830 to km123+175, chainage km123+980 - 125+160, chainage km126+350-129+105, bridge on the Sitnica river.

2.2.5. Hydrogeological properties of the terrain

Several geotechnical areas may be recognised in the surveyed corridor, whereby, according to their hydrogeologic characteristics, their categorisation ranges from water permeable to water impermeable.

Water permeable areas are: a part of the area 1, embankment, i.e. the area 1a, 4, 5 and 6.

Water impermeable areas are: 1b, 2 and 3.

According to the type of porosity, the water permeable areas have intergranular and crack-cavernous porosity.

Areas 1a and 4 are characterised by good water permeable intergranular porosity. When it comes to the construction zone of the designed road and objects, significant layers of conglomerates which would affect the character of the water permeability of the area have not been identified. Laboratory experiments showed that the coefficient of permeability (USBR) is 4x10-1 to 1x10-2.

The water-permeable area which is characterised by good to low water-permeability was recorded in the area 5. It is characterized by a locally higher content of the clayey component, so the coefficient of permeability (USBR) can decrease up to 4x10-4. In the area 6, carbonate rocks are considered to have attributes of high water-permeability, characterized by cracks and cavernous porosity, which can be confirmed by observing the explored terrain as a whole. Water permeable areas are characterised by a low permeability coefficient (USBR) of $4x10^{-7}$, which has been confirmed by the laboratory tests.

As part of the water impermeable areas, especially when it comes to the area 2, permeable interlayers of sand which contain groundwater occur in this section. Groundwater occurs both in interlayers of sand and in carbonate rocks, area 6, where the level of groundwater was determined at the depth of 35m through the process of survey drilling for the purpose of Matica Bridge. This was determined at Bm-2, at the point of entry to the area of carbonate rocks.
All groundwaters towards the existing watercourses Sušica, Matica and Sitnica. Likewise, surface waters also gravitate towards the abovementioned watercourses and their tributaries, but it should be taken into account that, during the periods of heavy precipitation, the terrain regularly floods around the bridge on the river Sušica and the part of the terrain which is comprised of the area 3.

2.2.6. Hydrological characteristics

The Zeta river parallel to the existing road route, which is going to be subject to reconstruction. However, the Zeta river does not have a point of contact with the road route, except from the part which represents its point of confluence with the Susšica riverber, which mostly occurs when the water level is high. Donja Zeta

("lower Zeta") is generated through springs which are located at Glava Zete ("glava Zete"), at 75 m asl. Its course continues through the Bjelopavlići plain, which is located at around 50 m als, and it reaches it point of confluence near Podgorica at 30 m asl. Along the right side of its flow, its tributaries are Oboštica, Smrdana, Gračanica and Sušica. Mean annual flow rate of the Zeta river at VS Danilovgrad is 99,6 m^3/s.

For the period of the previous 20 years, the absolute minimum flow rate of river Zeta was 5.16 m^3/s. The absolute maximum flow rate was 488 m^3/s.

Sušica river, which is the main tributary of the Zeta river as well as the body of water which is located underneath the Danilovgrad-Podgorica road, is generated from the spring "Modra oka" below Dubrava, and it reaches the point of confluence with Zeta next to the Main Road.

From its source and all the way to the Petra Sunjina Bridge in Orašje, it has an almost linear course over the length of 3.000m.

It has a meandering flow from the Petar Sunjin bridge to Bileća, and this stretch is 5.800 m long.

Along the entire length of its course (7.500m) from the point of confluence with Zeta (this area is marked on the map in the way that it shows constant presence of water, which means that the Zeta River enters in the Sušica riverbed) – has a meandering flow. It reaches the point of confluence with the Zeta River at around 150m from the Sušica bridge (road Danilovgrad-Podgorica). It is marked by 5 meandara (krivina) in Ćurilac-Strahinići, while another 5 meandera may be recognised in the area which stretches from the settlement Pitome Loze to the main road.

The total length of the Sušica River is approximately 16.300m.

In the section below the Sušica Bridge, which represents a part of the subject road section, Sušica rivebed has a flow profile which provides conditions for the highest flow rate of Sušica (both in terms of its width and depth) on one hand, and inflow of water from the Zeta River into the Sušica riverbed on the other hand. Additionally, water level was always significantly lower than the existing roadbed of the Podgorica-Danilovgrad road section. This means that the water from river Sušica and Zeta cannot cause danger in regards to the existing nor in regards to the newly designed road when it comes to flooding.

When it comes to the section of the road which goes over the river (creek) Crkovnica, it is also envisaged to build this section on the height which will ensure safe conditions in respect to the newly-designed roadbed.
Mareza and Sitnica are the most important tributaries downstream of the point of confluence of Zeta and Morača. The upper course of River Matica is called Sitnica. Mareza wells represent a series of siphon and overflow springs. They are located west of "Velje brdo" (283m), on the north-east side of the "Lješkopolje lug", at an altitude of 34-40m. Springs are located along the foot of "Velje brdo", and they are situated at the frontier between the upper cretaceous limestone on "Velje brdo" and limnoglacial sediments on "Lješkopolje lug". These springs take up the longitudinal area of around 2.000m. Along the first 1.000m of their flow, from north-west towards south-east direction, these springs have a permanent flow, while the other 1.000m of their flow (towards southeast) is also permanent, but they turn into intermittent sources past this point and they only occur during periods marked by heavy precipitation. V. Radulović (1989) states that, water flows out of 29 springs which are located on an altitude of 32m during the dry periods, and these sources from the Mareza flow. A bridge was built at the location where there is no water flow from the permanent springs, and the downstream part of the waterflow is called Trešenica. The remaining part of its flow is channelled, and a fish hatchery was built in this section. Water from the Mareza watercourse was diverted towards the Sitnica watercourse by means of digging channels, and the point of confluence of these two watercourses is located upstream from a bridge on the Podgorica-Nikšić road.

The total yield of the Mareza wells during the dry periods is 1.5 10 m^3/s, while its yield reaches around 10 m^3/s during the rainy periods.

There are several wells ("Modro oko", „Baločke pećine", etc.) which form the river Matica, and they are located at the furthest north-west end of "Tološko polje", in the settlement called Bandići. These wells are located at an altitude of around 70 m and they are located along the foot of the hill Sađavac (302m). Permanent wells which are located along the south-east part of the foot of hill Sađavac and limestone plateau Daljam (between the Bjelopavlići plain and Zeta plain) are Kraljičino oko, Crno oko, etc, and they form a creek which has permanent flow and flows into river Matica. A special underground hydrological connection was established between the "Tubin" well and chasm which are located in "Zorski lug" (Bjelopavlići plain) and the spring "Kraljičino oko". At the point of entry into the "Tološko polje", Matica gets another name and its further part of the flow is called

Sitnica. The total length of Matica and Sitnica watercourse, up to the point of confluence with Morača, is around 20km.

From the hydrogeological aspect, there are 2 geological areas along the subject road section:

*__Mesozoic carbonates__ which are characterised by high degree of water permeability, in which the piezometer level decreases from Daljam towards Lužnica. For this reason, even if there are some impacts during reconstruction of the subject road section, these groundwaters cannot have an impact on any of the surrounding important springs, and especially not on Mareza since groundwater runs towards the south, below the quaternary layers.
*** Alluvial sediments** make up the greatest part of the terrain along the subject road route. These are mostly clayey sediments, characterised by sporadic occurrence of dust and sand. As such, they represent a classic hydrogeological isolator, with a filtration coefficient which mostly ranges from 0,00001 to 0,0000001 cm/s. This is the reason why this terrain should be treated only as a part of the Sušica river basin, from which rainfall quickly flows down to the primary erosion base.

2.2.7. Seismic characteristics

From the micro seismic point of view, the territory of the Municipality Podgorica and the territory of the Municipality Danilovgrad are located within the area with very pronounced seismic activity. From the aspect of seismicity, intense coupling of forces occurs in this area, and the occasional phases of the increased tension affect the differential rise or lowering of the blocks. Figure 10 shows the map of the seismic regionalization of the territory of Montenegro and its surroundings (expected maximum horizontal acceleration of ground in parts of gravity) within a return period of 475 years (EUROCOD 8) and a 70% probability of occurrence.

According to the map of seismic micro-reionization, the considered area belongs to the zone with the basic degree of seismic intensity VIII on MCS. According to the Map of seismic micro-reionization of the areas of Podgorica and Danilovgrad, the observed area belongs to seismologic zones from B3 to C3, which indicates a significant difference in ground acceleration, i.e. the intensity of earthquake effects on the surface of the terrain. On the basis of the obtained average maximum ground acceleration expected in the above seismologic zones, the seismic

parameters for the design are determined for the indicated return periods of time. The assumption was that the objects have a normal period of depreciation of 50 years and a period of exploitation of 100 years, coupled with the fact that the projected seismic forces which are relevant to their stability have the same probability of occurrence as earthquakes (63%), whereby they may cause maximum acceleration of the ground in certain return periods of time.

The expected maximum horizontal acceleration of $\mathbf{a^{o}_{max}}$ (% g) and the expected maximum intensity of the earthquake Imax (EMS98) in the return period of 50 years, with a probability of realization of 63% is shown in Table 2.2.6/1.

Table 2.2.6/1. Expected maximum horizontal acceleration and expected maximum earthquake intensity

Seismic parameter	Type of earthquake for a return period of 50 year-zone B2	Type of earthquake for a return period of 50 year-zone C_3
I_{max} (EMS98)	7.30 – 7.35	
a^{o}_{max} (%g)	0.14	0.22
Ks	0.035-0.037	0.055

Figure 10. *Map of seismic reionization of Montenegro*

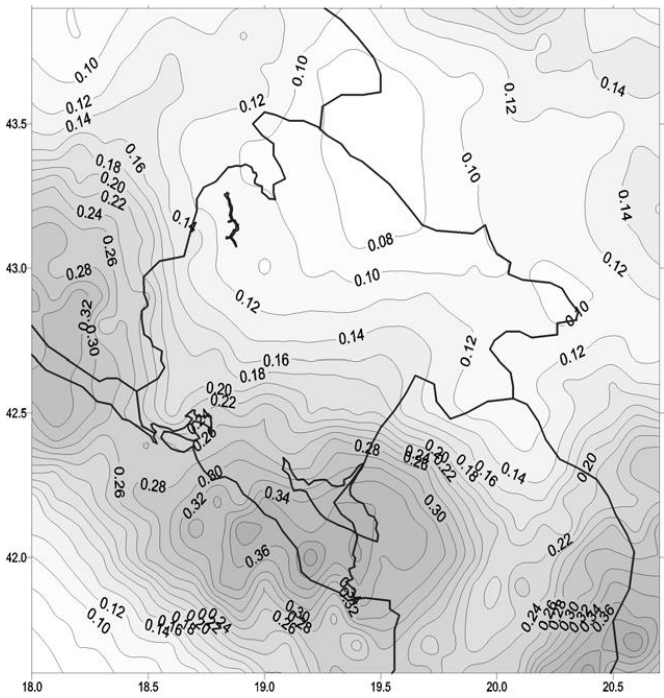


Figure 11. Map of the seismic hazard of Montenegro and the environment (expected maximum horizontal acceleration of ground in parts of the weight of gravity) within the return period of 475 years (EUROCOD 8), and a probability of realization of 70%.

2.3. Climate characteristics

Podgorica

In respect to the characteristics of climate, Podgorica and its wider surroundings is located in the so called transitional sub-Mediterranean area which spreads out from the seaside on the south (Mediterranean) and it makes a transition towards the continental climate on the north. It is primarily characterised by very long, warm and dry summers (max. temperature reaches up to 40 °C), and mild and rainy winters. Precipitation is highest during winter and spring, while it occurs very rarely or almost never during the entire summer. The occurrence of snowfall is very rare during winter and the snow cover does not stay for long, unless it is followed by north wind.

Climate characteristic of Podgorica are determined by the characteristics of relief, altitude (40 m asl), air currents, vicinity of the Adriatic Sea and latitude. In line with the established practice related to ensuring data validity, an overview of the elements of climate is given in sequence for a period of several decades. Data

about the elements of climate for Podgorica was taken from the current Spatial Plan of Montenegro.

Table 2.3/1. *Average monthly sums of precipitation and standard deviation*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearsum
srv	191.6	173.3	159.4	145.7	89.8	63.4	39.6	64.4	120.2	166.1	233.1	217.2	1663.7
max	381.0	404.0	349.0	307.0	230.0	162.0	100.0	276.0	342.0	523.0	639.0	406.0	639.0
min	0.5	33.0	28.0	14.0	1.0	8.0	0.0	5.0	1.0	0.0	20.0	37.0	0.0
std	115.0	100.0	70.7	76.0	55.7	39.6	27.4	61.3	89.7	130.4	134.5	102.2	83.5

Table 2.3/2. *Number of days with precipitation higher than > 0.1 lit/m^2*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearsum
srv	12	12	12	13	10	9	6	6	7	9	14	13	121
max	21	21	24	20	21	17	14	14	12	21	26	21	26
min	1	3	5	6	3	3	0	1	0	0	4	4	0
std	5.1	5.1	4.7	3.7	4.1	3.0	3.0	3.2	3.4	4.9	5.2	4.6	4.2

Table 2.3/3. *Number of days with precipitation higher than > 1 lit/m^2*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearsum
srv	10	10	10	11	8	7	4	5	5	9	12	11	101
max	20	20	23	18	17	14	11	12	12	20	23	19	23
min	0	3	3	4	0	2	0	1	0	0	3	3	0
std	4.8	4.7	4.4	3.5	3.8	2.6	2.5	2.5	3.2	4.7	4.6	4.6	3.8

Table 2.3/4. *Number of days with precipitation higher than > 10.0 lit/m^2*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearsum
srv	6	5	5	5	3	2	1	2	3	5	7	7	51
max	12	14	10	15	8	7	4	7	8	15	14	13	15
min	0	1	1	0	0	0	0	0	0	0	0	1	0
std	3.7	3.1	2.4	3.1	2.1	1.7	1.0	1.7	2.3	3.2	3.2	3.2	2.6

Table 2.3/5. *Mean maximum air temperature*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
srv	9.5	11.3	15.0	19.1	24.3	28.2	31.8	31.6	27.3	21.7	15.4	11.1	20.5
max	13.2	16.6	19.9	22.9	28.3	30.7	35.5	36.3	32.7	24.0	17.6	14.0	36.3
min	5.8	6.0	10.1	16.8	20.4	26.2	30.1	26.9	22.8	16.6	12.0	8.8	5.8
std	2.0	2.1	2.3	1.5	1.9	1.2	1.2	2.0	2.2	1.5	1.2	1.2	1.7

Table 2.3/6. *Mean maximum air temperature*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
srv	1.4	3.1	5.8	9.1	13.5	17.3	20.3	20.2	16.5	11.6	6.8	3.2	10.7
max	4.1	6.5	8.9	11.3	16.0	19.3	22.9	23.2	18.9	14.1	9.4	13.4	23.2
min	-2.6	-1.1	1.9	6.6	11.2	15.2	17.8	16.6	13.7	8.4	2.2	0.1	-2.6
std	1.7	1.8	1.3	1.0	1.3	1.0	0.9	1.4	1.4	1.2	1.9	2.3	1.4

Table 2.3/7. *Mean maximum air temperature*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
srv	5.0	6.8	9.8	13.9	18.9	22.8	26.0	25.5	21.4	15.9	10.5	6.5	15.3
max	8.0	10.6	13.2	17.2	22.3	25.2	29.5	29.3	25.9	18.0	13.0	8.4	29.5
min	2.2	2.1	5.4	11.7	15.5	20.9	24.7	21.4	18.2	12.0	6.7	4.0	2.1
std	1.5	1.7	1.9	1.2	1.6	1.1	1.0	1.7	1.8	1.3	1.4	1.1	1.4

Table 2.3/8. *Average number of tropical days (Tmax>30 °C)*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR sum
srv	0.0	0.0	0.0	0.0	2.0	11.0	23.0	22.0	8.0	0.0	0.0	0.0	66.0
max	0.0	0.0	1.0	1.0	10.0	23.0	31.0	31.0	27.0	6.0	0.0	0.0	31.0
min	0.0	0.0	0.0	0.0	0.0	2.0	17.0	1.0	0.0	0.0	0.0	0.0	0.0
std	0.0	0.0	0.2	0.2	2.8	5.8	3.5	6.6	6.6	1.2	0.0	0.0	2.2

Table 2.3/9 *Average number of frost days (Tmin<0 °C)*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR sum
srv	12.0	5.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	7.0	27.0
max	24.0	20.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	16.0	24.0
min	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
std	6.2	4.5	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	4.1	1.6

Table 2.3/10. *Average monthly cloudiness (one tenth)*

period: 1961-1990.godina

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
srv	5.7	5.9	5.7	5.7	5.1	4.4	2.8	2.8	3.4	4.2	5.9	5.8	4.8
max	8.3	8.7	8.4	7.5	7.1	6.2	5.7	5.4	5.2	7.9	8.9	8.5	8.9
min	1.4	2.7	3.7	3.9	3.5	3.0	1.1	1.0	1.2	1.9	2.2	3.8	1.0
std	1.7	1.6	1.2	0.9	0.8	0.8	0.9	1.0	1.1	1.4	1.5	1.3	1.2

Table 2.3/11. *Average number of clear weather days (mean daily cloudiness<2/10)*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEARsum
srv	8.0	9.0	7.0	5.0	5.0	8.0	14.0	15.0	13.0	12.0	7.0	7.0	110.0
max	24.0	70.0	15.0	13.0	12.0	16.0	25.0	26.0	25.0	23.0	19.0	16.0	70.0
min	1.0	0.0	1.0	0.0	0.0	2.0	0.0	0.0	4.0	1.0	0.0	2.0	0.0
std	5.8	12.3	3.8	3.3	2.7	3.1	5.2	5.6	4.9	5.1	4.5	4.1	5.0

Table 2.3/12. *Average number of cloudy days (mean daily cloudiness>8/10*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEARsum
srv	12.0	11.0	11.0	10.0	6.0	4.0	1.0	2.0	4.0	7.0	12.0	13.0	93.0
max	22.0	19.0	22.0	18.0	13.0	8.0	7.0	9.0	9.0	19.0	24.0	24.0	24.0
min	2.0	3.0	4.0	4.0	1.0	0.0	0.0	0.0	0.0	0.0	4.0	4.0	0.0
std	5.6	4.4	4.4	3.1	3.3	2.3	1.7	2.2	2.3	4.0	4.6	4.8	3.6

Table 2.3/13. *Maximum depth of snow cover (cm)*

period: 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
srv	3.3	2.3	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.4	7.3
max	25.0	30.0	24.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	23.0	20.0	30.0
min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
std	6.1	6.4	4.6	0.0	0.0	0.0	0.0	0.0	0.2	0.0	4.1	3.9	2.1

Table 2.3/14. *Distribution of average maximum and mean wind speed and its frequency per direction - vmax (m/s), vsr (m/s), čestina (%)*

direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Silent period
v_{max}	24,0	29,0	16,0	13,4	10,8	17,0	17,0	21,0	15,0	9,1	8,1	12,6	6,2	14,0	17,8	20,0	
v_{sr}	4,8	5,3	3,3	3,0	3,3	3,0	3,8	4,0	2,9	2,9	2,7	2,9	2,4	3,6	3,8	3,8	
Freq.	10,0	9,1	1,5	1,5	0,7	1,3	1,6	8,0	7,3	1,5	1,1	1,2	0,5	1,5	1,8	3,8	47,6

However, taking into account the obvious changes of climate parameters in the area of the Capital in the past several years, data for the area of the Capital for 2013 was provided as well (published on the website of the Hydrometeorological and Seismological Institute of Montenegro). According t the available data, mean air temperature in 2013 was 17,3 °C, and the deviations from the mean air temperature expeeded the value of the climate normal (1961-1990 by 1,7 °C. Still, 2015 was one of the warmest and driest years in the past 130 years. The amount of precipitation measured in 2013 was 2.427 lit/m^2, which was 47% than the climate

normal, as this was also the highest recorded amount of precipitation so far (so far, the highest amount of precipitation was recorded in 2010 and it was 2.357 lit/m^2). Zetsko-Bjelopavlićka plain belongs to the climate sub-type C (according to Kőppenu). This type of climate is Mediterranean, and it is strongly characterised by hot period of summer. Average temperature during the warmest months is >22 ^oC.

Climate characteristics of the area of Podgorica are determined by its geographic position, altitude and relief. The area of Podgorica is characterised by moderately continental climate, long, warm and dry summers, and mild and rainy winters. Occurrences of snowfall are very rare, and they are completely insignificant. Summers are characterised by high temperatures, which reaches over 35°C in July and August. Area of Podgorica is characterised by mild winters, whereby mean air temperature is around 5°C, while summers are very warm and thus mean temperature in July is around 26.1 °C. Annual fluctuations of mean minimum and mean maximum monthly temperatures in January in Podgorica is 7,6 °C (1,4-9,0°C), while this value reaches 10,8°C in September (16,6-27,4 °C). Absolute maximum and absolute minimum temperature were recorded in August (41,4 °C), i.e. -9,7 °C in February. Data about average values of the basic climate parameters is shown in table 2.3/15, they indicate the forty-year period (1960-2000) and they were taken from the Hydrometeorological Institute of Montenegro from Podgorica. On the basis of measurements which were carried out during several years (B. Radojičić, 1995), total average annual amount of precipitation in Podgorica is 1653 mm. Average annual relative humidity (in %) in Podgorica is 63, while mean annual cloudiness, which is determined on the basis of observations (from 0 to 10 parts of the sky covered above the horizon) is 4.9, and it is highest in November and December. Share of snowfall in the total amount of precipitation in Podgorica is 4.24%, while the average number of days with snow is 3.

	Mean monthly temperature (°C)												
Location	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
Podgorica	5.1	6.7	9.7	13.9	18.8	23.0	26.1	25.7	21.5	15.7	10.5	6.8	15.3
	Mean monthly amount of precipitation (mm or l/m^2)												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
Podgorica	184	180	151	135	92	62	40	63	117	182	232	214	1653
	Mean number of days with clear weather												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
Podgorica													
	Annual sunshine duration (in hours)												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
Podgorica	117	125	173	190	251	277	334	314	248	205	118	108	2460
	Frequency of winds and silent periods (in %)												
	N	NE	E	SE	S	SW	W	NW	C				
Podgorica	22.2	7.4	1.1	7.3	13.1	1.8	0.9	1.5	44.7				

Average annual number of frost days (minimal daily temperature below 0°C) in Podgorica is 15. These climate characteristics of the area enable conditions for a continuous exploitation, i.e. conditions for carrying out exploitation and processing of technical-construction stone during the entire calendar year.

Out of all the wind directions, two are most prominent when it comes to "determining" the weather conditions in the area of Podgorica (Rose of winds, Figure 12). North and south wind are the ones which determine weather conditions, and they are most frequent during the period from September to April. Average number of days with wind is 60, which has a special impact on the Podgorica climate since it affects the subjective thermal sensations by decreasing the temperature by 2 to 3 degrees Celsius. Strength of north wind increases almost proportionally from the northernmost to the southernmost point. South winds are characterised by less frequency and strength, and by the rule, they bring rainfall.

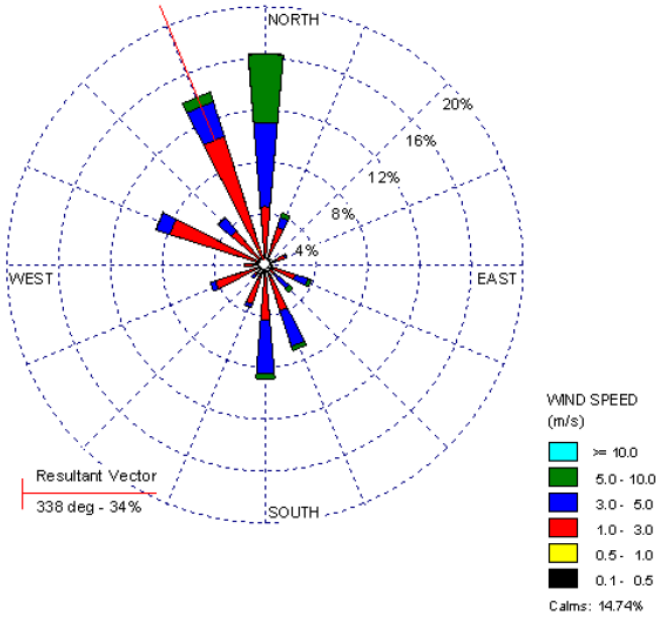


Figure 12. *Rose of winds in Podgorica*

From the aspect of air pollution, meteorological conditions are very important, and they fortunately contribute to reduction of air pollutant concentrations. For example, precipitation purifies the air and removes many pollutants.

Contribution of the wind is also reflected in the content of general indicators of air quality. For example, the emission of smoke in the Municipality of Podgorica is very pronounced, and its dynamics is followed by the content of sulphur dioxide.

The dominant directions and wind speed can be corrected by means of the measurement data at the planned micro location, due to the extreme variability of this meteorological factor in space and time. However, strong north winds are dominant along the subject road route and special attention should be paid to this aspect.

In the area of Podgorica, the degree of representation of the "silent "periods are 15%. The dominant winds originate from the northern (30%) and the southern (10%) quadrant. The resulting wind is northern. Wind velocity in this area ranges from 3-5 m/s to 5-10 m/s, and it blows directly from the north.

Danilovgrad

Area of the Municipality Danilovgrad belongs to the wider area of Zetsko-Bjelopavlićka plain and it is impacted by the Adriatic-Mediterranean climate.

All of its typical characteristics, which are slightly modified compared to the area of Montenegrin seaside, are limited to the area in the Zeta river valley. Summers in this area are dry and long, and they are characterised by prominent periods of high temperatures and mild winters.

Air temperature

Mean annual air temperature is a very variable element and it ranges from 4°C on the slopes of Mount Maganik, to 15°C in the Zeta river valley. The most important factor which determines these variations is the altitude, as well as the fact that the Zeta river valley under significant impact of the Adriatic Sea.

The number of summer days during which the maximum daily temperature reaches and goes over 25°C in the central area of Danilovgrad is 130 per year, while the number of cold days over the year rarely exceeds 5 (T-max 0 °C).

According to the data obtained from the local Hydrometeorological station in Danilovgrad, for the period of 30 years, it may be stated that:

- Mean annual air temperature is 16.4 °C
- Mean annual maximum air temperature is 28,3 ^{o}C
- Mean annual minimum air temperature is 2,7 ^{o}C

Cloudiness

Average annual cloudiness measured at the station in Danilovgrad is 5.2 (expressed in 0 to 10 parts of the sky covered above the horizon), which is lowest value of this parameter in Montenegro, along with the cloudiness observed on the seaside. Mean cloudiness per months ranges from 3.2 in July up to 6.5 in November.

Average number of cloudy days per year is 115. The smallest number of cloudy days is recorded in July (2.9) and August (3.2), while the highest number is recorded is in November (14.7), December (14.6) and January (14.4). Average number of days with clear weather is 96.3 per year, while mean value per months ranges from 4.9 days in April up to 12.8 days in August. July and September are marked by a high number of days with clear weather (11.77 during each of these two months).

Precipitation

The amount of annual precipitation ranges from 2300 to 2500mm, whereby the distribution of precipitation is indicative of all the characteristics of the Mediterranean regime. The highest mean annual amount of precipitation is recorded in the mountain region (around 2500mm), while these values are around 2000mm in the wider plain area.

Mean monthly amount of precipitation is highest in the period from November until January, while it is lowest in the period from June until August. The maximum average amount of precipitation is recorded in November (359mm), while the minimum amount is recorded in June (60mm).

The number of days during which the amount of precipitation is 0.1mm or higher is 122.8 per year, while there are 114.6 days per year during which the amount of precipitation is 1.0mm or higher, and there are 61.1 days with the amount of precipitation of 10.0mm or higher. Distribution of these categories per months corresponds to the monthly distribution of precipitation.

Based on the data obtained from the Hydrometeorological station, from the period of 30 years, the number of days with precipitation higher than 10 lit/m^2 is 46, while the number of days during which the depth of the snow cover is higher than 1.0 cm is -5.

Relative humidity

Average value of relative humidity is 71% annually. It is highest in November (80%), which is also the month with the highest number of days during which relative humidity is equal to or higher than 80% (11.1). The smallest relative humidity is recorded in July and August (62%). August is also the month with the lowest number of days during which relative humidity is equal or higher than 80% (1.3).

Wind

Winds from the southeast and northwest are the most frequent (with 12% of frequency), and their average speed is about 20 m/s. The northern wind has less frequency (6%) with highest average speed of 30 m/s. West wind is least frequent with frequency rate of mere 3 %. The number of silent days is 46. The strong wind (more than 8 Beaufort) is most pronounced in February (an average maximum of 5 days), and its annual frequency is 2.8 days.

Based on data from the local Hydrometeorological Station in Danilovgrad, the number of days with winds which are characterised by speed higher than 9 m/s is 51.

2.4. Sources of water supply

(Data was obtained from the document Revision and update of the study "Projection of the long-term water supply in Montenegro, 2016).

Danilovgrad

Seven springs are used for water supply in Municipality Danilovgrad:

- Slatina springs

- “Oraška Jama” – old facility
- “Oraška Jama” – old facility
- “Žarića Jama”
- “Brajovića Jama”
- “Viški bunar”
- “Milojevića vrelo”
- “Mareza”

The amounts of water provided by the abovementioned springs are satisfactory during autumn, winter and spring, but water level drops during summer due to increased use and irrigation of arable areas, thus the users who live on higher altitudes may become endangered. This situation was caused because of poor condition of the water supply network and significant losses on the water supply network, which led to development of a series of studies and plans aimed at improving the condition of this network.

Slatina spring

The Slatina area is located northeast of Danilovgrad, at a distance of around 6km, at an approximate altitude of 380 m asl. All four sources from this are captured. “Bistiga” spring was captured in 1890, “Žedani” and “Studenac” were captured during the period between the two world wars, and “Godavac” spring was captured in 1953.

“Oraška Jama“ source

Oraška Jama is the largest spring used by the Danilovgrad water system. In the initial exploration phase, it was planned to use this source in the capacity from 20 to 40 l/s. Since the needs in the Danilovgrad Municipality have significantly increased sine this period, nowadays the capacity that is used from this spring during the dry period is 120 l/s. In fact, these are the capacities which have been installed on three water catchment wells. Exploitation capacities of this extent have not yet been confirmed at any other location in Danilovgrad and the surrounding area. It is possible that they exist, but their presence has not been confirmed during the explorations which have been carried out so far. Such richness in water resources gives a special quality to the water intake structure, since, in perspective, it may be used for higher amount of water. This is one of the reasons why this water should be protected from pollution, which may also be cheaper than opening new water sources.

During the dry period, around 65% of water is taken from the Oraška Jama source in order to meet the requirements of the Danilovgrad water supply system.

"Žarića Jama" source

"Žarića Jama" is located north of the Railway station Ljututuk, at a distance of around 700m. This source was connected to the Bjelopavlići water system in 1983, whereby its capacity was Q = 20 l/s. Later, the pump was replaced, thus this source is nowadays using its full capacity Q = 50 l/s.

"Brajovića jama"

Spring "Brajovića jama" is located northeast of Danilovgrad, at a distance of 4km. This source is in fact an opening in the karst terrain, which was rebuilt in order to have the function of a village well. During winter, large amount of water overflows this well, and it is used as a natural piezometer during the remaining part of the year. Examination was carried out by going down the shaft and it was determined that the main aquifer channel is located at the depth of 21m. Yield of the source was not measured, but the conclusion made during exploitation is that using 26 l/s of water during the summer minimum water level does not cause the water level to become significantly lower, since it only causes the water to be at the depth of 19m, instead of 21m. Consequently, a more powerful aggregate was installed for the purpose of pumping this water. In 1998, a 30m deep well was made at the source, whereby a Ø300 mm hole profile was made at this location.

Viš spring

Viš spring is located north of Danilovgrad, at a distance of around 7km. More than 20 springs which are still active cover the surface of around 1000 m², and these springs are active during winter, while only 2 of them remain active during summer. Organised procedures of measuring yield of the captured springs have not yet been carried out. Additionally, continuous measuring of the amount of water at the source of the springs is not being carried out. A 15m deep village well is located at this location, and it has never run dry. In summer 2013, a 33m deep well was made at the central point of the spring area, whereby a Ø250 mm hole profile was made at this location.

"M*ilojević" spring*

This spring is located northwest from Danilovgrad, at a distance of around 12km, and it is located at an altitude of 44 m asl. Water springs from limestone debris,

and it runs out at the point of contact between a plateau and a hilly agglomeration. This spring is not contained in one area, but the water diffuses from the cracked aquifer. Organised procedures of measuring yield of the captured springs have not yet been carried out. Additionally, continuous measuring of the amount of water at the source of the springs is not being carried out. According to visual inspection, minimum yield of the Milojević spring during summer is 50-60 l/sec. Water is captured from the intake trench and it is pumped by two aggregate pumps. The pump station facility was built in 1982. It supplies water to the users along the right bank of the Zeta river, as well as the users who live in the northwest part of the Bjelopavlići plain.

Mareza

Mareza is spring which is used in the Podgorica water supply system. It is located on the territory of Municipality Danilovgrad. Three intakes are located at the source, and the total amount of water intake at all three of them is around 1.800 l/s. Two pump stations have been built at this section: an old pump station was built in 1963, and a new pump station was built in 1995.

Since 2002, "Water Supply and Sewerage" Danilovgrad has been using around 62 l/s which is produced by one of the pumps which is installed in the old pump station. Pump has the capacity of 90 l/s, and it is owned and maintained by the Podgorica water supply company. A dividing unit is located just behind the pump, and it ensures that (on average) 62 l/s are pumped towards Danilovgrad, while the rest of the water is pumped towards Podgorica.

Podgorica

Six main springs are used for the Podgorica water supply system:

- "Mareza",
- "Zagorič",
- "Ćemovsko polje",
- "Vuksanlekići",
- "Milješ", and
- "Dinoša"

The installed capacity on these springs is 2300 l/s, while the average daily supply is around 100.500 m^3/day (for the year 2015).

Mareza

Water source Mareza consists of natural springs which have been used for water supply of Podgorica and Danilovgrad since 1950. It is not familiar what is the exact yield of the watercourse at its source, but it is assumed that it is around 147.000 m^3/day. This assumption is not based on facts since there are no reports which could be used for validation of this data. The installed capacity for Podgorica is occasionally completely used during summer, while only around 5.616 m^3/day (out of the total installed capacity – 8.640 m^3/day) of water is used for Danilovgrad. Reconstruction of the old and the new pump should increase the installed pump capacity up to 129.600 m^3/day, and it should also provide conditions for capturing water from the fourth spring.

Ćemovsko Polje

Ćemovsko Polje is located on the territory which is included in the Podgorica Urban Design Plan, and it is characterised by a mild inclination from east towards wet. Ćemovsko polje is a part of the Zeta plain, which represents a collection area for all the surface water and groundwater from the wide Skadar lake basin.

Zagorič

Zagorič pumping station is included in the Main Urban Design Plan of Podgorica, and it is situated northeast from Gorica hill, i.e. it is surrounded by the road Podgorica-Zlatica on the northeast side and the railway Beograd-Podgorica on the northwest side. Its basin is much larger and, upstream from the point of confluence with the Ribnica river, it belongs to the Morača river basin. Basin covers the area of around 3.000 km^2.

Other water sources

Other water sources are mostly used for the purpose of providing water supply to the settlement "Tuzi". Water is obtained from several wells which are located on the territory of the capital. Water is captured from wells at all these sources: Dečići, Milješ, Dinoša and new source uksanlekići.

2.5. Flora and fauna

Chapter Flora and fauna was taken from the "Report on vascular flora, habitats and fauna (fish, amphibians, reptiles, birds and mammals) in the impact area of the project of reconstruction of the road M-18, section Danilovgrad-Podgorica, which was provided as the annex to the study.

Flora and habitats

The following types of habitats were identified during survey of the subject area, which spreads from the roundabout in Danilovgrad to Mareza Bridge in Podgorica (15 km): meadows, swampy meadows, reed beds, swamps, coastal riparian forests, watercourses and devastated forests on hilly terrain. A large part of the terrain in the project impact area is under significant anthropogenic impact. Terrain surveys were carried out during the last days of March and beginning of April, and they lasted three days (30th March, 06th April, 07th April). Woody and bushy species are currently in the blooming and flowering stage, while herbaceous plants along the subject road route are in the flowering period, whereby this is especially prominent among the ruderal species. When it comes to the swampy areas ("Mareške bare" (swamps), "Lužničke livade" (meadows) along the Matica River), herbaceous plants have just started developing, so the habitats were defined based on identification of dry plants from the previous year and on the basis of assumption of the quantitative and qualitative floral composition of the biotope. Locations at which flora and habitats are going to be under higher or lower degree of negative impact, caused by the planned construction of the main road Danilovgrad-Podgorica, have been preliminarily defined.

Tabular overview of the locations selected for site surveys

No.	**Number (mark) on the map**	**Location description**	**Altitude**	**Coordinates**
1.	Location 1 - Curilac	Zeta River arm, stagnant water with flood forests and meadows	47 m	42°32'26.07"N; 19° 6'58.54"E
2.	Location 2 – Susica Bridge	Susica River (characterised by interrupted flow already in March)	45 m	42°30'25.54"N; 19° 8'12.02"E
3.	Location 3 – Novo Selo	Hill covered in Macedonian Oak forest *Quercus trojana*	81 m	42°29'55.99"N; 19° 9'3.72"E
4.	Location 4 – swampy meadows	Swampy meadows with common reed *Phragmites australis*	30 m	42°27'47.08"N; 19°10'27.67"E
5.	Location 5 – flood-meadows	Flood-meadows with the appertaining drainage channel	30 m	42°27'42.55"N; 19°10'41.28"E
6.	Location 6 – Matica River	Matica River with flood-forests and riparian vegetation	30 m	42°27'38.31"N; 19°10'39.02"E

7.	Location 7 – Sitnica River	Sitnica River with flood-forests and riparian vegetation	36 m	42°26'53.00"N; 19°12'7.31"E
8.	Location 8 – Sitnica Bridge	Sitnica River with flood-forests and riparian vegetation	30 m	42°26'39.79"N; 19°12'14.44"E
9.	Location 9 – Mareza Bridge	Mareza River with flood-forests and riparian vegetation	30 m	42°26'36.03"N; 19°12'25.16"E

List of the assumed species

Alnus glutinosa, Fraxinus excelsior, Populus nigra, Populus alba, Salix purpurea, Salix alba, Salix fragilis, Quercus trojana, Carpinus orientalis, Phyllirea latifolia, Ficus carica, Punica granatum, Ruscus aculeaus, Brachypodium distachyum, Brachypodium ramosum, Cymbopogon hirtus, Chrysopogon gryllus, Avena barbata, Poa bulbosa, Festuca pseudovina, Aira capillaris, Holoschenus vulgaris, Helianthemum guttatum, Scabiosa alba, Cychorium intybus, Medicago rigidula, Medicago prostrate, Aegilops geniculata, Dasypirum villosum, Andropogon ischaemum, Bromus erectus, Festuca illyrica, Plantago lanceolata Stipa mediterranea, Eryngium campestre, Stipa bromoides, Erianthetus hostii, Koeleria splendens, Salvia officinalis, Lotus corniculatus, Phlomis fruticosa, Bellis perennis, Sanguisorba minor, Teucrium capitatum, Scorzonera villosa, Plantago holosteum, Asphodelus microcarpus, Asphodeline lutea, Phragmites australis, Typha longifolia, Rosa canina, Lythrum salicaria, Callitriche hermaphroditica, Lycopus europeus, Lysimachia vulgaris, …

List of the identified species

Ulmus minor, Fraxinus angustifolia, Populus nigra, Populus alba, Quercus frainetto, Robinia pseudoacacia, Ailanthus altissima, Morus alba, Ficus carica,

Punica granatum, Cornus sanguinea, Cornus mas, Ligustrum vulgare, Salix purpurea, Salix alba, Salix triandra, Salix fragilis, Salix cinerea, Rubus ulmifolius, Alisma plantago-aquatica, Mentha aquatica, Veronica anagalis- aquatica, Ranunculus aquaticus, Ranunculus fluitans, Ranunculus trichophyllus, Potamogeton fluitans, Myriophyllum spicatum, Lemna trisulca, Ceratophyllum demersum, Fontinalis pyretica, Oenanthe aquatica, Phragmites australis, Bolboschenus maritimus, Holoschoenus vulgaris, Typha latifolia, Juncus effusus, Taraxacum palustre agg., *Gratiola officinalis, Lysimachia nummularia, Eleocharis palustris, Nasturtium officinale, Leucojum aestivum, Nuphar luteum, Nymphea alba, Ficaria calthifolius, Lamium purpureum, Erodium cicutarium, Rosa canina, Carex acuta, Carex distans, Carex tomentosa, Carex cupina* (*Carex otrubae*), *Carex flacca, Primula vulgaris, Viola odorata, Scilla bifolia, Fritillaria messanensis* subsp. *gracilis, Anthoxantum ovatum, Bromus racemosus, Chrysopogon gryllus, Taraxacum officinale, Alopecurus utriculatus, Aristolochia rotunda, Ajuga reptans, Arum maculatum, Plantago intermedia, Geranium lucidum, Cychorium intybus, Bellis perennis, Cruciata laevipes, Vicia grandiflora, Veronica persica, Vinca minor, Lunaria rediviva, Lagoseris bifida, Senecio vulgaris, Tragopogon pratensis, Xantium italicum, Tammus communis, Clematis vitalba, Hedera helix, …*

Estimate of the degree to which the species are endangered (tabular overview)

Table. Assessment of the conservation status

No.	Locality (with coordinates)	Species name (Latin)	Species name (English)	Endemic	Conservation status (IUCN)	Status in relation to the Habitats Directive o Birds Directive
1.	Coastal forests along Sitnica	*Ulmus minor*	Field elm	NO	-	-

	River 42°27'29.92"N 19°10'52.98"E					
2.	Coastal forests along Matica River 42°27'35.81"N 19°10'46.63"E; Matica Bridge 42°27'38.53"N 19°10'38.60"E; Curilac 42°32'27.18"N 19° 6'57.74"E	*Fraxinus angustifolia*	Raywood ash	NO	-	-
3.	Coastal forests along Matica River 42°27'35.81"N 19°10'46.63"E; Most na Matici 42°27'38.53"N 19°10'38.60"E; Curilac 42°32'27.18"N 19° 6'57.74"E	*Populus nigra*	Black poplar	NO	-	-
	Willow shrubs along the channel which leads to the Matica Bridge 42°27'45.27"N 19°10'39.25"E; Coastal forests along Matica River 42°27'35.81"N 19°10'46.63"E;	*Salix purpurea*	Purple willow	NO	-	-
	Swampy meadow next to the Matica Bridge 42°27'46.04"N 19°10'35.89"E	*Salix cinerea*	Large grey willow	NO	-	-
	In the water or along the water	*Alisma plantago-aquatica*	Mad dog weed	NO	LC	-

	(Sitnica, Matica, channel on swampy meadow, Curilac)					
	In water or along the water (Sitnica, Matica, channel on a flood meadow, Curilac)	*Ranunculus aquatilis*	White water-crowfoot	NO	LC	-
	In the water or along the water (Sitnica, Matica, channel on swampy meadow, Curilac)	*Ranunculus trichophyllus*	Threadleaf crowfoot	NO	LC	-
	In the water or along the water (Sitnica, Matica, channel on swampy meadow, Curilac)	*Ranunculus fluitans*	River water crowfoot	NO	LC	-
	Matica 42°27'35.93"N 19°10'47.41"E	*Nuphar lutea*	Yellow water-lily	NO	LC	-
	Matica 42°27'35.93"N 19°10'47.41"E	*Nymphea alba*	White water lily	NO	LC	-
	Matica River 42°27'33.71"N 19°10'50.95"E Swamp along Matica 42°27'48.48"N 19°10'26.27"E; Swampy meadows which are drained through the channel which runs along Matica 42°27'46.59"N	*Phragmites australis*	Common reed	NO	LC	-

	19°10'34.87"E					
	Swamp along Matica 42°27'51.90"N 19°10'30.70"E	*Carex acuta*	Slim sledge	NO	LC	-
	Matica River coastal line 42°27'36.11"N 19°10'46.54"E; Curilac, swampy meadows 42°32'26.31"N 19° 6'58.16"E	*Leucojum aestivum*	Summer snowflake	NO	-	-
	Matica River coastal line 42°27'36.11"N 19°10'46.54"E	*Nasturtium officinale*	Watercress	NO	LC	-

Plant taxa identified during site survey are categorised as endangered or vulnerable on any of the European or IUCN lists.
There is no map of Natura 2000 habitats for the subject area.

Natura 2000 habitats

The following Natura 2000 habitats were identified along the designed road route:

1. Natura 2000: 3150; Eunis: C1.3, C1.32, C1.33 – Natural eutrophic water with Magnopotamion and Hydrocharition vegetation
2. Natura 2000: 3260; Eunis: C2.1, C2.18, C2.19, C2.1A, C2.1B, C2.2, C2.25, C2.26, C2.27, C2.28, C2.3, C2.33, C2.34 – Watercourses with river water-crowfoot vegetation (Ranunculus fluitans, Callitricho-Batrachion)
3. Natura 2000: 6420; Eunis: E3.1, E3.1 – Mediterranean tall humid grasslands of the Molinio-Holoschoenion
4. Natura 2000: 92A0; Eunis: G1.1, G1.112, G1.3, G1.31 – White ivy and white poplar forest

Description of Natura 2000 habitats and their location along the designed road route:

3150 Natural eutrophic water with Magnopotamion and Hydrocharition vegetation

Description of the habitat: slow-flowing river with blue-green water, characterised by smaller or higher degree of turbidity, and rich in dissolved bases (pH is most often above 7). This water is also characterised by *Hydrocharition*-type free-floating plants, or *Magnopotamion-type* rooted plants which occur in the deeper open waters. Free-floating communities (*Hydrocharition* and *Lemnion)* are comprised of the following species: *Lemna* sp., *Spirodela polyrhiza*, *Hydrocharis morsus ranae, Utricularia vulgaris, etc.;* while the dominant species in the rooted communities (*Magnopotamion) are: Potamogeton lucens, P. zizii, P. praelongus, P. perfoliatus, P. gramineus*. This type of habitats also includes the rooted floating vegetation, whereby the white water-lilly (*Nymphaea alba),* yellow water-lily *(Nuphar lutea)* and water chestnut (*Trapa natans* aggr.) represent the dominant vegetation. This type of vegetation develops in eutrophic and mesotrophic waters in Montenegro.

Distribution: Relatively frequent eutrophic water habitats in Montenegro. They are especially highly represented in the Skadar Lake.

Plants: *Hydrocharis morsus ranae, Lemna minor, L. gibba, L. trisulca, Spirodela polyrhiza, Utricularia vulgaris, Potamogeton lucens, P. zizii, P. praelongus, P. perfoliatus, P. gramineus*.

3260 Watercourses with river water-crowfoot vegetation (RANUNCULION FLUITANTIS, CALLITRICHO-BATRACHION)

Description of the habitat: Watercourses in the area which ranges from lowland to mountain areas, with submersed or floating vegetation comprised of river water-crowfoot (*Ranunculion fluitantis* and *Callitricho-Batrachion*) and water moss. These watercourses are characterised by low water level during summer. This type of habitats includes natural or nearly natural watercourses in which the abovementioned type of vegetation is developed. Generally, these watercourses always have slower or faster water flow, whereby they are characterised by predominance of submersed and immersed plants, while the most common type of floating plants belong to the species *Callitriche* sp.

Distribution: These types of habitats probably occur relatively frequently in Montenegro, but there is no enough information about their distribution. Representative stands of these communities were identified along the banks of

Otoka and Glava Bukovice at Durmitor, Mareza spring near Podgorica, in watercourses around Niksic, and in other similar areas.

Plants: *Ranunculus trichophyllus, Ranunculus fluitans, Ranunculus aquatilis, Myriophyllum* sp., *Callitriche* sp., *Zannichellia palustris, Potamogeton* sp., *Fontinalis antipyretica.*

6420 Mediterranean tall humid grasslands (*Molinio-Holoschenion*)

Description of the habitat: Mediterranean wet meadows which are covered in tall grass and sedges and which are widely spread around the entire Mediterranean basin. These hygrophilous meadows occur in areas which are prone to frequent flooding, as well as in areas where water is retained in the ground for long periods of time, which is why they are often called "swampy meadows". Even though they occur in the area characterised by Mediterranean climate, which is prominent by droughts during summer, these meadows are not affected by physical or physiological droughts during summer, thus they are rather abundant and productive. In terms of physiognomy, they often resemble real swamps, but they still differ from them by the floral composition and significantly shorter period of soil water saturation (as a rule, it lasts less than 6 months). These communities are characterised by predominant representation of different hygrophilous and hygro-mesophylls grass (*Molinia coerulea, Alopecurus nodosus, Agrostis alba*) and clover (*Trifolium fragiferum, T. resupinatum*). However, apart from these species, some other rather important species which occur in this area are sedges (*Holoschoenus vulgaris*, *Cyperus longus*, *Schoenus nigricans*, *Carex sp.*), site (*Juncus maritimus, J. acutus, J. inflexus, J. effusus*), etc.
Distribution: there is no specific data about the locality, but it is obvious that this type of meadows occurs in certain areas along the Montenegrin seaside.
Plants: *Scirpus holoschoenus* (*Holoschoenus vulgaris*), *Molinia caerulea, Alopecurus nodosus, Agrostis alba, Trifolium fragiferum, T. resupinatum, Cyperus longus, Schoenus nigricans, Carex* sp., *Juncus maritimus, J. acutus, J. inflexus, J. effusus, Inula viscosa, Pulicaria dysenterica, Orchis laxiflora, Succisa pratensis*.

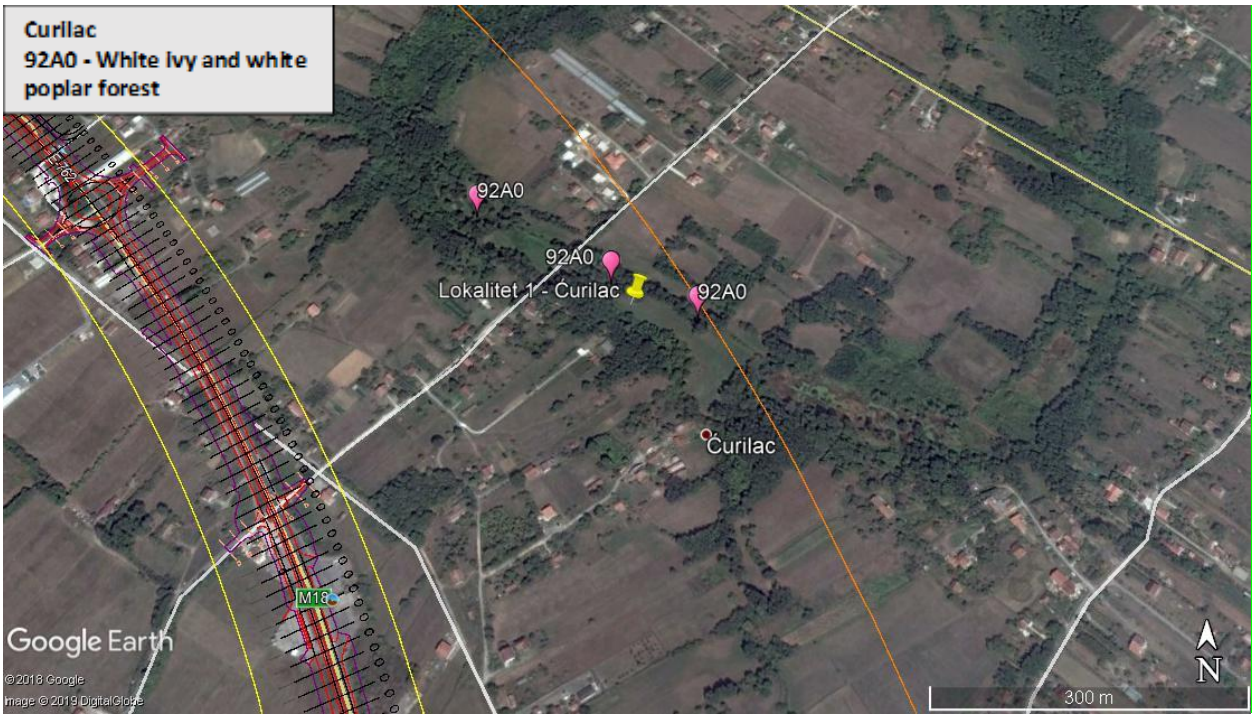
92A0 White ivy and white poplar forest
Description of the habitat: willow (*Salix alba, Salix fragilis*) and poplar (*Populus sp.*) forests along the banks of the rivers and lakes in the area of the Mediterranean and Black Sea. Other types of hygrophilous non-coniferous forests (*Ulmus* sp., *Salix* sp., *Alnus* sp., *Acer* sp., *Tamarix* sp., *Juglans regia, Quercus robur, Quercus pedunculiflora, Fraxinus angustifolia, Fraxinus pallisiae*) occur along the banks of the Mediterranean freshwater basins. The communities which are present in this area are often characterised by presence of numerous lianas. Tall poplar trees are

usually dominant, but sometimes they may not be present in these habitats, in which case they are replaced by other types of hygrophilous non-coniferous trees which are typical for these habitats.

Distribution: Area surrounding Lake Skadar and Ulcinj, Bojana River, "Cemovsko polje", lower course of the Zeta River.

Plants: *Salix alba, S. fragilis, Populus alba, P. nigra, Alnus glutinosa, Ulmus canescens, Quercus robur* subsp. *scutariensis*, *Fraxinus angustifolia*, *Periploca graeca*, *Carpinus orientalis, Althaea officinalis, Aristolochia rotunda, Bolboschenus maritimus, Leucojum aestivum, Lythrum salicaria, Mentha aquatica, Tamarix africana, Ulmus foliacea, Viburnum opulus*, *Vitex agnus castus.*

Some types of habitats which are listed in the Appendix I of the Habitats Directive (Natura 2000 habitats) were also identified in rivers: Susica, Matica and Sitnica, as well as on flood-meadows along the left and the right side of the designed road route, at the locality Luznica (before the Mareza Bridge, from the direction of Danilovgrad). Type of habitat – 92A0 white ivy and white poplar forests were also identified at the locality Curilac (Zeta River backwater), but they are far away from the Project impact area.

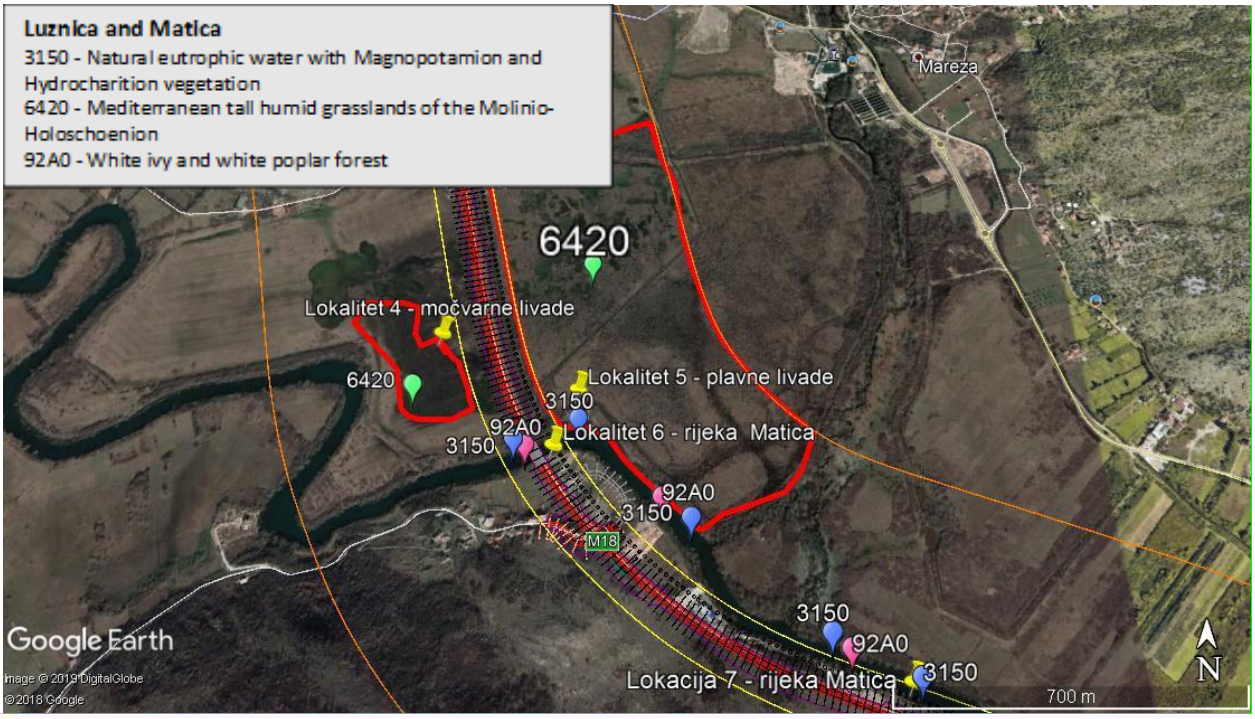


Ćurilac

Locality Curilac is outside of the Project impact area. Flood-forests were identified in this area, whereby the representative species in these forests are *Fraxinus angustifolia* and *Populus nigra*. The following species cover the flood-meadow which is located next to the channel (Zeta River arm): *Scilla bifolia, Alopecurus utriculatus, Ranunculus sardous, Aristolochia rotunda, Arum maculatum, Ajuga reptans, Taraxacum officinalis*. The species which stand out as predominant in shallow stagnant water are: *Ranunculus trichophyllus*, *Leucojum aestivum, Ficaria calthoides* and *Iris pseudacorus*.

Sušica River

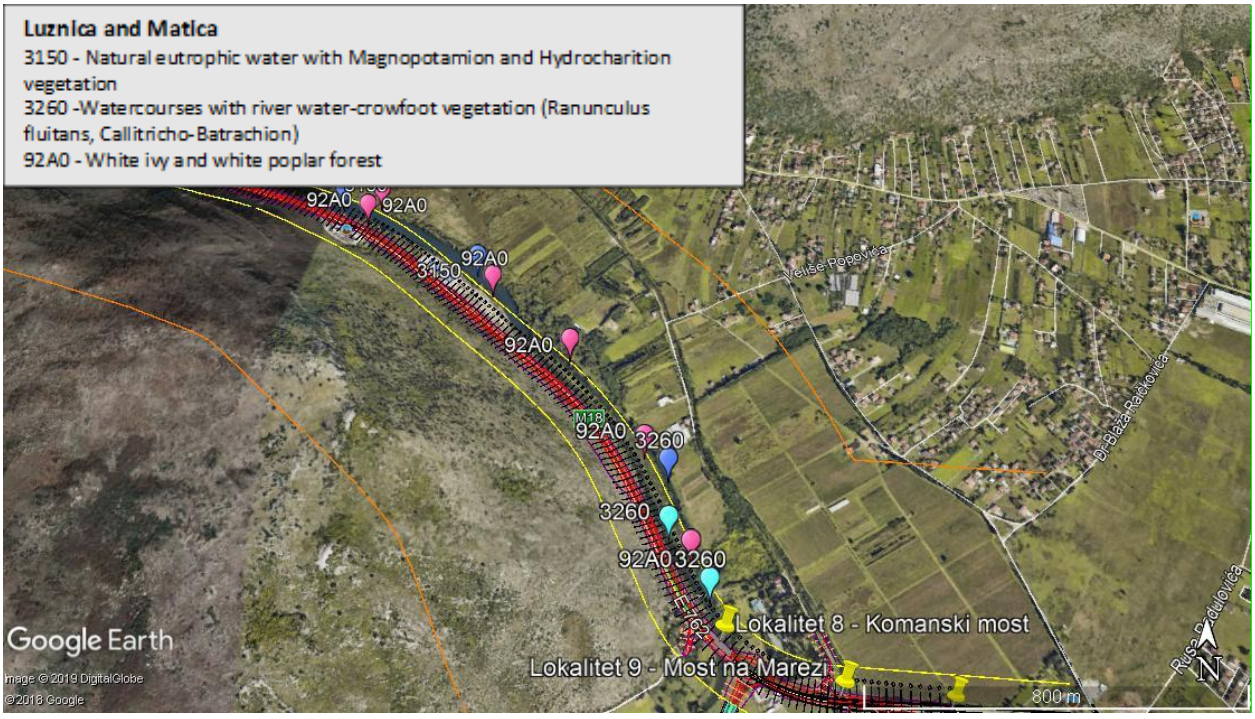
Coastal forests grow along the Susica River (locality 2), whereby narrow-leafed ash *Fraxinus angustifolia* and black poplar *Populus nigra* represent the predominant species in these forests. The river dried up in March. Only puddles could be seen in the riverbed. Following the first heavy rain, the river swelled again. Habitats 3150 and 3260 were not identified in this part of the terrain, as it was the case in Sitnica and Matica.



Luznica and Mareška swamps (swampy and flood-meadows)

Swampy habitats-reed beds were identified at the locality Luznicke meadows and Mareske bare (swamps) (before the Matica Bridge in the direction to Podgorica), whereby they are positioned along the left and right side of the designed route and these habitats are characterised by predominant representation of common reed *Phragmites australis.* The common reed area is well developed along the right side of the road, while the area covered in common reed along the left side of the road is narrow and it is located just below the road embankment. The following plant species were identified in reed beds: *Carex acuta*, *Taraxacum palustris*, *Lychis flos cuculi*, *Oenanthe aquatica*... Meadows which are characterised by dominant representation of sedges *Holoschoenus vulgaris*, *Juncus effusus*, *Carex tomentosa*, *Carex distans* are located behind reed beds at the survey point 5 (flood-meadows). Plants determine the Natura 2000 habitats – 6420 Mediterranean tall humid grasslands. Rare specimens of *Salix cinerea* and *Quercus frainetto* grow on the flood-meadow. The meadow is drained through a channel which runs from Mareza and it reaches the point of confluence with Matica under the bridge. The channel is covered in willow trees *Salix purpurea* and *Salix alba*, while there are also few white poplar P*opulus alba* specimens. Species which are predominant in the water in the channel are *Oenanthe aquatica*, *Carex otrubae* and *Alisma plantago-aquatica.* The same type of swampy habitats is located along the right side of the subject area, whereby this habitat is characterised by a significantly higher degree

of moisture, thus the dominant species in this area are: sea clubrush *Bulboschoenus maritimus*, *Holoschoenus vulgare*, *Carex distan*s, *Carex flacca*, *Eleocharis palustris*, *Lythrum salicaria*, *Gratiola officinalis*, *Lysimachia nummularia*... The hinterland is characterised by ponds, along which the following species are present: *Bulboschoenus maritimus*, *Typha latifolia* and *Carex acuta*. The swamp slowly turns into dry meadows, which are characterised by predominant representation of grass, such as *Chrysopogon gryllus*. Butterfuly orchid *Orchis papilionacea* and vernal sedge *Carex caryophyllea* were identified in hinterland at the embankment above Matica River. The meadows are regularly mowed, and they are used for livestock grazing. The channel which flows into Mareza River spreads along the section where the road turns towards the village Kuznice. Species which grow in this channel are: *Alisma plantago-aquatica*, *Juncus inflexus*, *Eleocharis palustris* and *Carex distans*.



River Matica – Sitnica

The following species were found in Sitnica River during the site survey: *Ranunculus fluitans*, *Ranunculus trichophyllus*, *Ranunculus aquatilis*, *Veronica anagalis-aquatica*, *Lemna trisulca*, *Alisma plantago-aquatica*, *Mentha aquatica*, *Myriophyllum spicatum*, *Fontinalis antipyretica*. These plants determine a Natura 2000 habitat – 3260 watercourses with river water-crowfoot vegetation (*Ranunculus fluitans-Callitricho-Batrachion*). Coastal forests take up the area

along rivers, whereby the dominant species in this area are field elm *Ulmus minor,* black poplar *Populus nigra,* different types of willow *Salix alba, Salix fragilis* and *Salix purpurea* – 92A0 white ivy and white poplar forest. Species which most often occur as the integral elements of coastal forests around the Komanski ski Bridge are: common fig *Ficus carica*, pomegranate *Punica granatum,* common dogwood *Cornus sanguinea,* including sporadic narrow-leafed ash trees. Coastal forests along Sitnica are not representative, but they have an important role in stabilisation of the terrain, prevention of erosion, bird nesting, and they also act as a habitat for reptiles… The flat areas above the coastal forests are covered in impassable underbrush, in which wild blackberry *Rubus ulmifolius* represents the ultimate predominant species.

As a single watercourse, Matica has only one name up to the point of reaching two channels with a separating island. Downstream from this point, its name is Sitnica. Coastal forests – 92A0 white ivy and white poplar forests are developed on the left and right bank of Matice, along its entire flow. Along with field elm *Ulmus* minor, the most prominent species in these forests are narrow-leafed ash *Fraxinus angustifolia*, black poplar *Populus nigra*, white mulberry *Morus alba*, different types of willow *Salix alba, Salix fragilis* and a number of *Salix triandra* trees. These are the representative coastal forests. Common reed *Phragmites australis* grows in certain parts of the river flow, in the coastal area. During summer, water level decreases, thus Matica-Sitnica dry up in the area near Podgorica. The following floating types of plants were identified in Matica (upstream from the Sitnica channel): white water-lilly *Nymphaea alba* and yellow water-lily *Nuphar luteum.* Apart from these species, the following types of plants are represented in this area: *Myriophyllum spicatum*, *Ceratophyllum demersum*, *Potamogeton fluitans*, *Mentha aquatica*... These plants determine a Natura 2000 type of habitat – 3150 Natural eutrophic plants with *Magnopotamion* and *Hydrocharition* vegetation. This type of habitats is present along the entire flow of Matica River in the subject area. Species which grow in water along the banks and on alluvial terraces are: *Carex otrubae, Leucojum aestivum, Nasturtium officinalis, Ficaria calthifolia...*

River Mareza

When it comes to the designed road route, Mareza River runs along a concrete canal. The canal is covered in wild blackberry *Rubus ulmifolius, black locust Robinia pseudoacacia,* common dogwood *Cornus sanguinea,* field elm *Ulmus minor,* tree of heaven *Ailanthus altissima.* Ruderal flora covers the area above the canal: *Vicia grandiflora, Geranium lucidum, Lunaria rediviva…*

Fauna

Taking into account the fact that the area of Bjelopavlići plain and Mareza, along with river courses, is characterised by diverse habitats and that the composition and distribution of fauna greatly depends on the diversity of habitats, it may be concluded that this area is characterised by diverse fauna.

Great biodiversity of the Bjelopavlići region was primarily caused by the impact of Mediterranean climate which reaches this area through the land area, by following the Zeta river valley and allowing for the presence of some Mediterranean elements of fauna (e.g. *Hemidactulys turcicus*, *Hierophis gemonensis*, *Platyceps najadum, Telescopus fallax*) (Ikovi, et al. 2016).

Herpetofauna and batrachofauna

Site surveys of amphibians (batrachofauna) and reptiles (herpetofauna) in the impact area of reconstruction of the Main Road M-18, section Danilovgrad-Podgorica, were carried out during March and the beginning of April 2019. A quick inspection of the road section Podgorica-Danilovgrad was carried out in Mid-March (17th March), for the purpose of selecting locations at which further surveys of batrachofauna and herpetofauna are going to be carried out. The surveys were carried out at regular intervals, during the period of favourable weather conditions when the abovementioned groups of animals were active (24th and 30th March, and on 6th April).

Route of the Danilovgrad-Podgorica section of the Main Road M-18 runs through the area which has special importance for batrachofauna and herpetofauna, which may be recognised in the fact that a large number of species has been discovered so far at different localities in the subject area (see the section – potential species). This is additionally purported by diversity of habitats which are adequate for reptiles which inhabit dry rocky areas, sparse forests, edges of fields, hedges, overgrown road embankments and road sides, swamps, creeks and rivers which are highly important for amphibians, whereby these areas or also adequate for reptiles which prefer these types of habitats (e.g. *Emys orbicularis*, *Natrix natrix, N. tessellata*).

Table 1. Locations selected for survey of amphibians and reptiles

No.	Number (mark) on the map	Location description	Altitude	Coordinates
1	1	Terrain around the Mareza Bridge	30 m	42° 26.609'N, 19° 12.425'E
2	2	Terrain around the Komanski ski Bridge (Sitnica Bridge)	33 m	42° 26.685'N, 19° 12.227'E
3	3	Terrain around the Matica Bridge	29 m	42° 27.659'N, 19° 10.612'E
4	4	Terrain close to the Bandici intersection u (Crkovnica River)	36 m	42° 29.126'N, 19° 9.884'E
5	5	Terrain around the Susica Bridge	44 m	42° 30.432'N, 19° 8.174'E
6	6	Terrain between Susica and Curilac (locality Grude)	46 m	42° 31.227'N, 19° 7.280'E
7	7	Curilac	46 m	42° 32.461'N, 19° 6.925'E

Assumed species

Species which are assumed to inhabit the selected locations were provided on the basis of data obtained from the References about the localities which are located in the area of the M18 road route, section Danilovgrad – Podgorica (Iković et al., 2016; Iković, 2017; Polović i Ljubisavljević, in press).

Amphibians (Amphibia)

Triturus macedonicus (Macedonian crested newt)

Lissotriton vulgaris (smooth newt)*

Bombina variegata (yellow-bellied toad)

Bufo bufo (common toad)

Hyla arborea (European tree frog)

Pelophylax ridibundus (marsh frog)

*sub-species which inhabits Montenegro *L.v. graecus* has recently been ranked up to the level of species *L. graecus*

Reptiles (Reptilia)

Emys orbicularis (European pond turtle)
Testudo hermanni (Hermann's tortoise)
Anguis fragilis (slow worm)
Pseudopus apodus (European glass lizard)
Hemydactilus turcicus (Mediterranean house gecko)
Algyroides nigropunctatus (Blue-throated keeled lizard)
Lacerta trilineata (Balkan green lizard)
Lacerta viridis (European green lizard)
Podarcis muralis (common wall lizard)
Podarcis melisellensis (Dalmatian wall lizard)
Dolichophis caspius (Caspian whipsnake)
Elaphe quatuorlineata (four-lined snake)
Hierophis gemonensis (Balkan whip snake)
Malpolon insignitus (Eastern Montpellier snake)
*Natrix natrix (*grass snake)
Natrix tessellata (dice snake)
Platyceps najadum (Dahl's whip snake)
Telescopus fallax (European cat snake)
Zamenis longissimus (Aesculapian snake)
Zamenis situla (European ratsnake)
Vipera ammodytes (Horned viper)

Identified species

During the four-day site survey, the following amphibian and reptile species were identified in the subject area (photo 5-19)

Amphibians (Amphibia)

*Lissotriton vulgaris** (smooth newt)
Bufo bufo (common toad)
Hyla arborea (European tree frog)
Pelophylax ridibundus (marsh frog)
Pelophylax shqipericus (Albanian water frog)
Rana dalmatina (agile frog)

* Representation of a hybrid zone between *L. vulgaris* and *L. graecus* is possible in the subject area (according to Wielstra et al. 2018)

Gmizavci (Reptilia)

Emys orbicularis (European pond turtle)
Podarcis muralis (common wall lizard)
Podarcis melisellensis (Dalmatian wall lizard)
Natrix natrix (grass snake)

Table 1. Estimate of the degree to which the species are endangered (tabular overview)

No.	**Locality with coordinates**	**Species name (Latin)**	**Species name (English)**	**Endemic**	**Conservation status (IUCN)**	**Status in relation to the Habitats Directive or the Birds Directive**
1.	Terrain around the Mareza Bridge 42° 26.608'N 19° 12.422'E 42° 26.659'N 19° 12.413'E	*Pelophylax ridibundus*	Marsh frog	widespread	LC	Habitats: Appendix V
2.	Terrain around the Mareza Bridge 42° 26.589'N 19° 12.425'E 42° 26.659'N 19° 12.413'E	*Podarcis muralis*	Common wall lizard	widespread	LC	Habitats: Appendix IV
3.	Terrain around the Mareza Bridge 42° 26.615'N	*Podarcis melisellensis*	Dalmatian wall lizard	Balkan peninsula endemic species (east coast of the	LC	Habitats: Appendix IV

	19° 12.422'E 42° 26.660'N 19° 12.402'E			Adriatic Sea)		
4.	Terrain around the Komanski ski Bridge 42° 26.685'N, 19° 12.227'E 42° 26.699'N, 19° 12.225'E 42° 26.665N, 19° 12.254'E	*Pelophylax ridibundus*	Marsh frog	widespread	LC	Habitats: Appendix V
5.	Terrain around the Komanski ski Bridge 42° 26.699'N, 19° 12.225'E	*Bufo bufo*	Common toad	widespread	LC	/
6.	Terrain around the Matica Bridge 42° 27.560'N, 19° 10.730'E 42° 27.609'N, 19° 10.748'E	*Podarcis muralis*	Common wall lizard	widespread	LC	Habitats: Appendix IV
7.	Terrain around the Matica Bridge 42° 27.605'N, 19° 10.774'E	*Hyla arborea*	European tree frog	widespread	LC	Habitats: Appendix IV
8.	Terrain around the	*Pelophylax shqipericus*	Albanian water frog	Balkan peninsula	EN	/

	Matica Bridge 42° 27.657'N, 19° 10.635'E 42° 27.728'N, 19° 10.533'E			endemic species (SE Montenegro, Albanian coastline)		
9.	Terrain around the Matica Bridge 42° 27.873'N, 19° 10.532'E 42° 27.730'N, 19° 10.555'E 42° 27.659'N 19° 10.587'E	*Natrix natrix*	Grass snake	widespread	LC	/ *subspecies which are represented in Montenegro are not listed in Appendix IV of the list of Habitats
11.	Terrain in proximity to the Bandici intersection (River Crkovnica) 42° 29.060'N 19° 9.913'E 42° 29.098'N 19° 9.852'E 42° 29.078'N 19° 9.781'E	*Pelophylax ridibundus*	Marsh frog	widespread	LC	Habitats: Appendix V

12	Terrain in proximity to the Bandici intersection (River Crkovnica) 42° 29.078'N 19° 9.781'E	*Natrix natrix*	Grass snake	widespread	LC	/ *subspecies which are represented in Montenegro are not listed in Appendix IV of the list of Habitats
13	Terrain around the Susica Bridge 42° 30.459'N, 19° 08.110'E 42° 30.421'N, 19° 08.246'E	*Podarcis muralis*	Common wall lizard	widespread	LC	Habitats: Appendix IV
14	Terrain around the Susica Bridge 42° 30.459'N, 19° 08.110'E	*Podarcis melisellensis*	Dalmatian wall lizard	Balkan peninsula endemic species (east coast of the Adriatic Sea)	LC	Habitats: Appendix IV
15	Terrain around the Susica Bridge 42° 30.459'N, 19° 08.110'E 42° 30.479'N, 19° 08.079'E 42° 30.482'N,	*Bufo bufo*	Common toad	widespread	LC	/

	19° 08.071'E 42° 30.476'N, 19° 08.063'E 42° 30.470'N, 19° 08.080'E 42° 30.374'N, 19° 08.376'E					
16	Terrain around the Susica Bridge 42° 30.374'N, 19° 08.376'E 42° 30.441'N, 19° 08.170'E	*Pelophylax ridibundus*	Marsh frog	widespread	LC	Habitats: Appendix V
17	Terrain around the Susica Bridge 42° 30.393'N, 19° 08.290'E 42° 30.417'N, 19° 08.118'E	*Pelophylax shqipericus*	Albanian water frog	Balkan peninsula endemic species (SE Montenegro, Albanian coastline)	EN	/
18	Terrain between Curilac and Susica Bridge (Kosic area)	*Podarcis melisellensis*	Dalmatian wall lizard	Balkan peninsula endemic species (east coast of the Adriatic Sea	LC	Habitats: Appendix IV

	42° 31.315'N, 19° 07.279'E					
19	Terrain between Curilac and Susica Bridge (Kosic area) 42° 31.315'N, 19° 07.279'E 42° 31.239'N, 19° 07.291'E	*Emys orbicularis*	European pond turtle	widespread	NT	Habitats: Appendix II, IV
20	Terrain between Curilac and Susica Bridge (Kosic area) 42° 31.239'N, 19° 07.291'E	*Lissotriton vulgaris**	Smooth newt	widespread	LC	/*sub-species listed in the Appendix II and IV is not represented in Montenegro
21	Terrain between Curilac and Susica Bridge (Kosic area) 42° 31.315'N, 19° 07.279'E	*Pelophylax ridibundus*	Marsh frog	widespread	LC	Habitats: Appendix V
22	Curilac 42° 32.461'N, 19° 6.925'E	*Emys orbicularis*	European pond turtle	widespread	NT	Habitats: Appendix II, IV
23	Curilac	*Pelophylax*	Marsh	widespread	LC	Habitats:

	42° 32.461'N, 19° 6.925'E	*ridibundus*	frog			Appendix V
24	Curilac 42° 32.450'N, 19° 6.956'E	*Podarcis muralis*	Common wall lizard	widespread	LC	Habitats: Appendix IV
25	Curilac 42° 32.461'N, 19° 6.925'E	*Rana dalmatina*	Agile frog	widespread	LC	Habitats: Appendix IV

Bird fauna (avifauna)

Classification of habitats

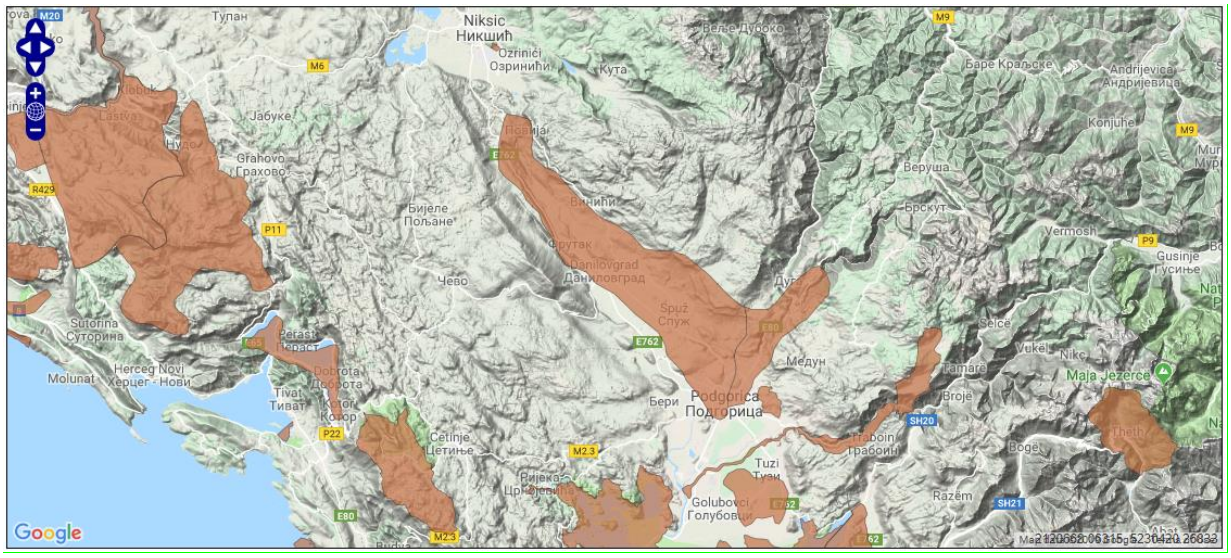
Table 1: Classification of bird habitats (habitat associations)

Habitats of Birds in Europe: a conservation strategy for the wider environment (Tucker, G.M. and Evans, M.I. 1997)		Corresponding localities on the boulevard route:
Marine habitats	None	Marine habitats
Coastal habitats	None	Coastal habitats
Inland wetlands	The Sitnica river, flood meadows – swamps of Mareza and Luznica, backwater of the Zeta river, near Curilac	Inland wetlands
Tundra, mires and moorland	None	Tundra, mires and moorland
Boreal and temperate forests	None	Boreal and temperate forests
Mediterranean habitats	Hillside area on the west side along the entire road route	Mediterranean habitats
Agricultural and grassland habitats	The western parts of the Podgorica valley, the valley of Sitnica, Mareza, the valley of Zeta	Agricultural and grassland habitats
Montane grassland	None	Montane grassland
Unclassified	Anthropomorphic habitats - settlements and cultivated areas	Unclassified

Protected areas

According to the national legislation, there are no protected areas in the subject area. The only protected object is the Natural monument - the cave Magara which is located outside the perimeter of 500m. However, the valley of the Zeta river has been declared as a Key Biodiversity Area (KBA), i.e. an area that meets the criteria of the EU Birds Directive and the Natura 2000 network in Montenegro. The boundaries of this area also include the zone of influence of the future road in the area of village Curilac.

Figure 1.2.1: Overview of protected areas in the construction area (IBAT, 2019)



Significant localities

In addition to the above-mentioned KBA area, several other localities with typical habitats of importance for protection have been identified.

1. Water flow of the Sitnica river, from Komanski ski bridge to the flood meadows of Mareza.

Explanation: In this part, the road route passes directly above the Sitnica river, through the zone which has an average width of 65m. This belt/area, in the length of approximately 4 km makes the natural environment of the riverbed, which is characterized by the flood forest of willow and poplar trees, which is a natural habitat for several species of birds that have an unfavourable protection status. The route continues through the periodically flowing Mareza Swamp, which also belong to wet habitats with elements of endangered avifauna. In this area, it is planned a field work at a total of 6 points (locations 1-6).

In this area, it is planned to carry out site surveys at the total of 6 locations (locations 1-6).

2. The Sušica riverbed

Explanation: Similar to the Sitnica river, construction of the road will lead to loss of a part of habitats which are used by birds that inhabit riparian forests and riparian habitats, in the total length of two kilometres. In this area, field work is planned to be carried out at two locations (location 7 and 8).

3. The flood area of Zeta, near Curilac

Explanation: In the area of Curilac, the road route passes through the KBA (Key Biodiversity Area) of the Zeta valley, which is a potential Natura 2000 habitat. The Zeta valley fulfils several criteria for protection according to the N2000 methodology, so it is necessary to carry out additional research about the impact of construction. In this area, it is planned to carry out field work at 2 locations, with the aim of covering an area of approx. 5 km^2, in the immediate surroundings of the Zeta river arm (locations 9 and 10).

Table 1.1: *Overview of coordinates of the research locations*

No.	Number (mark) on map	Location description	Altitude (m)	Coordinates D.DDDDDD	
				Latitude (N)	
1	1	Water flow of the Sitnica river from Komanski ski bridge to the flood meadows of Mareza	33	42.445331	1
2	2		32	42.449583	2
3	3		30	42.455345	3
4	4		42	42.456629	4
5	5		30	42.461255	5
6	6		35	42.466897	6
7	7	Susica riverbed	48	42.502669	7
8	8		45	42.507375	8
9	9	Flood area of Zeta, near Curilac	49	42.538841	9
10	10		46	42.542503	10

Results

For the purpose of this study, 3 field surveys were carried out in the subject area, in the period from March 16th 2019 to April 14th 2019. On the basis of the data obtained through survey field data, data obtained from References, bird ringing and online sources, a table of species that definitely populate the subject area is provided.

Table 3.1: *The survey results from March 16th to April 14th 2019*

No.	**Species of birds in the subject area**		**Location**	**Number**
1	*Accipiter gentilis*	Northern Goshawk	6	1
2	*Accipiter nisus*	Eurasian Sparrow hawk	5, 8	2
3	*Acrocephalus arundinaceus*	Great Reed Warbler	4,5,6	5+
4	*Actitis hypoleucos*	Common Sandpiper	6	2
5	*Aegithalos caudatus*	Lon-tailed Tit	5	2
6	*Anas platyrhynchos*	Mallard	3,5	4
7	*Ardea cinerea*	Grey Heron	5	3
8	*Buteo buteo*	Common Buzzard	6,9	2
9	*Carduelis chloris*	European Greenfinch	3,6,9	6
10	*Carduelis spinus*	Eurasian Siskin	4	4
11	*Casmerodius albus*	Great White Egret	6	2

12	*Circus aeruginosus*	Marsh Harrier	5	1
13	*Columba livia*	Rock Pigeon	4,5,10	11
14	*Corvus corax*	Raven	1	2
15	*Corvus corone cornix*	Hooded Crow	4,5,7,9	7
16	*Corvus monedula*	Jackdaw	2	4
17	*Cuculus canorus*	Common Cuckoo	5,8	2
18	*Dendrocopus major*	Great Spotted Woodpecker	4	2
19	*Dendrocopus syriacus*	Syrian Woodpecker	10	1
20	*Emberiza cia*	Rock Bunting	6	3
21	*Emberiza cirlus*	Cirl Bunting	5,6	5
22	*Erithacus rubecula*	Robin	1,2,9	3
23	*Falco subbuteo*	Eurasian Hobby	5	1
24	*Fringilla coelebs*	Chaffinch	1,3,6,8,9	20
25	*Fulica atra*	Coot	2,3,6	5
26	*Gallinula chloropus*	Moorhen	2,3	2
27	*Garrulus glandarius*	Eurasian Jay	2,5,7,10	8
28	*Hirundo rustica*	Barn Swallow	1,2,6,8,9	20
29	*Larus michahellis*	Yellow-legged Gull	6	2
30	*Larus ridibundus*	Black-headed Gull	4,6	6
31	*Luscinia megarhynchos*	Nightingale	10	2
32	*Melanocorypha calandra*	Calandra Lark	9,10	5
33	*Merops apiaster*	Bee-eater	6	2
34	*Motacilla alba*	White Wagtail	3	8,9
35	*Motacilla cinerea*	Grey Wagtail	1	8
36	*Oriolus oriolus*	Eurasian golden oriole	2	10
37	*Parus caeruleus*	Blue Tit	1	3
38	*Parus major*	Great Tit	7	2,3
39	*Passer domesticus*	House Sparrow	9	1,2,9,10
40	*Phalacrocorax carbo*	Great Cormorant	2	5
41	*Phalacrocorax pygmeus*	Pygmy Cormorant	4	5,6
42	*Pica pica*	Magpie	6	7,8,9
43	*Picus viridis*	Green Woodpecker	1	9
44	*Podiceps nigricollis*	Black-necked Grebe	1	6
45	*Saxicola rubetra*	Whinchat	2	6
46	*Streptopelia decaocto*	Collared Dove	11	1,2,7,8
47	*Sturnus vulgaris*	Starling	6	4
48	*Sylvia atricapilla*	Blackcap	4	2
49	*Tachybaptus ruficollis*	Little Grebe	2	5
50	*Tringa glareola*	Wood Sandpiper	1	6
51	*Turdus merula*	Common Blackbird	8	7,8,9
52	*Upupa epops*	Hoopoe	8	1

Presence of the total of 52 bird species was determined through the fieldwork which took place during the mentioned period. Based on the collected data from the References and other surveys in the period outside the reproductive season, presence of 183 species of birds was determined in the subject area during the year, which makes up approximately half of the total number of birds of Montenegro. According to data obtained from the References, there are 10 species with unfavorable status in the subject area, which are listed on the IUCN's Red List of Threatened Species.

Also, based on ringing data and previous research, it is known that the Zeta valley represents a migratory corridor. For this reason, during the winter here can be found representatives of forest songbirds which are local migrants, and also the flying of the common crane (Grus grus) as an obligatory migrant has been noticed.

Overview of Threatened Species

During the field work during the mentioned period, on March 16th, April 13th and 14th 2019, species which have IUCN conservation status were not identified. However, given the limited number of field days, their presence during the year cannot be excluded in the wider area of the impact zone.

Species from the duck and geese families are threatened at global and local level due to the destruction of wetland habitats and excessive hunting. At the project location, construction works are endangering a minor part of their nominal habitat in the part of the Sitnica river basin and the area of the flood meadows on Mareza. In addition, the area of the Zeta valley and Sitnica is the dispersion vector of the waterbirds population from the Skadar Lake. Therefore, it is concluded that for this group the influence of the road construction is negligible compared to other anthropogenic impacts, for example poaching.

Birds of prey like Red-Footed Falcon and Greater Spotted Eagle are seasonal visitors for whom the characteristic habitats are not critical in the subject area, so the impact of road construction on them is considered as negligible.

The Rock partridge inhabit a large part of Montenegro belonging to a group of Mediterranean habitats, which include rocky and rocky pastures and underbrush. This type of habitat is present mainly on the hills along the corridor of the road, where occurs also a minimal loss of habitat, so the impact on this species is considered negligible.

For threatened songbirds, we also consider that the impact of road construction is negligible, as it does not lead to critical habitat losses or other negative effects, especially when take into account their seasonal concentration and habitat use.

Table 3.2: Overview of birds with an unfavorable IUCN protection status

No.	Species of birds in the project location		IUCN Global conservation status
1	*Alectoris graeca*	Rock partridge	NT
2	*Anser erythropus*	Lesser White Fronted Goose	VU
3	*Anthus pratensis*	Meadow Pipit	NT
4	*Aquila clanga*	Greater Spotted Eagle	VU
5	*Aythya ferina*	Pochard	VU
6	*Aythya nyroca*	Ferruginous Duck	NT
7	*Branta ruficollis*	Red-breasted Goose	VU
8	*Falco vespertinus*	Red-footed falcon	NT
9	*Streptopelia turtur*	Turtle Dove	VU
10	*Turdus iliacus*	Redwing	NT

Invertebrates represent the most numerous groups of animals, while insects are the most numerous species among them. Systematic surveys of flora in the subject area have still not been carried out, and the only data is presented in Biodiversity actions plans for the Municipality Podgorica and Municipality Danilovgrad. The available literature data is only related to certain entomological groups which have been surveyed at certain locations.

Species of international and national importance which may be found in this area are: *Limax wohlberedti* Simroth, 1900, *Tandonia reuleaxi* (Clessin, 1887), *Deroceras turcicum* Simroth,1894, *Cerambyx cerdo* Linnaeus, 1758 (Cerambycidae, Coleoptera), *Lucanus cervus* Linnaeus,1758 IUCN category VU, criteria A1c + 2c Ver.2.3. Habitats Directive 92/43 EEC, Appendices II and IV, the Bern Convention, Appendix II, *Oryctes nasicornis* Linnaeus, 1746, *Iphiclides podalirius* Linnaeus, 1758, *Papilio machaon* Linnaeus 1758 (IUCN category LC), *Callimorpha (Euplagia) quadripunctaria* Poda 1761 - Habitats Directive 92/43 EEC, Annex II, *Eriogaster catax* Linaeus 1758 - IUCN category DD, version 2.3). Habitats Directive 92/43 EEC, Appendix II and IV and the Bern Convention, Appendix II. Snail *Helix vladica* (Kobelt, 1898) (Gastropoda, Helicidae) may be found on grassy slopes, as well as in forests and vegetation which are located close to creeks. This species is under national protection and it is categorised as Least concern (LC) on the IUCN Red List. Additionally, it is considered that population of this species in Europe is table since it has been proven that this species is adaptable to changes of habitats.

Ichthyofauna

Site survey of fish (ichthyofauna) in the impact area of the road reconstruction project, which will be carried out from the roundabout in Danilovgrad to the Mareza Bridge, in the total length of 15 km, was done during March and beginning of April 2019. An assessment was made in mid-March (March 17th), whereby the method used was visual inspection and it was aimed at determining the locations at which impact on fish is expected to be highest during the period of carrying out construction works. Additionally, this inspection was aimed at determining locations at which additional ichthyofauna surveys are going to be carried out.

Table 1. *Locations selected for ichthyofauna surveys*

No.	Number (mark) on the map	Location description	Altitude	Coordinates
1	Location 1 Mareza Bridge	Mareza River channel	30m	42°27'39.2"N 19°10'37.7"E
2	Location 2 Komanski ski Bridge	Sitnica River	26m	42°26'43.0"N 19°12'13.0"E
3	Location 3 Matica Bridge	Matica River	30m	42°27'38.8"N 19°10'37.57"E
4	Location 4 Susica Bridge	Susica River	45m	42°30'25.42"N 19°12'25.25"E

The surveys were carried out on 7th, 9th and 11th March. Due to heavy rainfall during the period when survey was conducted, it was difficult to carry out the field research, which is the reason why the methodology of work slightly differed from the one stipulated by the preliminary report. Only a few species were discovered during this site survey, whereby all the identified specimens were very small and that is why no measurements were taken. Taking measurements is an important part of the process for eel (its length may indicate the degree of maturity and sex) and Adriatic trout, both of which should be considered with special attention in terms of protecting them as endangered species.

Results

The species which are assumed to be represented at the selected locations were provided based on information from the References (Marić & Milošević, 2010).

List of the assumed and identified species

No.	Species' name (Latin name)	Endemic	Conservation status (IUCN)	**Determined species**
1.	*Salmo faroides* Karaman, S., 1937		Not evaluated	
2.	*Salmo marmoratus* Cuvier, 1829		LC	
3.	*Salmo zetensis* Hadžišće, 1962		EN	
4.	*Cobitis ohridana* Karaman, 1928	endemic Ohrid – Drim- Skadar	LC	Location 2,3,4
5.	*Barbatula zetensis* (Šorić, 2000)		LC	Location 3
6.	*Rutilus prespensis* (Karaman, S., 1924)	endemic Ohrid – Drim- Skadar	LC	Location 2,3,4
7.	*Squalius platyceps* Zupančić, Marić, Naseka & Bogutskaya, 2010	endemic Ohrid – Drim- Skadar	LC	Location 2,3,4
8.	*Telestes montenigrinus* (Vukovic, 1963)	Endemic to Skadar basin	LC	Location 3
9.	*Gobio skadarensis* Karaman, S., 1936	Endemic to Skadar basin	LC	
10.	*Scardinius knezevici* Bianco & Kottelat, 2005	Endemic to Skadar basin	LC	
11.	*Cyprinus carpio* Linnaeus, 1758		LC	
12.	*Carassius gibelio* (Bloch, 1782)		LC	
13.	*Anguilla anguilla* (Linnaeus, 1758)		CR	
14.	*Alburnus scoranza* Bonaparte, 1845		LC	
15.	*Alburnoides ohridanus (*Karaman, S., 1928)		LC	
16.	*Pachychilon pictum* (Heckel & Kner, 1858)		LC	Location 2,3,4

Such a small number of the determined species indicates that short-term surveys cannot provide a realistic image of fish biodiversity. Trap net was empty at the locality Mareza, and according to the testimonies provided by the local fishermen, fish has not been recorded in that channel for years. This channel is shallow, full of garbage and the only period when water runs through this channel is during the rainy periods. Some fish specimens were found at the other three localities, but the number of specimens which were identified was much lower than it was expected. Some of the collected ichytiological material was determined and processed on-site, after which the fish was released. A smaller portion of the collected material was preserved in 4%-formalin for the purpose of redetermining the species and carrying out additional laboratory analyses.

Salmonid species, nor eel, were not found at the subject localities. The local population deems that such condition of the fish fund is a direct consequence of use of electricity, i.e. aggregates for fishing, which is strictly prohibited. Of course, this does not mean that there are no specimens of trout and eel in these rivers; on the contrary, the local fishermen have confirmed that these species are present in these rivers, but that the weather conditions did not allow the fish to "be active". *Salmo zetensis* is the only species which is protected by law in Montenegro, while eel is listed on the so-called Red List of the endangered species, and its conservation status is CR-critically endangered species. Matica, Sitnica and Susica are the rivers in which these fish species feed, since these are predatory species and they eat other fish, smaller fish species, fish eggs, crayfish, larvae and worms (Morović, D. 1966. "Bilješke o jegulji". Ribarstvo Jugoslavije, 21, no.5, p. 98-101). Salmonidae move towards the upper course in order to spawn, and they do this during winter, from November until January. Another fish species is Cyprinidae, which spawns during the period from Mid-March until Mid-June.

Mammals fauna

Description of the survey area

The survey was carried out mostly at the most critical locations identified by the Terms of Reference, as well as by the personal assessment of the importance of individual road sections (habitats) in relation to mammals.

Table 1. Overview of the survey area (Map 1)

Serial number	Number (mark) on map	Location description	Altitude (m)	Coordinates
1	1	Sitnica bridge (Komanski bridge) Meadow and the coastal surfaces of the riverbed	72	42. 26 53 N 19. 12 30 E
2	2	Matica bridge	71	42 27 37 N 19 10 375 E
3	3	Wetland and semi-wetland part from the Matica bridge	67	42.27 56 N 19.10 31 E
4	4	Luznica	66	42 47 91 E 19 16 28 E
5	5	Novo Selo - Tomasevici		42 29 30 N 19 9 30 E – 42 31 11 N 19 7 24 E
6	6	Susica bridge	88	42 50 68 N 19 13 64 E

RESULTS

Based on the available References, data from hunting association from the Municipalities Podgorica and Danilovgrad, population survey, natural characteristics of the area (habitats), conducted survey on the field, it has been provided the following data: List of assumed species; List of determined species; Assessment of threatened species.

By assessing the natural characteristics of the subject area characterized by diversity of the habitat (field, meadows, vineyards, semi-wetlands and wetlands, river banks, degraded forests, underbrush, bushes of surrounding hills), it was concluded that the whole area, and especially certain parts suitable for many types of mammals.

Thus, on the preliminary list of expected species in this area, the presence of species of small mammals from the Insectivore family, Rodentia, as well as the medium mammals from family Mustelidae, Felidae, Canidae were assumed.

The results of the field survey are:

Location 1 (Map 1) Sitnica bridge. No traces found, nor mammals' shelter. The presence of bat at the time of the study (1 day - 2h from dusk) did not found by the ultrasound detector.

The location was assessed as insufficiently interesting for mammals (devastated, urbanized), but potentially interesting for feeding bat due to the presence of water. Also, (according to hunting associations, Zelenika Hill (opposite the location), an important habitat for mammals that cross the existing main road to reach the water.

Location 2 (Map 1) Matica bridge. No traces found, nor mammals' shelter. The presence of bat at the time of the study (1 day - 2h from dusk) did not found by the ultrasound detector.
The site was assessed as interesting and important for mammals due to the presence of water.

Location 3 (Map 1) semi-wetlands and wetlands part from the Matica bridge. Traces of small mammals have been found (holes, Appendix). There were placed traps and photo traps, but after 3 days of survey, neither a single mammal was catch or recorded (Appendix 2). The presence of bat at the time of the survey (1 day - 2h from dusk) did not found by the ultrasound detector.
The location was assessed as a valuable and significant habitat, especially for small mammals (water vole), as well as bat (feeding grounds).

Location 4 (Map 1) Luznica. No mammals found. On the left side of the road (direction Podgorica-Danilovgrad) there are old trees, rocks with recesses and cuttings that can serve as a potential shelter for some mammals and bats (Appendix 2). There were placed a traps and photo traps, but after 3 days of survey, neither a single mammal was catch or recorded (Appendix 2).
The site was assessed moderately significant to significant for mammals.
The presence of bat at the time of the survey (1 day - 2h from dusk) did not found by the ultrasound detector.

Location 5 (Map 1) Tomasevići. No traces found, nor mammals' shelter. The presence of bat at the time of the study (1 day - 2h from dusk) did not found by the ultrasound detector.
The site was assessed as interesting for mammals due to the presence of water (small stream) but it is also unsuitable due to anthropogenic impact.

Location 6 (Map 1) The bridge on the Susica river. No traces found, nor mammals' shelter. The presence of bat at the time of the study (1 day - 2h from dusk) did not found by the ultrasound detector.
The site was assessed as interesting for mammals due to the presence of water but it also unsuitable due to anthropogenic impact.

Although direct research has not unequivocally established the presence of mammals in the subject area, that does not mean that they are not present.
By overview of the available References as well as some of the more recent unpublished research data in the area and surrounding, data from hunting associations, local population survey, data published in the media, it has been concluded that the presence of these species of mammals in the area can be confirmed with great certainty.

Table 2. Overview of determined species in the subject area and immediate surroundings

No.	Locality with coordinates	Latin name of the species	English name of the species	Endemism	Conservation status (IUCN)	Status on Habitat Directive or Birds Directive
1	Beri, Doljani, Vranici, (Sitnica)-liter.	*Microtus (Pytymus) thomasi*	Montenegrin /Balkan Vole	yes	-	-
2	Malo brdo, Velje brdo, Rsojevici, Danilovgrad-lit.	*Apodemus mystacinus*	Eastern broad-toothed field mouse	no	LC	-
3	Sitnica river, Zelenika, Danilovgrad, Podgorica-assessment	*Apodemus sylvaticus*	Long-tailed Field mouse	no	LC	-
4	Podgorica, Danilovgrad-media, hunting associations, population survey	*Erinaceus roumanicus (concolor)*	Hedgehog	no	LC	-
5	Along the entire route of the road, hunting associations, population survey, assessment	Sitnica river, Zelenika, Danilovgrad, Podgorica-assessment	Rabbit	no	LC	-
6	Zagreda –lit. Wet meadows Slavnica-	*Arvicola terrestris*	Water Vole	no	LC	-

	42.44 53 N 19.20 30 E					
7	Mareza, Zagreda, Beri	*Mus domesticus*	Common mouse	no	LC	-
8	Zelenika, Luznice, Novo selo	*Vulpes vulpes*	Red Fox	no	LC	-
9	Luznice, Zelenika, Novo selo	*Martes martes*	European pine marten	no	LC	Appendix V (a) Habitat Directive
10	Zelenika Luznice, Novo selo	*Martes foina*	Beech, Stone marten	no	LC	-
11	Novo Selo,	*Meles meles*	European badger	no	LC	-
12	Along the entire route of the road	*Felis silvestris*	European wildcat	no	LC	Appendix IV Habitat Directive
13	Široka lazina, next to the Sitnica	*Canis lupus*	Grey/gray wolf	ne	LC	Appendix V (a) Habitat Directive
14	Along the entire route of the road	*Mustela putorius*	European polecat	no	LC	Appendix V (a) Habitat Directive
15	Zelenika, Luznica	*Mustela nivalis*	Common weasel	no	LC	-
16	Vilina cave, Cafe 42,4538°N, 19,1760°E 258 m.a.s.l.	*Rhinolophus ferrumequinum*	The greater horseshoe bat	no	NT	Appendix II and IV Habitat Directive
17	Along the road, Vilina cave, Cafa 42,4538°N, 19,1760°E 258 m.a.s.l.	*Rhinolphus hipposideros*	Lesser horseshoe bat	no	NT	Appendix II and IV Habitat Directive
18	Near the Susica,	*Pipistrellus kuhlii*	Kuhl's pipistrelle	no	LC	

	around the street lights, shrubs in the karst along the road, near Zeta					Appendix IV Habitat Directive
19	Near Susica, around the street lights along the road	*Pipistrellus pygmaeus*	Soprano pipistrelle	no	LC	Appendix IV Habitat Directive
20	Near Susica, around the street lights along the road	*Pipistrellus nathusii*	Nathusius' pipistrelle	no	LC	Appendix IV Habitat Directive
21	Meadows along the road	*Myotis mystacinus*	Whiskered bat	no	NT	Appendix IV Habitat Directive
22	Shrubs in the karst along Zeta	*Myotis capaccinii*	long-fingered bat	no	NT	Appendix II and IV Habitat Directive

2.6. Topography of the area

For the most part, route of the existing Main Raod M-18 Podgorica-Danilovgrad runs through a plain, including occurrence of a smaller area of hilly parts of the terrain.

2.7. Protected objects and cultural-historical heritage

There are no protected objects or goods which belong to cultural-historical heritage in the area in which the road route M-18 Danilovgrad-Podgorica is located.

2.8. Population and population density

This project is being implemented in the inter-municipal area which is characterised by a certain density of objects and population. A number of objects which are used as individual residential objects are located close to the road route of the M-18 road section Podgorica-Danilovgrad. Compared to other sections which were show in the figures above, density of residential objects is highest at the section which stretches from the Iveco business premises to the Danilovgrad roundabout. Other section are characterised by a lower number of individual

residential objects. Additionally, the area along the route is characterised by a significant number of business premises, i.e. objects which are used for providing services and production facilities.

According to the data obtained during the 2011 Census, the total number of people who live in Municipality Danilovgrad is 17.678, out of which 6.892 live in urban areas. The subject road route passes through the section which was treated as a rural area during the Census, and this area consists of the following settlements:

Begovina - 277 people
Gruda - 168 people
Ćurilac - 550 people
Jastreb - 304 people
Novo Selo - 613 people
Strahinjići - 53 people

According to the data obtained during the 2011 Census, the total population of Municipality Podgorica is 187.085, out which 156.169 people live in urban areas. Out of all the rural areas which were included in the Census, the subject road route passes through the following settlements:

Baloči - 42 people
Beri - 556 people

It is important to mention that the centres of the abovementioned settlements are located far away from the main road, and that only a small percentage of the total number of people who live in these settlements inhabits the area in vicinity of the road.

When it comes to the planned project, it is not going to affect the demographic characteristics.

Truth be told, it should be noted that some of the occurrences which will be brought about during the construction and implementation phase of the project may be: higher amount of dust, concentration of exhaust gases from the construction machinery, noise, etc. However, these works will be characterised by limited duration, and values of these parameters will be in line with the legally allowable concentrations through implementation of assessment and measures.

2.9. The existing business, residential and infrastructure objects

Route of the existing Main Road M-18, road section Podgorica-Danilovgrad, which is planned to be reconstructed, is stretching through a zone which is characterised by a certain population density, and which is also characterised by a significant number of business premises. Objects along the road which are used are residential objects and business premises are located along the left and the right side of the main road, as it was described in the introductory section of this chapter.

Around 50 objects which are used for residential purposes and a large number of business premises are located in the 50m zone along each side of the road: "N&B Plast", "Feal", "Đak Sport", "DAK Petrol", restaurant "Ognjište", "Viner co", "Ataco", "Roma", "Montecco", "Poljovita", "RS Rakočević", shop „Tekamik", restaurant "Bagrem", shop "DDI Trade", "Velco", "Iveco", "GSI", "Monteno Maks", hotel "Pejović", restaurant "Muštuluk", "Drvo Mont", "Garmin", "Flemer Stone", gas station "Eko", restaurant "Perper", "Okov", "Europetrol", shop "Idea", shop "Alfa".

This project is implemented in the zone which was defined by the items provided in the Spatial Plan of Montenegro until 2020, and by the guidelines provided in the Spatial Urban Planning Plan of the Capital Podgorica until 2025. Reconstruction of the existing Main Road M-18, section Podgorica-Danilovgrad was confirmed by the urban-technical conditions number 0503-1660/11, which were issued on 11 August 2014 by the Ministry of Sustainable Tourism and Development, Civil Engineering Department.

3. DESIGN DESCRIPTION

The design envisages the reconstruction of the trunk route M-18, Danilovgrad-Podgorica, from km 114 + 500 to km 129 + 632. The total length of the section is 15,132 km.
The route of the M-18 trunk route that will be reconstructed on the Danilovgrad-Podgorica section is laid along the corridor of the existing road. The existing road is a two-lane road with width of approx. 7.0 m. It is planned to build a boulevard on the whole section with two lanes in each direction, a divisional island, and in Danilovgrad and Podgorica and with sidewalks and a green belt.

The concept of the expansion of the road is proposed left or right in relation to the existing ones, and if it is necessary (for reasons of demolition of objects or major earth works) road expansion on both sides is envisaged.
By widening the road to the left or right in relation to the existing one, it is considerably easier to execute, because during execution of the new traffic lanes traffic can be smoothly executed along the existing road. In the case of double expansion, the demolition of objects to the left and to the right of the road decreases, but it is difficult to execute it during traffic, in which case the entire existing carriageway structure must be demolished in order to place a green belt on it.
Expansion in both directions is especially unfavourable (impossible) in area of bridges, therefore it is being avoided.
Within the Conceptual design, the solutions of the intersection of the circular intersection - crossroads with intersection of traffic currents were analyzed. A circular crossroads solution was adopted if another type of intersection is not envisaged by some of the existing, already adopted, designs or planning documents.
Horizontal road elements meet conditions of traffic-technical conditions for design speed of 80 km/h. Due to high number of objects that will be connected to the road, a speed limit will be introduced.
On the route, reconstruction of existing objects and construction of new ones are planned as needed. The larger objects are bridges of the Sušica, Matica, Komanski ski most, as well as a number of supporting walls.

3.1. Description of the route

Location solution

From the existing roundabout in Danilovgrad to km 114+600 the road has already been extended to the right.
The newly-planned road continues on the constructed road on the right side up to the roundabout at km 116 + 260 (intersection Ćurilac). It is necessary to demolish the objects in the zone of the Europetrol gas station and the station itself, i.e. its displacement, which is conditioned by the already built extension of the road from that side.
At km 115 + 270 planning documents of the municipality of Danilovgrad, a four-leg intersection is planned, which is, at the request of the Municipality of Danilovgrad, re-designed into a roundabout.

Boundary of the “General Urban Decision of the Municipality of Danilovgrad” is at km 115-520.

At km 116 + 700 (deviation to Ćurilac) there are objects “Montenomax” and hotel “Pejović”. Due to proximity of objects to the road it was envisaged to retain the extension on the right side and demolition of the hotel “Pejović”.
At km 118 + 345 a roundabout is envisaged as turning to for settlements Jastreb and Strahiniće. A small object must be demolished at that place.
At a km 120 + 000 is envisaged an intersection with a deviation for the villages of Plana and Bileća.
From km 120 + 080 to km 123 + 700 it is envisaged both sides to avoid collapse of objects on the left or right side of the road to several places in this move, and especially on km 122 + 750 where, in addition to “Montecco” and other facilities, and more supporting walls. In addition, there is a deep cross-section on both sides of the road.
At km 121 + 280 a roundabout (intersection Novo Selo) is envisaged.
At km 122 + 890 a roundabout is envisaged (Bandići intersection). In this roundabout it deviates towards Bandići, Spuž, as well as towards commercial buildings near the road.
From km 123 + 700 to km 126 + 500, the extension is on the right side of the road is envisaged.
From km 123 + 740 to km 125 + 240 there are service and connecting roads envisaged by the Main design for the construction of service roads in area of the spatial plan of the municipality of Podgorica. The axis of the road, connecting roads and other elements of the stretch are taken over from this design, and the route fits into the mentioned design in front of and behind this stretch.

At km 124 + 900, a temporary connection to the existing road for Mareza to the construction of service roads is envisaged.
At km 125+230, connection to the existing road for Komanski e is envisaged.
At km 126 + 384 a roundabout is provided with deviation to Ćafa and Baloče.
From km 126+500 to km 128+700 extension to both sides is envisaged. This is influenced by the restaurant Ognjište, DAK Petrol and other objects near the road, the proximity of the river (supporting walls), the towers of the transmission line to the right and the high cuts to the right.
From km 128+700 to km 129+340 it is envisaged to extend the road to the left side (Komanski most).
From km 129+340 to km 129+642 it is envisaged to expand on the left side and to fit into the design for reconstruction of the road towards Podgorica, within which extension to both sides is envisaged.

3.2. Profile grade

As for the elevation of the terrain from the beginning of the route to Danilovgrad to km 120 + 500 (L = 6.0 km), the road is located in the ravine (cca. 50 m asl). In the next 1.2 km (km 121 + 700) the road elevates to level 84 m asl. From this point, the next 2.0 km of the road descends to level of 34 m asl. From this point, to the end of the route, the road goes between the elevation level of 33 m asl and 38 m asl. The entrance to Podgorica is located at level of 34 m asl.

The grade line to the larger part follows the existing asphalt, because it is necessary to preserve the elevation levels of the access to the objects that connect to the trunk route. Longitudinal slopes are greater than 0.5% (0.30%).
At km 125+700 there is frequent flooding of the terrain, and occasionally flooding of the road as well, therefore in that part raising the grade line in relation to the existing road is envisaged.
The following elements of the grade line have been applied: $R_{vmin},\cap$=5000m, R_{vmin},U=5000m, ipod,max=3.8 with a note that mainly the most favourable elements of the grade line have been used from the ones that were listed.

3.3. Cross section elements

From km 114+500 to km 115+270 (in Danilovgrad), the width of the cross-section profile of the road is as well as in the continuation of the route on the built part of the Boulevard to Danilovgrad, are envisaged as follows:

- Carriageway lanes ..... 2 x 3.25 = 6.50 m
- Marginal strips ..... 2 x 0.25 = 0.50 m
- Divisional island..... 4.50 m
- Pavements on both sides..... 2 x 1.50m = 3.00 m
- Divisional island between carriageway and pavements: ..... 2 x 2.00 m = 4.00 m

From km 129+167 to km 129+632 (in Podgorica) the following width of cross section profile of the road is envisaged:

- Carriageway lanes..... 2 x 3.25 = 6.50 m
- Marginal strips..... 2 x 0.25 = 0.50 m
- Divisional island..... 4.50 m
- Pavements on both sides..... 2 x 2.00 m = 4.00 m
- Shoulders ..... 2 x 0.50 = 1.00 m

On the remaining part of the section, the following cross section profile of the road is envisaged:

- Carriageway lanes..... 2 x 3.25 = 6.50 m
- Marginal strips ..... 2 x 0.25 = 0.50 m
- Divisional islands ..... 4.50 m
- Shoulders in embankment ..... 1.50 m
- Gutters in embankment ..... 0.75 m
- Banquettes in embankment..... 1.25 m

On newly designed bridges, the following cross section profile is envisaged:

- Carriageway lanes..... 2 x 3.25 = 6.50 m
- Marginal strips ..... 2 x 0.25 = 0.50 m
- Protective belt to elastic safety fence ..... 2 x 0.50 = 1.00 m
- Elastic safety fence ..... 2 x 0.18 = 0.36 m
- Service lane in central reservation ..... 0.75 m
- Footway..... 1.20 m

3.4. Implementation in phases

Traffic-technical conditions envisages implementation in phases, as follows:

1. I phase - Boulevard Danilovgrad – intersection Ćurilac (km 114+500 - km 116+260, L=1.76 km),
2. II phase - intersection Ćurilac - intersection Novo Selo (km 116+260 - km 121+280, L=5.02 km),
3. III phase - intersection Novo Selo- intersection Bandići (km 121+280 - km 122+890, L=1.71 km),
4. IV phase - intersection Bandići - intersection Mareza (km 122+890 - km 125+230, L=2.34 km),
5. V phase - intersection Mareza - Komanski ski most (km 125+230 - km 129+632, L=4.40 km)

3.5. Intersections and junctions

3.5.1. Intersections

The Main design of the Danilovgrad-Podgorica route provides for a solution with roundabouts except in places where other designs, additional requirements or

planning documents provide for a solution with intersection with the interruption of traffic currents (four-leg or three-leg intersections with additional lines for left turns).

The basic comparison of types of intersections for the Danilovgrad-Podgorica road:

Intersections with interruption of traffic currents have the following advantages in comparison with roundabout intersections:

1. Priority of the main direction, continuity of the main direction flow, maintenance of the main direction speed
2. Functional ranges of connecting roads and traffic loads of connecting routes are significantly different
3. Less space occupancy
4. A shorter footpath

Circular intersections have the following advantages over intersections with interruption of traffic flows:

1. Decrease the speed of all vehicles. Better safety and lower accident weights (especially if no traffic signal is used in case of intersection with traffic interruption). In relation to this, it should be noted that after re-designing of a four-leg intersection with interruption of traffic flow in circular intersection at the exit from Danilovgrad, the number and severity of the accident has been significantly reduced.
2. Avoiding semaphore signalling (cost reduction)
3. Increased power gap and time loss (here it is necessary to note that with the difference of load on the connecting lines the capacity of the circular intersection decreases).

Intersections are envisaged at the following locations:

Number	Location	Description	Phase
0	-	Existing circular intersection Boulevard Danilovgrad.	Start of phase I
1	km 115+270	Newly designed circular intersection in Danilovgrad – location envisaged by the "General urban decision of the Municipality of Danilovgrad".	Part of phase I
2	km 116+260	Newly designed circular intersection Ćurilac. Due to proximity of objects Montenomax and restaurant Muštuluk on the existing road the intersection was relocated	Start of phase II

		from 116+620.	
3	km 118+345	Newly designed circular intersection with turn to settlements Jastreb and Strahiniće	Part of phase II
4	km 120+000	Newly designed three-leg intersection with turn to villages Plana and Bileća	Part of phase II
5	km 121+280	Newly designed circular intersection Novo Selo	Start of phase III
6	km 122+890	Newly designed circular intersection Bandići	Start of phase IV
7	km 123+740 - km 125+230	In this stretch several intersections were envisaged, as well as junctions, with connections to service roads provided within the "Main Design of construction of service roads in area urban plan Podgorica", as well as three leg intersection (temporary connection) of the existing road to Mareza	Part of phase IV, Start of phase V
8	km 126+384	Newly designed circular intersection with turn to Ćafa and Baloče. It is envisaged to firstly execute connection to the right (looking from direction from Danilovgrad to Podgorica) and only part of connection to the left which will be upon need executed later on.	Part of phase V
9	km 129+210	Newly designed circular intersection at the entry to Podgorica – Detailed urban plan "Gornja Gorica 3 - part A" Podgorica envisages a intersection at the place of intersecting the future road with the road Danilovgrad-Podgorica.	Part of phase V
10	km 129+365	Newly designed three-leg intersection with connection to Tološi. Connection over the existing low level on km 129+400 left is terminated.	Part of phase V

Location, dimensions and description of circular intersections:

Number	Location	Description	Circuit (m) / circular pedometer diameter (m) Reason for decreasing transverse cross section
0	/	Existing circular intersection in Danilovgrad	62/40
1	km 115+270	Newly designed roundabout intersection in Danilovgrad	62/40
2	km 116+260	Newly designed roundabout intersection Ćurilac	62/40
3	km 118+345	Newly designed roundabout intersection with turn to settlements Jastreb and Strahiniće	62/40
4	km 121+280	Newly designed roundabout intersection Novo Selo	55/35 Closeness of objects, execution of connecting roads
5	km 122+890	Newly designed roundabout intersection Bandići	55/35
6	km 126+384	Newly designed roundabout intersection to Ćafa and Baloče	55/35 Cuttings to the right, connection

7	km 129+210	Newly designed roundabout intersection at the entry of Podgorica	55/35 Closeness of the bridge and houses. Intersection of such dimensions is envisaged within the Detailed urban plan "Gornja Gorica – part A"

Elements of newly designed roundabout intersections:

- Number of lanes in the roundabout 2
- Circuit Diagram Diameter (D)..... 62 m (55)
- Width of carriageway in the roundabout (bk) ..... 12 m (10)
- Circular cross-sectional area..... 40 m (35)

Circular crossroads at the beginning of the route (existing circular crossroad in Danilovgrad) and at the end of the route (circular intersection foreseen in Detailed urban plan "Gornja Gorica 3 - part A") have different dimensions.
For this reason, no roundabouts of the same dimensions are envisaged on the entire route, but two types of circular intersections are envisaged (for the dimensions see the table above), so that they correspond to the dimensions of the circular intersections at the beginning and at the end of the route.
At the part of the route from the existing roundabout at the exit from Danilovgrad to km 120 + 000 circular intersections with the diameter of the entered circle 62 m and the width of the carriageway in a roundabout of 12 m are envisaged. These dimensions are the dimensions of the existing roundabout in Danilovgrad.
On the part of the route from km 120 + 000 to the end of the route, circular intersections with the diameter of the entered circle 55 m and the width of the pavement in a roundabout of 10 m are envisaged. On this stretch, due to the proximity of objects, major earthworks, the position of connecting roads reduced the dimensions of roundabout. These dimensions for the roundabout are envisaged by the Detailed Urban Plan "Gornja Gorica 3 - Part A" at the entrance to Podgorica.
On the connecting roads connecting to the roundabouts, it is envisaged to extend the roadway for passing of two trucks with a trailer.

3.5.2. Junctions

All envisaged junctions are marked in the location plan.
Significant number of objects of various types and purposes (individual households, petrol stations, restaurants, warehouses, sales salons, super markets

and other business and private objects for various purposes) are directly connected to the trunk route, which influences traffic safety. Due to terrain configuration and structure of the settlement, it is impossible within the planned design for reconstruction to provide an alternative road to collect traffic and connect it in control manner to the trunk route.
Wherever possible, in the intersection zone, at the points of the connection points of the roads as well as at the connections of larger economic facilities, which are currently in operation, an additional exit lane of 3.00 m width is envisaged. This is the case in the state of play. No weaving lanes are envisaged. In the intersection, islands are also envisaged for separating traffic flows. In places where this is not the case, the traffic needs to be separated with appropriate traffic signalization.
In the locations of connection of individual households, a direct connection with the trunk road is envisaged, without outflow and weaving lanes.
The future objects to be built near the Danilovgrad-Podgorica road will either be directly connected to the road or an exit road will be provided depending on the type and purpose of the object.
Since the construction and expansion of the new road interrupted individual access at these locations, it is envisaged to construct roads connecting existing roads or access roads and linking along the main road.

It is necessary to remove the canopy at the following gas stations:

Europetrol at km 114 + 770 right and
DAK Petrol at km 127 + 180 right.

3.5.3. Realignment of local roads

In order to provide connection of the existing roads and objects on road Danilovgrad – Podgorica, realignment of local roads and junctions was envisaged in several locations, as follows:

Number	Location	Road designation	Description and reason for designing additional road
1	km 115+315-115+370 right	Dev. 1	Enabling the connection to objects located near the roundabout intersection to the local road.
2	km 115+450 - 115+720 right	Dev. 2	Realignment of the existing local road and enabling connection of objects to the road.
3	km 116+260 - 116+680 right	Dev. 3	This road is not the subject of the design because it goes beyond the boundaries of the terms of reference and requires additional land purchase but is designated as a possible solution

			(if necessary) of the future direct link between the village Gruda and the surrounding households at a roundabout with a turn to Ćurilac.
4	km 121+800 - 122+060 right	Dev. 4	Road parallel to the main road. Allows connection of existing objects to the main road.
5	km 122+840 right	Dev. 5	This road is not the subject of the design because it goes beyond the boundaries of the Terms of reference and requires additional land purchase but is designated as a possible solution (if necessary) of the future direct connection of Milšped and other objects to the roundabout with a turn for Bandići and Spuž. Without this road, it is not possible to turn directly from these objects to Podgorica.

3.5.4. Bus stops

Location plan marks bus stations outside of the carriageway, as follows:

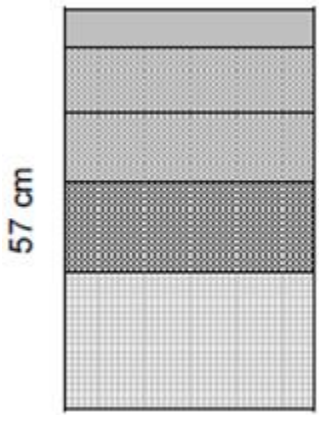
1. km 115+180 (direction Podgorica-Danilovgrad. Roundabout in Danilovgrad.)
2. km 115+365 (direction Danilovgrad-Podgorica. Roundabout in Danilovgrad.)
3. km 115+675 (direction Podgorica-Danilovgrad. Close to Eko petrol station.)
4. km 116+165 (direction Podgorica-Danilovgrad. Turn to Ćurilac, Sladojevo Kopito and Grude.)
5. km 116+350 (direction Danilovgrad-Podgorica. Turn to Ćurilac, Sladojevo Kopito and Grude.)
6. km 117+540 (direction Podgorica-Danilovgrad. Turn to Jastreb and Grude.)
7. km 117+620 (direction Danilovgrad-Podgorica. Turn to Jastreb and Grude.)
8. km 118+250 (direction Podgorica-Danilovgrad. Turn to Strahinjići and Jastreb.)
9. km 118+435 (direction Danilovgrad-Podgorica. Turn to Strahinjići and Jastreb.)
10. km 119+550 (direction Podgorica-Danilovgrad. Closeness of the Sušica Bridge. Turn to Begovina and Kosić.
11. km 119+630 (direction Danilovgrad-Podgorica. Closeness of the Sušica Bridge. Turn to Begovina and Kosić.
12. km 120+250 (direction Podgorica-Danilovgrad.)
13. km 120+155 (direction Danilovgrad-Podgorica.)
14. km 121+200 (direction Danilovgrad-Podgorica. Turn to Novo Selo.)
15. km 121+360 (direction Podgorica-Danilovgrad. Turn to Novo Selo.)
16. km 122+800 (direction Danilovgrad-Podgorica. Turn to Bandići and Spuž.)

17. km 122+975 (direction Podgorica-Danilovgrad. Turn to Bandići and Spuž.)
18. km 124+115 (direction Podgorica-Danilovgrad. Envisaged by the Main Design to build service lanes in area of spatial plan of the municipality of Podgorica. Novit Pharm, Top Art garden and other objects).
19. km 124+280 (direction Podgorica-Danilovgrad. Envisaged by the Main Design of building service roads in area of urban plan Podgorica. Novit Pharm, Top Art garden and other objects).
20. km 124+565 (direction Podgorica-Danilovgrad. Envisaged by the Main Design of building service roads in area of urban plan. Novit Pharm, Top Art garden and other objects).
1. km 124+780 (direction Danilovgrad-Podgorica. Envisaged by the Main Design of building service roads in area of urban plan. Novit Pharm, Top Art garden and other objects).
21. km 126+290 (direction Podgorica-Danilovgrad. Turning to Ćafa and Baloče.)
22. km 126+470 (direction Danilovgrad-Podgorica. Turning to Ćafa and Baloče.)

The Main Design for the reconstruction of the M-18 main road from Branko Deletić street to the Komanski ski most in Podgorica provides for bust stops on both sides at km 129 + 590 (direction Podgorica-Danilovgrad) and about 80m from the point of completion of this design in the design in question (direction Danilovgrad-Podgorica).

3.6. Carriageway construction

On the basis of visual observation, the condition of the existing carriageway is without major damage.
In accordance with the attached dimensioning of the carriageway structure, the following carriageway t structure is envisaged:

	wearing a layer of asphalt concrete AB 11s bituminous structural layer BNS 22sA crushed stone aggregate 0/31.5 crushed stone aggregate 0/63	d=4 cm d=2x6 cm d=15 cm d=26 cm

On less loaded access roads, the following carriageway construction is envisaged:

- AB 11 .... d=4 cm
- BNS 22A .... d=7 cm
- Crushed stone aggregate 0/31.5 .... d=15 cm
- Crushed stone aggregate 0/63 .... d=20 cm

At the points of deviation and fitting of asphalt connections, the following pavement structure is envisaged:

- Bituminous material BNHS 16 A .... d=6 cm
- Crushed stone 0/31.5 mm .... d=12 cm
- Crushed stone 0/63 mm .... d=20 cm

The following pavement structure is envisaged on the sidewalks:

- Concrete MB 30 .... d = 12 cm
- Bottom bearing layer - buffer..... ..... d = 15 cm

3.7. Cuttings and embankments

In some locations, the cascading arrangement of slopes is planned in accordance with the recommendations given in the Study on geotechnical research of the terrain.
On larger sections of the route there are no larger embankments.
On the following stretches is envisaged embankment made of crushed stone, due to proximity to a river:

- after the Sušica bridge
- km 127+200 – 127+290
- km 127+515 – km 127+630
- in front of bridge Komanski ski most

If necessary, the construction of stairs for the support of the embankment is envisaged.

It has been estimated that a certain volume of works should be executed for construction of cuttings:

- drilling
- mining

Drilling works

Drilling of mining boreholes will be executed with a pneumatic-hydraulic Impact Drill Drill Atlas Copco ROC F6. The drilling time is 20 m^1/h.

Mining works

Mining works have been described in detail in chapter A-6.1.1.

Supply with explosives and explosive devices

The supply of explosives and explosive substances will be executed directly from the manufacturer, and it will be taken into account that the delivered quantity is immediately consumed in the mining process to avoid any stock of explosives. The mining explosives are delivered on the day of the mining in smaller quantities, as envisaged by the mining plan. An authorized company that performs mining delivers mining equipment. If the entire amount is not used, the authorized company will return the remaining of explosives. Therefore, there will be no explosive storage at the site.

3.8. Bridges and underpasses

Overview table of bridges and underpasses

Marking	Location / cross section	Title of the object	Dimensions	Description
Al. A2	**Rehabilitation/reconstruction of the existing bridges and construction of the new ones**			
1	km 119+830	Bridge Sušica	24 50.25 0+24 50 = 74.0 m	Rehabilitation/reconstruction of the existing bridge and construction of the new bridge parallel to the existing one

2	km 126+140	Bridge Matica	L=20+20+20 = 60 m	Rehabilitation/reconstruction of the existing bridge and construction of the new bridge parallel to the existing one
3	km 129+135	Bridge Sitnica (Komanski most)	L=22+22+22 = 66 m	Rehabilitation/reconstruction of the existing bridge and construction of the new bridge parallel to the existing one
4	km 129+400	Bridge over Mareza	L=15 m, light span = 8.96 m	Rehabilitation/reconstruction of the existing bridge and construction of the new bridge parallel to the existing one Dismantling of culverts parallel to the bridge on the road to Tološi.
5	km 123+392	underpass	Light span of existing =4 m light span of the new one=7.5 m	Rehabilitation/reconstruction of the existing bridge and construction of the new bridge parallel to the existing one

The Sušica Bridge is 74 m long and it is planned to reconstruct the existing one and build a new bridge parallel to the existing one. The bridge is located on the main road Danilovgrad - Podgorica at chainage 119 + 821 and bridges the Sušica river. The newly designed bridge is next to the existing bridge.
The existing bridge is located on two pillars on the banks and two river pillars. The left abutment and the nearby middle pillar are resting on the limestone, the middle pillar at a depth of 4-5 m. The right abutment is based on a layer of sandy clay at about 3 m. Substantial compressibility of the soil below the foundation required a costly construction with an equal amount of soil stress with the expectation that land subsidence would be performed before the sensitivity of the structure to unequal subsidence of abutments. Foundation engineering on plates instead on piles were adopted.
The total bridge width is constant 10.75 m and consists of:

- Distance from the fence to the edge 2 x 0.22 = 0.44 m
- Service path 1.20+0.75 =1.95 m
- Elastic safety fence 2 x 0.18 = 0.36 m
- Safety area to the fence 2 x 0.50 = 1.00 m
- Marginal strips 2 x 0.25 = 0.50 m
- Carriageways 2 x 3.25 = 6.50 m

  Total = 10.75 m

The object is reinforced concrete and pre-stressed construction. The bridge ranges are L = 24.40 + 25.0 + 24.40 = 73.80 m. Mounting bearers are placed on temporary

supports. Continuation is executed with bridge deck and transversal bearers in a way to form a rigid connection between the middle pillars and the span structure. The pillars on the banks are connected to the main bearers via elastomeric bearings.
Abutment P1R is founded on 6 piles Φ150 cm in two rows of length L = 22.0 m. The middle pillar P2R is funded on 4 piles Φ150 cm in two rows of length L = 15.0 m. The piles on these two pillars pass through the layers of sand and clay of extremely high compressibility and floating, so they take load by friction on the sheath.
The middle abutment P3R is based on 4 piles Φ150cm in two rows of length L = 6.0 m. They rely on the geotechnical environment 6 and are standing. In a narrower location, the geotechnical environment 6 is covered with diluvial clays in a thickness of up to 1.0 m.
The abutment P4R is based in geotechnical environment 6 with a depth of funding of 1.8-2.0 m and designed foundation of 5.8 m x 11 m x 1.5 m.
The supporting structure consists of two abutments P1R and P4R and are connected to the main bearer through the bearing. The wings are 50 cm thick, rigidly connected to the pillars. The middle pillars P2R and P3R are circular cross-section Φ180cm, rigidly connected to the base plate and with a span construction over the bearing beam and crossbars.

Transition slabs 25 cm thick and 3.70 m long are connected to both abutments.
Mounting brackets are symmetrical T cross section of 1.20 m height. The lower flange is 46 cm wide and dimensioned so that it can accept stress pressure at all stages of construction and exploitation. The ribs are 20 cm wide in size so they can receive the main tensioning stress as well as provide space for installation of cables while providing the necessary protective layer. The upper flange is 1.67 m wide, dimensioned so that the flanges are practically touching, which allows the pavement to be concreted without shutters.
Mounting brackets are pre-stressed with three cables 7Φ15.7. 3x6 prefabricated bearers have been envisaged on the object.
The bridge deck is 20 cm thick, cast on the spot. It is dimensioned so as to ensure the bracing of the mounting brackets with as uniformed redistribution of impact as possible.
The cross girders are cast over the pillars and are additionally connecting mounting brackets. They are designed to provide a rigid connection between the pillars and the span construction.
As the most suitable technical solution for the waterproofing of the concrete bridge deck, as well as pedestrian paths, waterproofing systems based on bitumen tape have been selected.

The waterproofing system on the concrete bridge deck consists of the following layers:

- primer (pre-coating based on two-component epoxy resin),
- waterproofing layer (single-layer bitumen strip 5 mm thick),
- protective layer – carriageway concrete surfacing AB 11s (3 + 4cm).

All concrete surfaces in contact with soil are coated with two bituminous coatings.
The carriageway structure consists of two layers of asphalt. The first, protective layer is 3.0 thick, while the other is wearing layer with thickness of 4.0 cm.
The curbs are made of concrete, dimensions 13 x 20 cm, height above the underpass carriageway of 7 cm.
The quality of used material must comply with the applicable standards and before the installation, evidence of the quality of the material must be attached, without which the installation must not start.
Walking and official paths are made of reinforced concrete, with a rough top surface. It is protected from effects of frost and salt by UV-resistant multi-coating, with bridging possibilities and at temperatures below 0°C, resistant to CO_2 diffusion, waterproof, high resistance to aging and high wear resistance and chemically aggressive effects.
At the ends of the bridge asphalt dilatations of ± 40 mm are envisaged. Bridge bearings are envisaged above abutments. Bridge bearings are reinforced elastomeric and there is 12 of them in total.
The bridge wall is made of steel pipes with a vertical fill height of 110 cm, protected from the influence of corrosion by hot dip galvanizing.
The elastic safety fence should be executed in accordance with the technical instructions, stemming from the EN 1317.
For the passage of utility lines, PVC pipes with a diameter of 75 mm placed inside the pedestrian paths were used.
On the bridge there are 5 cast iron drains on the lower edge of the carriageway. The drainage system should be modern, with a construction that allows easy cleaning and that the waterproofing, placed on the concrete slab of the bridge, directs the water directly into the drainage pipe, not into the connection between it and the concrete.
Bridge Matica is located on the main road Danilovgrad - Podgorica on location 126+145 and is overpassing the river Matica. The newly designed bridge will be parallel to the existing one.

Total bridge width is constant 10.75m and consists of:

- Distance from fence to the edge 2 x 0.22 = 0.44 m

- Service path 1.20+0.75 =1.95 m
- Elastic safety fence 2 x 0.18 = 0.36 m
- Safety area to the fence 2 x 0.50 = 1.00 m
- Marginal strips 2 x 0.25 = 0.50 m
- Carriageways 2 x 3.25 = 6.50 m

Total = 10.75 m

The object is made of reinforced concrete and pre-stressed construction. The bridge ranges are L = 20.0 + 20.0 + 20.0 = 60.0 m. Mounting brackets are placed on temporary supports. Continuation is executed with a bridge deck and transversal bearers in a way to form a rigid connection between the middle pillars and the span structure. The abutments are connected to the main bearer via elastomeric bearings.

Abutments P1 and P4, as well as the middle pillars P2 and P3 are founded on two piles Φ1500mm. The piles pass through the layers of clay medium and high plasticity, exuded sand and sandy clay. The piles are "floating", the load is received by friction over the coat.

The supporting structure consists of two end pillars (P1 and P4). The pillars are a wall-cloth shape, in base measuring 1.50 x 10.05 m, constant altitudes and connected to the main bearer via the bearing.
The wings are 4.00 m long, 40 cm thick, rigidly connected to the pillars. The middle pillar (P2 and P3) are circular cross-section Φ1500 mm, that is, two piles that are ground-based on one side, and on the other are directly funded into a 2.80 m long and 2.20 m bridge bearing.
Transitional slabs 25 cm thick and 3.70 m long are connected on both abutments.

Mounting brackets are symmetrical T cross section of height 1.20 m. The lower flange is 46 cm wide and dimensioned so that it can accept load pressure at all stages of construction and exploitation.
The ribs are 20 cm wide in size so they can receive the main tensioning loads as well as provide space for installation of cables while providing the necessary protective layer. The upper flange is 1.68 m wide, dimensioned so that the flanges are practically touching, which allows the pavement to be concreted without the shutters. Mounting brackets are pre-stressed with three cables 6Φ15.7.
The object has 3x6 prefabricated bearers.

The bridge deck is 20 cm thick, cast on the spot. It is dimensioned so as to ensure bracing of the mounting brackets with as uniform a redistribution of impact.

The crossbars extend over the pillars and connect the mounting brackets further. They are designed to provide a rigid connection between the pillars and the span construction.

As the most suitable technical solution for the waterproofing of the concrete bridge deck, as well as pedestrian paths, waterproofing systems based on bitumen tape have been selected.

The waterproofing system on the concrete bridge deck consists of the following layers:

- primer (pre-coating based on two-component epoxy resin),
- waterproofing layer (single-layer bitumen strip 5 mm thick)
- protective layer - roadway asphalt concrete AB 11s (3 + 4cm).

All concrete surfaces in contact with soil are coated with two bituminous coatings.

The bridge deck consists of two layers of asphalt. The first, protective layer is 3.0 thick, while the other is wearing layer with thickness of 4.0 cm.

The curbs are made of concrete, measuring 13 x 20 cm, height above the underpass carriageway of 7 cm.
The quality of installed material must comply with the applicable standards and before the installation, evidence of the quality of the material must be attached, without which the installation must not start.
The official path is reinforced concrete with a rough top surface. From the effects of frost and salt, it is protected by UV-resistant multi-coating, with bridging possibilities and at temperatures below 0°C, resistant to CO_2 diffusion, waterproof, high resistance to aging and high wear resistance and chemically aggressive effects.

At the ends of the bridge, there are asphalt expansion joints of ± 30 mm. Bridge pads are envisaged above abutments. The bridge pads are reinforced elastomeric and there are 12 of them.
The bridge fence is made of steel pipes with a vertical fill height of 110 cm, protected from the influence of corrosion by hot dip galvanizing.
The elastic safety fence should be executed in accordance with the technical instructions, which derive from the regulations of EN 1317. For the passage of

utility lines, PVC pipes with a diameter of 100 mm are installed in the service paths. For the passage of utility lines, PVC pipes with a diameter of 75 mm placed inside the pedestrian paths were used.
On the bridge, there are 3 cast iron drains on the lower edge of the carriageway. The drainage system should be modern, with a construction that allows easy cleaning and that the waterproofing, placed on the concrete slab of the bridge, directs the water directly into the drainage pipe, not the connection between it and the concrete.

Bridge Komanski ski most – Sitnica is located on the main road Danilovgrad - Podgorica at the station 129 + 120 and bridges the Sitnica River. The newly designed bridge is next to the existing bridge.

The design was developed for the bridge over the Sitnica River, by the disposition solution. The axis of the main road is in the horizontal curve. The cross-fall on the culvert is constant and amounts to 5.0%.

The total width of the bridge is constant 10.75 m and consists of:

- Distance from fence to the edge 2 x 0.22 = 0.44 m
- Service path 1.20+0.75 =1.95 m
- Elastic safety fence 2 x 0.18 = 0.36 m
- Safety area to the fence 2 x 0.50 = 1.00 m
- Marginal strips 2 x 0.25 = 0.50 m
- Carriageways 2 x 3.25 = 6.50 m

Total = 10.75 m

The object is made of reinforced concrete and pre-stressed construction. The bridge ranges are L = 20.0 + 20.0 + 20.0 = 60.0 m. Mounting brackets are placed on temporary supports. Continuation is executed with a bridge deck and transversal bearers in a way to form a rigid connection between the middle pillars and the span structure. The abutments are connected to the main bearer via elastomeric bearings.

Abutment P1 is shallow founded in rock mass. Dimensions of the foundation are 11.00 x 5.0 m. middle pillars are founded on two piles Φ1500 mm. The base of the piles of pillar P2 is founded in limestone and dolomites, while piles of pillars P3 and P4 are founded in gravel and sad. Piles of pillars P2 and P3 are connected to the pile, by cushion head, and piles of pillar P4 are placed in bridge pads.

The supporting structure consists of two end pillars (P1 and P4). The pillars are a wall-cloth shape, in base with dimension of 1.50 x 10.05 m, constant altitudes and connected to the main bearer via the bearing.
The wings are 4.00 m long, 40 cm thick, rigidly connected to the pillars. The middle pillars (P2 and P3) are circular cross-section Φ2000 mm, fused into a 2.80 m long bridge pad and a changeable width of 2.06-2.86 m, and at the lower end, they are clamped to a cushion head height of 1.75 m to 2.25 m, width 2.50 m.
On abutment are connected transitional slabs 25 cm thick and 3.70 m long.
Mounting brackets are symmetrical T cross section of height 1.20 m. The lower flank is 46 cm wide, so it can receive tension pressure at all stages of construction and exploitation.
The ribs are 20 cm wide in size so they can receive the main tensioning pressure as well as provide space for installation of cables while providing the necessary protective layer. The upper flank is 1.63 m wide, dimensioned, so that the flanks are practically touching, which allows the bridge deck to be concreted without cladding. Mounting brackets are pre-stressed with three cables 6Φ15.7.
The object has 3x6 prefabricated bearers.

The bridge deck is 20 cm thick, cast on the spot. It is dimensioned so as to ensure bracing of the mounting brackets with as uniform a redistribution of impact.
The crossbars extend over the pillars and connect the mounting brackets further. They are designed to provide a rigid connection between the pillars and the span construction.

As the most suitable technical solution for the waterproofing of the concrete bridge deck, as well as pedestrian paths, waterproofing systems based on bitumen tape have been selected.

The waterproofing system on the concrete bridge deck consists of the following layers:

- primer (pre-coating based on two-component epoxy resin),
- waterproofing layer (single-layer bitumen strip 5 mm thick)
- protective layer - roadway asphalt concrete AB 11s (3 + 4cm).

All concrete surfaces in contact with soil are coated with two bituminous coatings.

The bridge deck consists of two layers of asphalt. The first, protective layer is 3.0 thick, while the other is wearing layer with thickness of 4.0 cm.

The curbs are made of concrete, measuring 13 x 20 cm, height above the underpass carriageway of 7 cm.
The quality of installed material must comply with the applicable standards and before the installation, evidence of the quality of the material must be attached, without which the installation must not start.
The official path is reinforced concrete with a rough top surface. From the effects of frost and salt, it is protected by UV-resistant multi-coating, with bridging possibilities and at temperatures below 0°C, resistant to CO_2 diffusion, waterproof, high resistance to aging and high wear resistance and chemically aggressive effects.

At the ends of the bridge, there are asphalt expansion joints of ± 30 mm. Bridge pads are envisaged above abutments. The bridge pads are reinforced elastomeric and there are 12 of them.
The bridge fence is made of steel pipes with a vertical fill height of 110 cm, protected from the influence of corrosion by hot dip galvanizing.
The elastic safety fence should be executed in accordance with the technical instructions, which derive from the regulations of EN 1317. For the passage of utility lines, PVC pipes with a diameter of 100 mm are installed in the service paths. For the passage of utility lines, PVC pipes with a diameter of 75 mm placed inside the pedestrian paths were used.
On the bridge, there are 3 cast iron drains on the lower edge of the carriageway. The drainage system should be modern, with a construction that allows easy cleaning and that the waterproofing, placed on the concrete slab of the bridge, directs the water directly into the drainage pipe, not the connection between it and the concrete.

The Mareza bridge. The existing bridge is located over the Mareza River on the main road Danilovgrad - Podgorica at the station km 129+400.
The existing bridge is a reinforced concrete reinforced concrete structure with striped foundations, wall-liners in support of the wall and a span construction - a bridge deck.
The total width of the span construction is 10.12 m and consists of:

- Carriageway 7.76 m
- Pedestrian paths 1.01 + 0.95 = 1.96 m
- Curbs 2 x 0.20 = 1.00 m

Damage to pedestrian paths, asphalt and fences was observed. The span structure as well as abutments are in satisfactory conditions.

A new characteristic cross section

The following cross-section on the bridge is envisaged:

- Distance from fence to edge 2 x min 0.22 = 0.44 m
- Walking/service paths 1.20 + 0.75 = 1.95 m
- Elastic safety fence 2 x 0.18 = 0.36 m
- Security clearance to the railing 2 x 0.50 = 1.00 m
- Marginal strips 2 x 0.25 = 0.50 m
- Carriageways 2 x 3.25 = 6.50 m

  Total = min 10.75 m
- Divisional area belt 4.50 m

Geometrically, the existing bridge does not fit either altitudes or widths in the newly designed route of the road.
The level of the reconstructed road is 10-18 cm above the existing level, and the width of the footpaths is below the required 120 cm, therefore it is necessary to correct the geometry on the bridge, giving it the layer of concrete 10-18 cm at the location of the carriageway and by extending the existing footpaths.

For the newly designed state, a static bridge calculation was performed using the Tower Software package. Static calculation was formed on a surface model. The effects of own weight, constant load, soil pressure, payload (vehicle V600), temperature and additionally concreted deck were analysed. The results of the mentioned impacts are presented through a cross-sectional diagram for each individual load.
Apart from correction of the geometry, the bridge needs to be strengthened with carbon strips.

The concreting of the MB30 concrete is envisaged for concrete.
Reinforcement - Reinforcement is performed with ribbed reinforcement B500B. Designed protective layers next to the reinforcement are 4.5 cm.
Anchors - In places where the design foresees the connection of old and new concrete with anchors, cleaning and dredging of old concrete surfaces is executed. Concrete drill holes are made, which are 1 mm wide from the diameter of the anchor and place the pre-made anchors ("G" shape according to the details of the design). The anchoring of the anchor for concrete is executed with high quality epoxy acrylate anaerobic anhydride with no content of solvents and styrene renowned manufacturers. The design resistance to the tensile forces is min. 18.5 kN.
Anchors Ø12 mm and depths of 11 cm are envisaged.

Carbon strips - Carbon strips for strengthening the main supports of the following characteristics are envisaged: width 100 mm, thickness 12 mm, computer tensile strength track σ_{tu} = 1600 MPa; elastic band modulus Et = 165000 MPa. Carbon strips and fabrics can be glued only to base which meet the prescribed quality conditions, such as: concrete strength at pressure, adhesion/bonding strength for the given surface, roughness and flatness (surface retardation), dew point and surface humidity.

- Determination of the concrete strength at the Schmitt hammer pressure.
- Depending on the applied reinforcement system, the following strength/adhesion should be met: ≥ 1.5 MRa in the case of application of strips – laminates.
- Freshly applied carbon strips in larger uneven areas are separated from the concrete surface. In dented zones, the "bubbles" and hollow places are created in the adhesive underneath the strip. These places are poorly connected and very dangerous, especially in the part where the strip is anchored. The unevenness of the concrete surface should be repaired using repair mortars.
- Estimation of the danger of creating condensate moisture on the surface for which data can easily be given based on the surface temperature of the building element being reinforced, where it must be at least 3 ° C higher than the temperature or creating of dew.
- Measurement of surface moisture content of concrete can be caused by the use of various moisture meters or by drying process on 105^{o}C samples of concrete to constant mass. Patching of carbon tape can be accessed only if the surface moisture content of the substrate amounts to a maximum of 4%.

Waterproofing - Waterproofing systems based on bitumen tape have been selected as the most suitable technical solution for waterproofing concrete bridge deck, as well as pedestrian paths.
The waterproofing system on the concrete bridge surfacing consists of the following layers:

- primer (pre-coating based on two-component epoxy resin),
- waterproofing layer (single-layer bitumen strip 5 mm thick),
- protective layer - roadway asphalt concrete AB 11s (4 + 3cm).

Asphalt - The pavement structure consists of two layers of asphalt. The first, protective layer of 4.0 cm thick is asphalt concrete SMA 0 / 11-4 cm, the other wearing is asphalt concrete AB 11S thickness 3.0 cm.

Dilatations - At the ends of the bridge were envisaged elastic-bitumen dilatations of polymerized bitumen with increased elastic properties, i.e. resistance to high temperatures and rut, which are installed in the asphalt pavement groove width of 50 cm, so that they become an integral part of the carriageway.
The steel parts are dipped into a coupling agent, which is sealed on the underside. From the upper wall of the rainwater flow, a drainage canal is installed between the coupling and the asphalt to weaken the pressure of the water possibly caught in that area. The coupling must provide a span of ± 6 mm.
Fastening is ensured by bonding the dilatation mass from the bottom to the concrete substrate and auxiliary metal fittings, and from the sides, the mass is glued to the layers of asphalt.

Curbs - the curbs are made of burning granite measuring 20 x 13 cm, height above the carriageway bridge 7 cm. The official path is reinforced concrete with a rough top surface. From the effects of cold and salt, it is protected by a multi-coated, UV resistant coating, with bridging possibilities and at temperatures below 0°C, resistant to CO_2 diffusion, aggressive impacts.
The quality of the built-in material must comply with the applicable standards and before the installation, evidence of material quality must be attached, without which the installation must not start.

Elastic safety fences are of type H2W4 and should comply with the provisions of the EN 1317.
Drains- the bridge is short and there is no need for drains.

Crossing slabs - there are no crossing slabs on the bridge, and as the settling of the embankment has been completed in the past 50 years and the soil is not needed for their subsequent installation.

Underpass at km 123+392

The existing underpass is a reinforced concrete structure with striped foundations, abutments as curtain walls and a span construction - a bridge deck. The luminous opening gap is 4.00 m wide, which is not enough for two-way traffic, if a need arises in the future. It is therefore necessary to replace the existing object with a underpass of a larger range. The object is funded shallow. The abutments are based on the foundations of the whole length.

The underpass is in the direction and with the longitudinal drop of 2% and the transverse of 2.5% is in line with geometry of the road. The total width of the span structure is 22.70 m and consists of:

- Distance from the fence to the edge 2 x 0.22 = 0.44 m
- Pavement 2 x 1.20 = 2.40 m
- Elastic safety fence 2 x 0.18 = 0.36 m
- Safety area to the fence 2 x 0.50 = 1.00 m
- Marginal strip 4 x 0.25 = 1.00 m
- Carriageway 4 x 3.25 = 13.00 m
- Divisional area belt 4.50 m

The underpass is a shallow, reinforced concrete, integral construction built with scaffolding, formwork and concrete cast on the spot. The cross-section of the span construction structure is a reinforced concrete slab with a thickness of 60 cm. The bearer is moulded on the spot and with reinforcement and concrete, the integrity of the main bearer, pillars and foundation is achieved. The bearer pattern follows the geometry of the road. Pillars and wings are made of reinforced concrete cast on the spot.

Wall claddings S1 and S2 are shallowly funded at a depth of approx. 1.60 m. The foundations are designed as a strip, dimensions of 3.50 x 0.90 m, with an extension below four wings of 1.00 x 2.20 m.
The supporting structure consists of two end pillars (S1 and S2). The columns in shape of curtain wall, with base measure of 0.70 x 14.11 m for the left-side construction and 0.70 x 10.99 m for the right side construction, constant heights and rigidly connected with the main bearer and foundations. The wings 1, 2, 5 and 6 are 7.65 m long, and the wings 3 and 4 are 6.65 m long, 50 cm thick, rigidly connected to the pillars.
Due to the large length, wing 1, 2, 5 and 6 partially have their foundation. Thus, with a rigid connection between the beam bearer, the end pillars and the foundation, a completely “integral” construction was obtained. The frame construction with a single field consists of a plate support, pillars with wings and foundations. On both abutments are connected transitional slabs 25 cm thick and 3.70 m long.

The construction of the bridge is monolithic; it is concreted with concrete cast on the spot, on a scaffold and form, a reinforced concrete slab, pillars, foundations and wings. The width of the left panel support is 14.11 m, while the width of the right main bearer is 10.99 m. The thickness of both bearers is 0.60 m.

The waterproofing system on the concrete pavement consists of the following layers: primer (pre-coat based on two-component epoxy resin), waterproofing layer (single-layer bitumen strip 5 mm thick), protective layer – concrete surface cover. The pavement structure consists of two layers of asphalt. The first, protective layer is 2 x6.0 cm thick, while the other is wearing layer, with thickness of 4.0 cm.

3.9. Walls

Overview table of walls

B	**Supporting walls**			
No.	**Location**	**Position**	**length (m)**	**Max. height (m)**
1	Idea 1	114+711	12.00	2.20
2	MB 1	115+840	37.24	1.50
3	Hotel 1	116+700	30.06	1.70
4	Iveco 1	118+850	39.04	2.30
5	Object 1	119+710	48.06	3.88
6	Sušica	119+760	18.00	7.20
7	Rakočević 1	121+900	252.42	8.00
7b	Rakočević 2	122+030	21.02	3.50
8	Pirella 1	122+000	70.12	5.50
9	Montecco 1	122+700	48.06	3.00
10	Montecco 2	122+780	159.24	1.60
11	Milšped 1	122+800	114.18	5.01
12	Object 2a	124+350	48.06	5.60
13	Object 2b	124+390	42.02	6.00
14	River 1	128+400	84.12	4.50

The supporting walls appear at places where the newly formed route cuts into the existing slope and thus ensures the stability of the slope and at the same time protects the hull of the road, that is, in places where the path of the road overhangs the slope, where the path is not levelled in relation to the yard or protects the road in close to existing rivers or streams. The shape of the walls is imposed by the elements of the road as well as the height and inclination of the slopes of the terrain.

For the facilities of PZ River 1 and PZ River 2 in the Preliminary Design, a variant solution with cladding of slope with stone was given, but it was rejected due to the embankment that is entering in the riverbed.

3.10. Culverts

Crnagoraput made a report on the state of the existing culverts on the road in question. According to this report, almost no existing culvert can be used, but a new, functional solution should be developed. Thus, on the future route of the main road, the envisaged culverts are given in the following table.

Overview table of culverts

19	120+013.140	Pipe culvert 01500	
20	120+260.810	Pipe culvert 01500	
21	120+513.590	Pipe culvert 5.0x3mm	
22	129+604.360	Pipe culvert 01500	
23	120+719.930	Pipe culvert 01500	
24	121+004.600	Pipe culvert 01500	
25	123+211.640	Box culvert 5.0x4.5m	
26	123+964.750	Pipe culvert 01000	with a shaft in the middle area
27	124+319.650	Pipe culvert 01000	with a shaft in the middle area
28	124+529.310	Pipe culvert 01000	with a shaft in the middle area
29	126+571.220	Pipe culvert 01500	
30	127+104.540	Pipe culvert 01500	
31	127+314.300	Pipe culvert 01500	
32	127+600.470	Pipe culvert 01500	
33	127+801.030	Pipe culvert 01500	
34	128+250.430	Pipe culvert 01500	
35	128+728.950	Pipe culvert 01500	

In addition to the aforementioned culverts, the pipes are envisaged, parallel to the road connection at the dimensions of: Ø600, Ø800, Ø1000, Ø1600. If the culverts on the access roads do not have sufficient over-layer, they need to be protected in accordance with the attached detail so as not to damage them.

Also, with the aim of preserving the animal population, additional passages will be built in the following locations:

LOCATION 1 - from PR 215 (km 117+803.890) to PR 229 (km 118+015.420)

It is necessary, on part from PR 215 (km 117 803.890) to PR 229 (km 118 015.420), along the periphery of the drainage channel for atmospheric water to the projected plate culvert on km 117 869.73, to construct routers in the form of parapet walls with a thickness of d = 20 cm and height h = 50 cm, left and right from the entrance and exit from the culvert.

LOCATION 2 - - from PR 319 (km 119+375.720) to PR 346 (km 119+789.430)
It is necessary, on part from PR 319 (km 119+375.720) to PR 346 (km 119+789.430), along the periphery of the drainage channel for atmospheric water to the projected plate culvert on km 119+496.71, to construct routers in the form of parapet walls with a thickness of d = 20 cm and height h = 50 cm, left and right from the entrance and exit from the culvert.

LOCATION 3 - - from PR 446 (km 121+340.200) to PR 477 (km 121+807.130)
It is necessary, on part from PR 446 (km 121+340.200) to PR 477 (km 121+807.130), on the edge of the supporting wall on both sides of the boulevard, to install pillars of steel tubes of height 50 cm, to which the road network will be fixed

LOCATION 4 - - from PR 704 (km 125+249.110) to PR 760 (km 126+100.630)
Potrebno je, na potezu od PR 704 (km 125+249.110) do PR 760 (km 126+100.630), izgraditi tri plocasta propusta svijetlog otvora širine 2 m i visine mín 1 m, kao i usmjerivace u vidu parapetnih zidova debljine d=20 cm i visine h=50 cm, lijevo i desno od ulaza i izlaza iz plocastih propusta.

It is necessary, on the part from PR 704 (km 125 + 249.110) to PR 760 (km 126 + 100.630), to construct three plate culverts of a lit opening - 2 m wide and 1 mheight , as well as routers in the form of parapet walls with a thickness of d = 20 cm and height h = 50 cm, left and right from the entrance and exit from the culvert.

Situation maps of added culverts are in Annex of the Study.

3.11. Hydro-technical infrastructure

The traffic solution is in the area of reconstruction of part of the existing road, envisaged curbs, which is conditioning creation of the atmospheric sewage collector for collection of atmospheric waters and their channelling and removal.
As per the traffic solution contained on locations of the existing culverts, new ones with diameter Ø1500 mm were envisaged, with regard to the rank of the road. In places where this was not possible because of the low embankment height, Ø1000

mm diameter culverts were designed with inspection chamber in the dividing island. As according to the rulebook for designing traffic roads for culverts with length greater than 20 m the minimum diameter of the culvert is Ø1500 mm, due to maintenance, adding these inspection chambers would decrease the length of the culvert. Also, on sections where there were longitudinal canals along the roadway, the design envisages the creation of the new ones, made of earth, with the same hydraulic characteristics.

As this is the two-way slope of the road, the longitudinal collectors are envisaged for water drainage from both lanes, which allows the traffic to unfold during the construction of a single lane, because there are no lateral cross-cuts.
As the designed road is with variable transient drop, the design solution for the discharge of atmospheric waters, on the sections with curbs on two sides of the road, it is envisaged that, along the lower edge of the pavement, collectors of atmospheric sewage with drains placed in the "niches" in the separated islands (which avoids for vehicles to pass over the drainage grid). The sections on which the sidewalk is planned along the road, in zones of roundabouts, and sections where the islands narrow, drainage grids are placed in the carriageway.
In cuttings and side cuttings, where drain channels are envisaged, at different lengths (from 120-200 m), depending on the longitudinal slopes, there are provided drains with double bars from which the water will be drawn by the pipes to the collector. In these sections, all the catchment waters that are not oiled will be taken over the banquette, whose transversal fall from the road to the intersection will be taken to the culverts at distances up to 250 m. This concept was abandoned only on the sections in the cuttings (where it is not possible to make culverts) on which the gradient is turned towards the carriageway, therefore catchment waters are taken into the separators, because these are relatively small quantities of water in relation to the water from the carriageway (section P469-P566, the amount of water from the surrounding area is about 30.64 l/s, and the amount of water that enters the separator is 608.22 l/s). The same solution was adopted on the section from P801 to P821 next to the restaurant "Ognjište", where it is not possible to envisage culverts due to the restaurant itself.
As it is necessary to purify atmospheric water according to UTC, Terms of Reference, and Water Conditions, the design envisages the installation of oil derivatives separators with bypass, precipitators and coalescent filters that provide water treatment according to SIST-EN 858-1 standards. Separators are placed in a divisional island (except the first three in the green belt between the carriageway and the sidewalk). Since it was not possible to dig in collectors at deeper depths due to shallow recipients, it is necessary to select a type of separator whose bypass

is at the top of the separator (manufacturer TECHEAU or some other with a bypass at the top of the separator).
The design envisages 31 separators. This relatively large number of separators came from a large number of shares with a small grade and relatively shallow culverts in which the water is poured after purification.
The purified water from the separator is discharged into the projected channels or into culverts. In front of each separator, an inspection gully is provided with a catch basin of AB pipe of Ø1000 mm in diameter, and for larger quantities of water, it is rectangular.
The separators are equipped with inspection chamber for its maintenance, from AB rings of diameter Ø1000 mm with lower plates, which transfer the load to the surrounding terrain and not to body of the separator.
Siphons (9 of them) are designed at crossing collector with culverts. In the hydraulic dimensioning of the siphon, the criterion was adopted, according to the recommendation from the literature, that the velocity in the siphon pipes is 2.0-3.0 m/s. In front of the siphon, inspection gullies with catch basins are envisaged, and inspection shafts on siphons are rectangular in size 1.00 x 1.50 m. Also, on the profiles P422, P453 and P777, siphons are envisaged for the water from the upstream banquettes to be down streamed through the connecting roads, because there is no possibility to create an culvert to empty waters from banquettes.

On sections, where there is no longitudinal fall or it is a minimal one, there are hollow curbs of height of 405 mm. Accepting water from hollow curbs is provided in rectangular inspection drains.
In these sections, with a small longitudinal fall, where there are no curbs, the installation of a drain in the drain channel on every 20 m is envisaged.
In individual sections (e.g. section from P704-P760), the diameter of the collector has been adopted, with capacity greater than the amount of waters that arrives on the roadway due to deeper imbedding, as the reduction of the diameter causes higher permissible minimum falls.
The drainage of bridges is given in the design of objects on the route, and this design envisages drains that will accept atmospheric water from bridges.
On designed collector, drainage with one-dimensional bar, dimension 600x600 mm D400, is envisaged, at a distance of about 25 m (the lattice capacity is about 20 l/s), except for the inspection chambers, where emptying banquettes is planned, therefore double bars are envisaged.
The drainage position is adapted to the traffic solution, respecting the transverse and longitudinal falls and other conditions from the given solution. The drainage body is formed of AB pipe diameter Ø1000 for collectors Ø300, Ø400 and Ø500.

The collector Ø600 is provided with AB square inspection drains dimension of the light opening 1.00 x 1.00 m.
For all collectors of atmospheric sewage, corrugated pipes of polypropylene PPR peripheral stiffness Sn8 were envisaged.

Hydraulic calculation of the atmospheric sewage collector

Since the road is surrounded by sidewalks, and there is no inflow of atmospheric waters from the surrounding terrain on it, because the transverse fall of banquette is turned from the road, the surface of the catchment is the surface of the carriageway and sidewalk under the asphalt and the greenery of the divisional island, except on the sections in the cuttings where there are no culverts.
The calculation included the intensity of ten-minute rainfall with a return period of 2 years, and bearing in mind that this is the main road. The data were taken from ITP curves for Podgorica, because there are no analyses for Danilovgrad for precipitation intensities, but they are in any case lower than for Podgorica. ITP curves for Podgorica are included in the Hydraulic Calculation.
The amount of water that can reach the road is calculated according to the following form:

$Q=F*i*\Psi$ (l/s)
Where:

- i = 276 l/s/ha - intensity of ten-minute rainfall with a return period of 2 years
- $\Psi = 0.90$ – runoff from asphalt and concrete surfaces
- $\Psi = 0.20$ - runoff from the surrounding terrain
- $\Psi = 0.10$ - runoff capacity of green surfaces
- F - the corresponding surface from which the atmospheric water enters the collector

The hydraulic calculation of pipeline capacity is provided in the Hydraulic Calculation, as well as the expected amount of atmospheric waters. The hydraulic calculation of the collector is done in the FlowMaster software, with the adopted Manning roughness coefficient of k = 0.011 and the maximum charge of 80%.
The level pipeline is guided so that the excavations are minimal, taking into account the intersection with the planned installations.

3.12. Execution of works on the route

● As part of the preparatory work, the cutting of trees should be done, the shrubs, logs and roots should be removed, demolition and removal of walls and objects, concrete and stone fences, dismantling of the existing wire fence with pillars and elastic safety fences, removal of existing signs, cutting of asphalt layers, scraping and demolition of the existing carriageway, as well as demolition of existing culvers, will be executed according to the dynamics of the progress of the works along the route.

● Excavation should be executed using mechanization and other means, so that manual labour is limited to the necessary minimum. Excavations in hard rock material should be executed by machine drilling, deep and ordinary mining and re-mining of larger rocks, if this would require the intended use of the excavated material. Mechanical pushing, i.e. loading of materials, and transport to the place of use, or to the landfill with the unloading, should also be considered. All excavations should be executed according to the profiles, envisaged altitude level and the prescribed slopes. Efficient drainage of the hull of the road must be enabled at this stage of work. During execution of works, attention must be paid to avoid undermining, disturbance or damage to the excavation slopes envisaged by the design. When using explosives, it is necessary to act in terms of positive regulations for such work, with due regard to the appropriate handling of explosives and the environment, objects roads and people. In mining, as well as in the execution of excavation work, it is necessary to minimize any impact that would interfere with traffic, people and the environment, whereby all necessary traffic and safety signals should be installed.

● Temporary landfills of excavation material to be used for the construction of embankments may be formed at suitable locations along the route of the road.

● Replacement of poor material of the land is executed in such manner that, after digging the humus, an excavation of soil material, which due to its poor geo-mechanical characteristics must be replaced, must be deposited and replaced with better material (gravel or sand), with the necessary compaction.

● The work on the construction of the embankment includes compacting, spreading, rough or fine planning, drying or moistening and compacting materials in the embankment, according to the dimensions defined in the design. The embankment cannot be made of material, which, due to biochemical action, will change its physical and mechanical properties. The embankment material can be obtained from cuttings on the route or from a borrowed area, provided it is not sensitive to the presence of water. Stone material may be a material obtained by blasting and sifting, gravel material or sand obtained by dredging of material. If the embankment is made of a non-coherent material, the grain size must not exceed 30

cm and not more than 10% by size up to 40 cm. For embankments, the materials for which the stability of the body of the road has been demonstrated can be used. Each individual layer must be spread in the longitudinal direction horizontally or at most in the slope with the same projected longitudinal inclination. In cross-section sense, each individual layer must have a two-sided or unilateral slope of 2 - 5% for the discharge of atmospheric water. When fitting, the transitions of the transport means must be as evenly distributed throughout the entire width of the planum. The height of a single spread layer must be in accordance with the effect of compacting the depth of the compacted agent, the type of bulk material and segregation phenomena, but not more than 30 cm in a loose state. Stone embankments are made in layers of the usual thickness of 30-50 cm, but the actual thickness of the spread layer of the embankment is proven on the test section.

The materials are compressed by vibrating rollers (self-propelled or trailed), vibrating plates and compactors. Each layer of embankment must be filled in full width with a suitable mechanical means, whereby the compaction must be executed from the edge to the middle. All inaccessible places for machinery or places where the use of heavy machinery would be inappropriate for other reasons (filling behind an object, retaining walls, etc.), should be compressed with other suitable means or methods. Before the start of compacting, the material of each layer must be crushed, mixed, moistened or dried to the humidity up to which, the type of material can be compacted to certain density. If after compaction and quality control, it is not continued immediately with the filling of the next layer, but it is continued with the filling after a long period, before the filling, the quality of compactness of the already made layer should be checked again. In case the predominantly coherent material is used for the embankment and weather conditions would prevent its use, other procedures for the construction of the embankments, such as stabilization, processing or replacement of materials, may be used. Work on the filling will be interrupted at any time when it is not possible to achieve satisfactory results, especially due to rain, high groundwater or some other atmospheric disasters. The embankment material must not be installed on frozen surfaces, snow and ice.

When the slope of the terrain is from 20 to 30%, side cuts must be graded in the course of the construction of the embankments, in the width of 1 - 1.5 m. The side cuts should be in the slope 2: 1. When the slope of the terrain is greater than 30%, the graded side cuts must be executed continuously, and when the slope of the terrain is between 20% and 30%, 1 m of intermediate space should be provided. The cross-slope of graded side-cuts should be 3% down the slope side. The surface layer of the earth embankment in the thickness of 30 - 50 cm should preferably be made of stone or gravel materials from the borrowed location.

● Arrangement of the subsoil includes the preparation of the foundation soil for the construction of the embankment, after the excavation and removal of poor or fertile soil and humus, and involves rough planning and compaction of the underground soil surface at a depth of 30-50 cm. The local soil that has the function of the subsoil should have physical-mechanical properties the same as the materials from which the embankment is built of. The surface of the underground soil (subsoil) should be roughly planned after a surface or broad excavation, so that in the given field conditions, the necessary cross-section for the drainage of surface and atmospheric waters is provided. After the planning, the natural subsoil should be compacted in full width with appropriate compacting means. Substrate material must at first have so much humidity that compacting can be done successfully. The poor load material (poor quality material) in the subsoil is replaced by other material, which has favourable geo-mechanical properties.

● The bedding arrangement includes the arrangement of the lower roadbed in the cuttings, side-cuts and embankments, with rough and fine planning and loading of the bedding material with possible wetting. Creation of the bedding implies making a layer of average thickness d = 30 cm from a coherent material. It must not be built during frost, as well as in the case where there is a layer of ice or snow on roadbed of the lower layer (embankment subsoil), or if the lower layer is frozen. Spreading, planning, and compacting is executed mechanically. Compaction is executed with appropriate means for compaction of coherent materials. The bedding must have a longitudinal and transverse inclination envisaged by the main construction design, that is, the levelled shot angles on each transverse profile must not deviate more than ± 20 mm. The placement of the executed road bed, measured on each transverse profile (left edge, axis, right edge) measured with a 4 m long strip and a wedge, must not have a depression greater than 20 mm.

● The lower part of road base is made of crushed stone material of granulation 0-63 mm in a layer of thickness d = 20-26 cm and granulation 0-31.5 mm, in the layer thickness d = 15 cm. the position includes procurement, delivery, installation, rough and fine scattering, possible wetting, and compaction of the road base. The material must be scattered in the longitudinal direction in the slope as the design slope of the level, and in the transverse sense, it must have a slope given by the design needed for the drainage of atmospheric water. Compacting is executed with the appropriate rollers in full width, from the lower edge to the higher. The crushed stone aggregate must meet requirements in terms of physical, mechanical and mineralogical-petrographic characteristics of the rocks and aggregates, bearing capacity, content of organic substance and light particles, that it is resistant to atmospheric conditions, that it is not prone to degradation due to urban traffic under different meteorological conditions. Vehicles with muddy wheels must not be driven on scattered or compacted material.

● Asphalt works are executed with a finisher and a suitable set of rollers. The production of asphalt mixtures is done by machine in the plant for the production of asphalt mixtures.

Prior to the commencement of works, the Contractor is obliged to create, in the authorized laboratory, a design of the previous asphalt mixture in all accordance with the requirements of the technical conditions. The production of the bituminous base layer BNS-22sA includes the procurement of materials, hot processing, disassembly, installation and compacting of asphalt mixtures of mineral material and bitumen in one layer of designed thickness, that is, according to the angles and dimensions given in the construction design. Composite materials for the production of the road base from bituminous materials are rock flour of carbonate composition, crushed stone material of carbonate or silicate composition 0-4 mm, crushed sedimentary stone aggregate 4/8, 8/16 and 16/22 mm and binder Bit 45 or Bit 60. In the asphalt mix, the bitumen content is orientated to 3.5-4%. The bituminous road base is executed in two layers (2 x 6 cm) of total thickness d = 12 cm and thickness d = 6 cm, depending on the position on the route. Before laying the BNS, the substrate must be well washed, cleaned with steel brushes and compressed with compressor, dry and free from frost. In parts where the surface of the substrate layer deviates from the prescribed height by more than 20 mm, it is necessary for the Contractor to repair the substrate by increasing the asphalt-mixing layer or appropriately removing the excess in the substrate. The temperature of the asphalt mixture at the installation site must not be lower than 130°C and higher than 175°C.

The final wearing layer is made of asphalt concrete AB-11s in the thickness of d = 4.0 cm. Composite materials for the production of the wearing layer are stone flour of carbonate composition, crushed stone material of carbonate or silicate composition 0 - 4 mm, crushed eruptive stone aggregate 4/8, 8/11 mm and as binder bitumen BIT 60. The optimal amount of bitumen in the asphalt mix should be less than 5.0%, in order to prevent rapid fatigue of asphalt concrete. The temperature of the asphalt mixture at the site of installation should not be lower than 140°C and higher than 175°C.

Installation of asphalt mixtures can begin when the substrate is purified from bonded and unbound material, dried and sprayed with bituminous emulsion in the amount of 150 g bitumen binder per m^2. For bonding between layers, apply a cationic semi-stabile emulsion or anionic emulsions. The type of emulsion depends on the type of substrate. The spraying must begin at least 2-3 hours before laying the asphalt, so that the water evaporates and the bitumen part is connected to the base. The asphalt layer can be installed only in the period when the air temperatures are higher than 5°C, without wind or min. 10^oC with the wind. Installation of the asphalt mixture must not be performed during mist or rain. The

substrate temperature should not be lower than + 5^{o}C. When continuing the work, after longer work stops or interruptions, the place of the composition should be cut off all over the thickness and coated with bituminous emulsion. The asphalt mass can be transported only in vehicles whose loading box is pre-cleaned and coated with a silicone emulsion solution. The use of oil and petroleum products is prohibited. The asphalt mass must be covered during transport. The asphalt layer is rolled until the required compaction, controlled at the site of the isotopic probe, is achieved.

● Concrete for drain channels should be resistant to cold and salt. A drain channel should be on the surface of mechanically compacted rock material, straight with allowed deviations not greater than + 2 cm. Concrete drain channels can be executed on-site in a full profile, prefabricated elements on concrete surfaces or with concrete curbs and plates concreted on the site. They should be executed in rings according to the design, usually at a length of 3 to 5 m. Rings are separated by joints. At 3 m lengths, the joints are executed with a roofing concreting paper that permanently remains there, and for lengths greater than 3 m, a 10 mm wide joints are executed, which are removed after curing of the concrete. Watering of joints is executed with a watering mass. If drain channels are used in pre-made formwork, they must be rigid and resistant to twisting. Concrete is incorporated into the formwork by vibration. The concrete surface must be flat.

● Instalment of concrete curbs of MB40 brand is executed on the prepared concrete substrate MB25 quality, which is installed through the previously compacted and tested base layer. The curb laying is done with joints of width 1 cm filled with cement mortar R = 1: 3, with processing of the joints 1 cm. All measures of protection against wind, sun and the effects of frost should be taken. For hollow curbs, curbs of different materials with an integrated line channel can be used. The material must be resistant to corrosion, freezing, the action of salt and chemicals. The lateral stabilization of the element is done with a concrete minimum C20/25.

● Construction of the sidewalk of concrete MB30, d = 12 cm, is executed by making 15 cm thick layer of gravelly sandy material on the previously prepared and technically adjusted base. Through the pre-fabricated purifying layer, the concrete is installed by means of plate-shaped vibrators with finishing profiling and roughing with a flattening machine. Concrete base is made with transverse construction joints at every 5 m. Upon completion of the concreting, protection and care of the finished structure should be executed during the first 7 days.

3.13. Execution of works on bridges

● **Construction of piles Ø150 from concrete MB 30** - For execution of drilled piles, access to the drilling kit and the required size of the work plate should be provided. The drilling machine is placed in the appropriate position at the marked location and the drilling device is brought to a vertical position.

Drilling can be done in the presence of groundwater, but it is necessary to protect the borehole during drilling, and installing concrete and reinforcement using a steel guide tube. Groundwater is not pumped out of the borehole so as not to break the ground. During drilling, rocks can be encountered, which must be broken and the drilling is continued until reaching the projected corner of the bottom of the pile. The drilling machine must be properly fitted for injection of the working pipe, the excavation of the ground and the extraction of the working pipe. The working pipe must be made of steel, composed of segments that are interconnected (welded) during pushing down, and separated (cut) into portions by pulling out each segment. The working tube is pushed to the bottom of the pile, with simultaneous excavation of the ground. These two operations are practically simultaneous: the machine pushes the tube to a certain depth, then excavates and takes out the material, and the tube is again suppressed. After reaching the bottom of the pile, the tube is pulled out depending on the speed of concrete installation. Installation of concrete is executed after the built-in rebar. Concrete is inserted into the working pipe through the pipe of diameter D = 200 mm, immersed along the axis of the hopper, with the tube fixing at about 10 to 15 cm above the bottom of the borehole before the beginning of the concrete installation. Then concrete is installed up to a height of about 2.0 m in the lowered pipe, when pulling out of the pipe begins, which is continued in accordance with the advancement of the concrete.

Immersing of pipes in concrete is mandatory, in order to avoid mixing of fresh and already embedded concrete, with rising to the surface of the ground and to the top of the borehole, where it will be cut off and removed. The depth of the pipe sinking in the mass is constantly controlled, so that it is always in the concrete for about 2 m. If the level of concrete in the pipe drops too fast, the depth of the immersing is controlled by the drilling machine. If the level of concrete is still too low, the water-cement factor should be reduced. It is allowed to install concrete with concrete pump, if it achieves faster work and better quality, as decided by the supervisory body. The funnel at the entrance to the tube should be in the form of a sealed coupe, with sides at an angle of 45 ° towards the horizontal. The size of the funnel should provide a volume equal to the total volume of the pipe, in order to achieve continuity in the movement of concrete through the pipe. For a pipe with a diameter D = 200 mm and lowering the concrete to a depth of 20 m, a funnel volume of about 0.65 m^3 is required. The proper start of concreting is of the utmost importance for the quality of the pile as a whole, and this phase of work should be

executed with due care. The first amount to be installed must be sufficient for the first two meters of the borehole. After this first installation, the embedding of the concrete will continue along with the simultaneous pulling of a 5 to 10 cm, taking care to avoid the appearance of the emptiness at the bottom of the pipe. If the tube is still empty during concreting, it should be slowly pulled down to the ground until the level in the funnel becomes equal to the level at the contact of the funnel and the pipe. Concreting stops at a level of min. 30 cm above the top of the pile, with a minimum height of 60 cm. In this way, the required length of cut is checked. Upon completion of the pile concreting, but not before the expiration of 72 hours, excessive concrete is removed to the bottom of the headband, i.e. of the projected tip of the pile and removes it (closure), with careful care of the installed reinforcement.

● **Preparation of concrete mounting brackets MB 45** - Concreting is executed on pre-prepared plate. The panelling of the panel supports must be smooth and straight, and coating with the approved agent will ensure its easy separation from the concrete. In the lower corners of the formwork, fixing triangular battens of 3x3 cm of hardwood are installed to prevent the spillage of cement milk onto the bottom surface of the finished plate through the contact joints between the elements in the concrete toping of the top plate. If steel is used, instead of the hard wood for formwork, a triangular steel element is welded 20x20 mm. The formwork can be used as many times as the supervisory authority permits, but each time it has to be previously cleaned and coated. Parts of the surface mounting brackets that come in contact with concrete cast on the site must be treated with tiny plastering or in some other way providing roughing. This also applies to the connection with the concrete slab of the bearer and to the connection with the transverse bearers.

● **Pre-stressing** - For pre-stressing the construction and structural elements of the construction, the design envisages approved domestic production systems IMS and SPB, post pre-stressing systems, i.e. with the application only when concrete achieves certain strength. Only steel that meets the requirements of the “Rules for technical standards for steel wire, bars and ropes for pre-stressing structures” can be used for pre-stressing. Pre-stressing steel is transported in clean, dry and closed transport vehicles. The steel must be stored in completely dry rooms, with a wooden floor, in which there is no possibility of condensation. When receiving wire and ropes, as well as before installing it, the wire must not be oxidized, nor may it have dents, unevenness, notches or any damage. For the cables, flexible ribbed tubes of white sheet metal are used. They must be sufficiently rigid to maintain shape under the weight of the cable and concrete during concreting, provided they are sufficiently elastic so that they can easily follow the cable line. Pipes must not leak cement milk and must be made of non-corrosive material for

pre-stressing, either directly or in electro-chemical manner. Keep anchor buckets at the site protected from moisture, dirt and mechanical damage. To tighten the cables, protect anchors from atmospheric influences and mechanical damage. Prior to pre-stressing, it is necessary to inspect the corners and clean the contaminated surfaces, to ensure the adhesion of the protective layer of concrete.

Cable tension can only begin when the concrete has reached the required minimum strength. When pre-stressing is performed at the age of concrete less than 28 days, the strength of the concrete must be determined by control samples wetted under the same conditions as the concrete construction. Prior to the start of pre-stressing work, a pre-stress program must be made. Pre- stress program is performed by the Contractor based on the data from the design and approved by the Supervisor, and must include, from the time of pre-stressing, the pre-stress data, the sequence of cable straining and the elongation for each cable with the corresponding depiction of the compression of the concrete due to pressure, and the friction size and flow . The sequence of straining must therefore be determined not to create undue stresses. After receiving the program and approving the start of pre-stressing by the Supervisor, appropriate preparations must be made: check the mobility of the cables, inspect the anchor blocks, set the required scaffolds, power connections, and cut the cables to the minimum length required for pressing. After shortening the cables, the pins with the wedges are placed and the press is set. Calibration diagrams of the hydraulic kit must not be older than 6 months. The maximum temporary force in the cable at the place of planting must not exceed 75% of the prescribed characteristic breaking force (exceptionally 80%). The size of the power in the cable will be determined using a pressure gauge. Measurement of cable elongation and comparison with the force achieved serves to assess whether frictional losses are well calculated. If there are significant differences, the calculation of the force in the design must be checked. During the work, a record of cable straining is kept. If it is determined that the sum of deviations from the prescribed pre-stress force, measured in the gauge, expressed in percentages, for each individual cable, is hired than proscribed one, the Supervisor will be informed about it in written form. Also, if the deviation from the prescribed total pre-stressed force or the total prescribed elongation is greater than 5%, Supervisor must be informed about it in written form. This must be executed regardless of whether the Supervisor is present or not during execution of straining works. In specific cases, the Supervisor may request the measurement of the force in critical cross-sections along the cable using special pre-assembled devices. These places, after finishing work, must be well protected. In order to protect the embedded cables from corrosion and to tie the surrounding concrete, the pre-stressing protection pipes must be carefully injected with the selected injection mixture. It must be ensured that immediately after the concreting, all protective pipes are cleaned from the

water that penetrated them. This must be done thoroughly by blowing out compressed air. Then, until the injection is started, the protective tubes must be protected from water re-entering the tubes. Also, air circulation in the protective tubes must also be avoided. The injection mixture consists of cement, water and possibly chemical and mineral additives. Injection is performed at temperatures above +5°C.

● **Repair of damaged concrete parts by reparative mortars** - The work in this position consists in the installation of reparative concrete or mortars in places where the concrete structure is damaged and it involves repairs of protective layers of reinforced or pre-stressed elements and repair of larger concrete surfaces. Smaller areas and shallow damage (1-2 cm depth) involve the use of plaster, and deeper damage, especially on a larger surface, as a rule requires reparative concrete. After all the unstable parts are removed by one of the abrasive methods (recommended sandblasting) and the contact surface is prepared by cleaning and pressure air, the contact surface should be moistened immediately before installation, and then a reparative mortar or fine-grained concrete is installed. The reinforcement is corrected and welded, if necessary, with the need to add the missing armature of the smaller profiles and properly connect the reinforcement with the wire. When the reinforcement is protected, the instalment of the repair material begins.

● **Injection of cracks/cavities** - Work on this position consists in repairing cracks or porous parts of concrete by injection - by filling damaged parts of concrete with a binder based on synthetic resins under high pressure. Fractures of cracks and cavities should be completely cleaned from unstable concrete parts with a wire brush or machine. After finishing the drilling, residual dust from cracks and cavities should be removed by blowing out compressed air which must not be contaminated with oil. The injection pipes should be fixed at the intended locations with the same synthetic resin that is intended for injection. The distance between the injection hoses depends on the depth of the cracks, the viscosity of the injection material, the temperature, the hardening time, and the correct positioning of the injection apparatus. As a rule, it should not be less than 10 cm and not more than 50 cm. The injection must be started in the injection tube located at the lowest point of the cracks and must not be interrupted until the mixture of the synthetic resin does not appear at the end of the next injected injection pipe or the next adjacent one. The injection should be stopped immediately when the pressure is high (there are no further cavities) or when there is no more pressure in the injection system. The ends of the injection hoses should be closed immediately after the mixture has been expelled at the ends thereof, in order to avoid pulling the resin back into the tube. For this reason, the injection hoses are fitted to the valves at the ends. The injection procedure is executed continuously until the mixture of

the synthetic resin does not appear on the injection hose. The injection pipes must be removed after complete curing of the mixture (12-48 hours).

● **Installation of carbon strips** - Work on this position involves reinforcing concrete elements using carbon strips that adhere to the surface of the concrete, and which have the role of an external reinforcement. The surface to be reinforced must be aligned, with variations and roughness of no more than 0.5 mm. The level of the substrate should be checked with a metal lath. Tolerance of 2 m length is maximum 10 mm and for 0.3 m length 4 mm. Ribbons are cut to the required length. Immediately before application of the adhesive, the surface of the strip should be cleaned with a solvent to remove dirt. The substrate temperature should be from + 8°C to + 30°C, humidity max 4% pbv and pay particular attention to condensation. The ambient temperature must be at least 3°C above the dew point. Inspection of embedded tape is executed by a "pull-off" test. When performing the test, it must reach the break of the concrete and not to detach the strip.

3.14. Lighting

Lighting of the roadway is designed with a central pillar arrangement (middle of the split band between the pavements) as shown in the drawings and shown in the calculation fields attached. All elements of the calculation meet both the level of lighting for the lighting class of the ME1 roadway, as well as CEO's lighting-technical characteristics at the points of crossings and roundabout. The insignificant deviations from the given values from the Terms of Reference are negligible and mostly refer to a higher value than the given one, which in any case is more favourable.

The lighting power is designed in accordance with the requirements of the Terms of Reference and the conditions of the relevant Power Distribution.

Selection of lighting sources and lights

Considering the recommendation of the Investor that the lamps are LED technology, and selecting the appropriate height of the pillars, the AMPERA MIDI /64LED/5137/139W/NW (4000K)/SPD 10kV)/CUSTOM DIMMING 50% is selected for the illumination of the boulevard and the AMPERA MAXI/128LED/5121/279W / NW (4000K)/SPD (10kV) / CUSTOM DIMMING 50% for illumination of the roundabout, from manufacturer Minel-Schréder or equivalent. Decision to choose these lamps, among the lamps that with a photometric calculation with another choice of pillars and the other range between them meet requirements of the requested class of roads, was mostly influenced by the fact that by installing these lamps, energy consumption would be significantly

lower at annual level. A photometric calculation is made for the above-mentioned lamps, but other lamps of the same characteristics or similar from the other manufacturer may be used.
Pillars with luminaires are arranged so that a good visual effect and a harmonious arrangement, as well as even light, are obtained.

Lights for lightning the boulevard

LED lamps should have the same or better characteristics, designed for functional lighting, fully equipped to use LED light source, which offers a large range of power, lumen output and distribution of lighting, designed to provide simple installation as well as replacement of an optical block and a switchgear, without the use of tools.
Color: AKZO GRAY 900 sanded
Luminaire base is made of aluminium cast under pressure and coloured with electrostatic powder coating, in the AKZO GRAY 900 sanded colour. The base should be designed to allow easy mounting to the top of the pillar or the lid, without opening the cover - an optical block and a part with a switching device, for easier and simpler installation and disassembly of the complete lamp.
Luminaire cover, in two parts of aluminum cast under pressure and painted with electrostatic powder coating, AKZO GRAY 900 sanded. The lid should be designed to allow easy mounting on the lamp base after mounting the base to the top of the pillar or lever.

Lights for lighting of the roundabout

LED lamps should have the same or better characteristics, designed for functional lighting, fully equipped to use LED light source, which offers a large range of power, lumen output and distribution of lighting, designed to provide simple installation as well as replacement of an optical block and a switchgear, without the use of tools.
Luminaire base made of aluminium cast under pressure and colored with electrostatic powder coating, in the AKZO GRAY 900 sanded color. The base should be designed to allow easy mounting to the top of the pillar or the lid, without opening the cover - an optical block and a part with a switching device, for easier and simpler installation and disassembly of the complete lamp.
Luminaire cover is made of two parts, of aluminium cast under pressure and painted with electrostatic powder coating, AKZO GRAY 900 sanded. The lid should be designed to allow easy mounting on the lamp base after mounting the lamp to the top of the pillar or lever.

Management of lighting

To turn on and off lighting, an astronomical clock (astroclock-2 ETI or equivalent) is provided, which is embedded in each PMO. These watches will be factory-set according to the time zone to which the Podgorica area belongs.
Since the terms of reference does not define the lighting mode, it is required from the Investor to make it a half-timer mode, which means that by 01:00 hours the lamps should work with 100% power, and from 01:00 h to 50%.
To adjust the level of illumination (or power), a switching device installed in LED lamps is used, which has the possibility of an autonomous dimming scenario. The luminaires should be factory-set for half-day operation, which means that they should work with 100% power by 01:00 am and from 1:00 h with 50% of power.

Selection of columns and light fixtures

For carrying lamps on the route of the boulevard, conical round pillars of type KRS-A-10 manufactured by "Amiga" Kraljevo or equivalent, and for circular currents, cone oscillating pillars of type VRS (8) -A-14 manufactured by “Amiga” Kraljevo or equivalent are envisaged.
Conical round pillar type KRS-A-10 “Amiga”, height 10.00 m, made according to the requirements of standards EN 40-5, EN 40-6, EN 40-2, EN 40-3-3, EN 40- 3-2, EN 40-3-1. The columns are made of steel polygonal tube and steel sheet S235JR, with anti-corrosion protection of hot zinc plating in accordance with EN ISO 1461.
Lyra double type LK-II production “"Amiga” Kraljevo or equivalent, is envisaged for the installation of AMPERA MIDI “Minel-Schréder”.
It is made of steel pipe S235JR and protected by hot zinc plating in accordance with EN ISO 1461. The lyre should be dimension: Ø60mm, side length 2x1.50 m, height 0.50 m; In the lower segment of the pillar, there should be an opening with a cover (the minimum degree of protection IP 43), within which the “PPR-4” connection plate or equivalent, with two fuses FRA 16/6 A for pillars with double lyre, or with one FRA 16/6 A fuse for single-pole lyras. For the connection from the terminal board to the luminaire, the cable type PPOO 3x2.5 mm² is used.

Conical oscillating pillar type VRS (8) -A-14 “Amiga”, height 14.00 m, made in accordance with the requirements of standards EN 40-5, EN 40-6, EN 40-2, EN 40-3-3, EN 40-3-2, EN 40-3-1. The columns are made of steel polygonal pipes and steel sheet S235JR, with corrosion protection of heat, which is in accordance with EN ISO 1461. On the pillars, it is planned to install a circular carriage for 10 AMPERA MAXI 279V “Minel-Schréder” lamps, type 10R-K production “Amiga”

Kraljevo or equivalent. The brackets are made of steel tubes S235JR and protected by heat-sealing in accordance with EN ISO 1461. In the lower segment it must open with a lid (at least IP 43 protection level), which means that the dashboard is mounted on the bearing carrier, with the terminals "Phoenix" 25 mm^2, with ten fuses C6A ("Schrack" or "Moeller"). For connection from dashboards to the luminaire, a cable of type PPOO 3k2,5 mm^2 is used.

The pillars were designed for installation on a prepared concrete base, through a welded base plate (at the bottom of the pillar), which can be protuberant or straight, but must enable efficient drainage of water and anchors (with nuts), incorporated in the foundation when it is made.

3.15. Supplying the project with the necessary raw materials

● ***Supply with material***

The location of the subject line is favourable in terms of supplying the construction site with material, since Danilovgrad is located at a distance of only 25-30 km from Podgorica and Nikšić, in whose areas there are several manufacturers of various types of building materials (crushed aggregate, concrete, asphalt, concrete pipes, and curbs). In addition, Podgorica and Nikšić have developed trade wholesale networks of other necessary construction and installation materials, which enables the future contractor to choose the most favourable supplier of certain types of materials, depending on the price and conditions of delivery. The supply of building materials is also suitable for the conditions for the delivery of materials to the construction site.

Material needed for construction of the carriageway construction

The types and quantities of materials required for the construction of the carriageway structure are shown in the following table.

Table 3.15/1. *Types and quantities needed for construction of the carriageway structure*

Number	**Type of works**	**Unit of measure**	**Quantity**
1	Construction of a mechanically stabilized bottom structural		

	layer of crushed stone material of granulation 0/63 mm, d = 20-26 cm	m^3	76,364.11
2	Construction of a mechanically stabilized bottom structural layer of crushed stone material of granulation 0/31.5 mm, d = 15 cm	m^3	37,821.30
3	Construction of a structural layer of bituminous crushed aggregate BNS 22sA, d = 6.0 cm	m^3	233,701.00
4	Construction of the base layer of bituminous crushed aggregate BNS 22A, d = 6.0 cm	m^3	233,701.00
5	Construction of the base layer of bituminous crushed aggregate BNS 22A, d = 7.0 cm	m^3	18,441.00
6	Construction of abrasive layer of asphalt concrete AB11s, d = 4.0 cm	m^3	233,701.00
7	Construction of abrasive layer of asphalt concrete AB11, d = 4.0 cm	m^3	18,441.00
8	Construction of drain channels including concrete curbs 18/24	m	8,887.00
9	Procurement and instalment of concrete curbs 18/24	m	50,935.00
10	Procurement and instalment of concrete lip curb 18/24 on part of pavement	m	20.00
11	Procurement and instalment of hollow curbs	m	782.00
12	Pavement construction: - concrete MB30, d=12 cm - lower bearing level - base, d=15 cm	m^2	4.469,00
13	Construction of flexible carriageway construction	m^2	10,757.00
14	Arrangement of non-asphalted roads and connecting roads	m^2	500.00

● ***Electricity and fuel supply***

The position of designed route allows the Contractor to execute electricity supply from the existing power grid. An alternative solution is the supply of electricity through an aggregate whose capacity needs to meet the daily need for compressor and per-vibrator operation and the provision of lighting in temporary buildings on the construction site.
Fuel delivery can be done from public pump stations due to the small transport distance and good connection to the construction site.

● ***Water supply***

Drinking water, work requirements and fire protection can be provided from the existing installations of the city water supply, subject to the conditions and approval of the Public company for Water and Sewage. Minor amounts of drinking water for the needs of workers can be stored in appropriate containers along the entire route.

3.16. Estimation of the duration of the works

Based on executed calculation, the estimated capacities for executing about 1500 m^3/day excavation, about 770 m^3/day embankment, about 270 m^3/day of buffers, about 150 m^3 per day of concrete drain channels and curbs, for installation about 50 m^3/day concrete and about 700 t/day asphalt, it was found that for the construction of the object it takes 624 working days or 24 calendar months. The planned 24 calendar months for construction period shall be counted from the date of the contractor's introduction into the business.

3.17. Types and quantities of discharged gases, dust, wastewater and other solid and liquid materials arising during the reconstruction of the road in question

Selection of machines for execution of works on excavations, embankments, removal, delivery of materials and asphalt works

As already mentioned, and shown in the previous text, for the execution of the designed works, it is not envisaged which machines and equipment can be used for the envisaged works. Because of this, and based on the previous experience in the

elaboration of similar studies, we have made a narrow selection of construction machinery for main works.

During the execution of construction works, that is, during the reconstruction of the main road M-18 from Podgorica (Komanski most) to Danilovgrad (roundabout) excavation of the rock mass and the construction of the embankments will be done by construction machinery. As these machines use motor oil as a fuel, we have shown in the following tables the emissions of gases and noise generated by the operation of these machines.

Table 3.17/1. *Selection of excavation machines*

Machine	*Engine power kW*	*Gas emissions from SUs engine (EU STAGE IIIB) in g/kWh*				*Noise in dB*
		CO	*CH*	*NO_x*	*PM10*	
Bulldozer CAT D8H	*199*	*696.5*	*37.81*	*398*	*4.975*	*104*
Hydraulic excavator Volvo EC460	*239*	*836.5*	*45.41*	*478*	*5.975*	*73*
Loader Volovo L120	*164*	*574*	*0.665*	*328*	*4.1*	*106*
Lorry MERCEDES BENZ Axor2633	*243*	*850.5*	*46.17*	*486*	*6.075*	*97*
Atlas Copco ROC F6	*186*	*613.8*	*35.34*	*372*	*4.65*	*123*

Table 3.17/2. *Selection of machines for construction of the bearing layer made of crushed stone*

Machine	*Engine power kW*	*Gas emissions from SUs engine (EU STAGE IIIB) in g/kWh*				*Noise in dB*
		CO	*CH*	*NO_x*	*PM10*	
Loader Volovo L120	*164*	*574*	*0.665*	*328*	*4.1*	*106*
Lorry MERCEDES BENZ Axor2633	*243*	*850.5*	*46.17*	*486*	*6.075*	*97*
Bulldozer CAT D8H	*199*	*696.5*	*37.81*	*398*	*4.975*	*104*
Vibration roller LiuGong 6116E	*103*	*515*	*19.57*	*339.9*	*2.575*	*92*
Water tank	*260*	*910*	*49.4*	*206*	*6.5*	*64*

Table 3.17/3. *Selection of machines for construction of asphalt layer*

Machine	*Engine power kW*	*Gas emissions from SUs engine (EU STAGE IIIB) in g/kWh*				*Noise in dB*
		CO	*CH*	*NO_x*	*PM10*	
Lorry MERCEDES BENZ Axor2633	*243*	*850.5*	*46.17*	*486*	*6.075*	*97*

Finisher VOLVO P4370B ABG	***88***	***440***	***19.72***	***290.4***	***2.2***	***90***
Vibration roller LiuGong 6611E	***93***	***465***	***17.67***	***306.9***	***2.325***	***92***
Roller with rubber wheels Volvo PT125	***63***	***315***	***11.97***	***207.9***	***1.575***	***89***
Vibration roller LiuGong 6116E	***103***	***515***	***19.57***	***339.9***	***2.575***	***92***

Table 3.17/4. *Selection of machines for execution of concrete works*

Machine	***Engine power kW***	***Gas emissions from SUs engine (EU STAGE IIIB) in g/kWh***				***Noise in dB***
		CO	***CH***	***NO_x***	***PM10***	
Concrete auto mixer MERCEDES BENZ ACTROS 4141B	***300***	***1050***	***57***	***600***	***7.5***	***98***
Concrete auto pump MERCEDES BENZ MB 2632	***235***	***775.5***	***44.65***	***470***	***5.875***	***97***

Release of water from the pavement to the outside environment

In Chapter 3.11. the method of draining atmospheric waters from the roadway is described. Considering that purification of atmospheric water from the subject line is also envisaged, it is envisaged to install a separator of oil and petroleum products.

All water from the carriageway must be taken to the separator, and from them can be released into the outside environment.

Table 3.17/4 shows the maximum permissible concentrations of hazardous and harmful substances in wastewater discharged into a natural recipient.

Table 3.17/4. *The maximum permissible concentrations in the waste water for discharge into the natural recipient (Official Gazette of Montenegro 45/08, 9/10, 26/12, 52/12 and 59/13)*

Parameter	**Concentration**
Temperature	30^0C
Suspended substances	20 mg/l
Sedimentation substances	0.5 ml/l/2h
pH	6.5-9
COD	45mg/l

BOD	30 mg/l
Aluminium	10 mg/l
Arsenic	0.05 mg/l
Barium	4 mg/l
Lead	0.2 mg/l
Boron	1 mg/l
Cadmium	0.01 mg/l
Total chrome	0.5 mg/l
C_r^{6+}	0.0 mg/l
Iron	1.0 mg/l
Copper	0.5 mg/l
Nickel	0.5 mg/l
Mercury	0.005 mg/l
Silver	0.1 mg/l
Zinc	1.0 mg/l
Tin	0.3 mg/l
Selenium	0.01 mg /l
Active chlorine	0.05 mg/l
Ammonium	0.5 mg/l
Cyanide	0.005 mg/l
Fluoride	2 mg/l
NO_2^-	0.5 mg/l
NO_3^-	40 mg/l
Phosphorus	1 mg/l
Sulphates	250 mg/l
Sulphides	0.1 mg/l
Thiocyanate	0 mg/l
Oil and fat (plant and animal origin)	5 mg/l
Mineral oils	0.5 mg/l
Aldehydes	1 mg/l
Chlorinated hydrocarbons	0.1 mg/l
Nitro solvents	0.05 mg/l
Phenols	0.01 mg/l
Detergents	0.5 mg/l
Aromatic hydrocarbons	0.01 mg/l
Chlorinated pesticides	0.0025 mg/l
Organic-phosphorus pesticides	0.0025 mg/l
Organic components	0.01 mg/l
Total alcohols	1 mg/l
Total radioactivity	0.27Bq/l
Total insoluble substance	80mg/l
Coliforms TC in 100ml	5000MPN/100ml
Coliforms FC in 100ml	1000MPN/100ml
Fecal Streptococcus FS in 100ml	100 MPN/100ml
Pathogenic microorganisms	without

Polluting substances in waters from the carriageway

As we have said in the previous chapters, the biggest pollution on the road and alongside the road originates from motor vehicles. The following concentration of pollutants in water from the carriageway is expected for the frequency of traffic on the section in question, Table 3.17/5.

Table 3.17/5. *Expected concentrations of pollutants in the waters from the main road Podgorica-Danilovgrad*

SUBSTANCE	**mg/l**
Suspended substances	155.14
Chlorides	96.40
Sulphates	0.803
Total phosphorus	0.267
Fuel	12.228
Mineral oils	15.383
Cadmium	4.756
Chromium	10.413
Copper	0.950
Iron	0.309
Lead	0.176
Zinc	0.0722

The displayed results of the concentration of pollutants should be accepted as a mean value.

Material created during preparatory work

During execution of preparatory works certain quantities of materials are generated, which will be removed from the site in accordance with the applicable legal regulations. The quantities of these materials are given in the following table.

Table 3.17/6. *Types and quantities of material generated during preparatory works*

Number	**Types of works**	**Measurement unit**	**Quantity**
1	Removal of roots, bushes and trees	km	15.04
2	Demolition of the existing carriageway and pavement	m^3	128,295.00
3	Removal of existing wire and metal fences with poles	m	1,915.00
4	Demolition of existing		

	concrete, stone fences and fences with concrete base	m	675.00
5	Demolition of existing walls	m	95.00
6	Dismantling existing elastic safety fence	m	3,097.00
7	Dismantling existing signs and advertising panels	peace	265.00
8	Demolition of objects: - part of petrol station at km 114+770 right - object as pert of hotel Pejović at km 116+715 - object at km 118+330 left - object at km 119+725 right	lump sum	
9	Additional arrangement at the following petrol stations: - Europetrol at km 114+770 right - Eko at km 115+825 left - DAK petrol at km 127+180 right	lump sum	
10	Cutting of the existing carriageway construction in line with the planned construction	m	100.00
11	Scraping off the existing asphalt	m^2	500.00
12	Arrangement of the existing asphalt	m^2	500.00

Materials generated during earth works

During execution of earth works certain quantities of materials are generated, as shown in the following table.

Table 3.17/7. *Types and quantities of material generated during earth works*

Number	**Types of works**	**Measurement unit**	**Quantity**
1	Removal of humus, thickness d=20 cm	m^3	5,354.27
2	Excavation in material II-IV category	m^3	59,383.57
3	Excavation in material V-VI category	m^3	424,619.04

4	Excavation of material for channel	m^3	12,972.80
5	Excavation of stairs for supporting of embankment for steep slopes	m^3	11,045.62
6	Excavation of material for replacement	m^3	264,289.89
7	Construction of embankment from material obtained from cutting in route V-VI category or from a borrowed area	m^3	384,672.90
8	Arrangement of the foundation ground (sub-soil)	m^3	406,822.19
9	Construction of shoulders with small stones width 1.5 m	m^3	23,705.00
10	Construction of shoulders with small stones width 1.0 m	m^3	4,014.00
11	Construction of shoulders with small stones width 50 cm	m^3	97.00
12	Construction of stabilized banquettes behind drain channels	m^3	9,929.00
13	Placing humus on green divisional area and island	m^2	74,209.00
14	Vegetative protection of slopes, embankments and cuttings by placing humus and planting grass	m^2	129,673.22
15	Vegetative protection of slopes, embankments and cuttings with hydro-sawing	m^2	120,167.56

Quality control

Before and during work, all changes in the excavation, or the quality of soil materials, should be taken suitable samples for testing the usability of the materials for the purpose for which they will be used. Approval must be obtained from an authorized institution regarding the usability of materials that will be able to be used for the reconstruction of this traffic road.

The quality control of the materials for installation shall be executed according to the valid regulations for quality control of the materials:

- JUS U.B1. 010 - taking samples
- JUS U.B1. 012 - determination of soil moisture

- JUS U.B1. 014 - determination of specific weight
- JUS U.B1. 016 - determination of volume weight
- JUS U.B1. 018 - determining the granulometric composition
- JUS U.B1. 020 - determining the limits of consistency
- JUS U.B1. 024 - determination of combustible and organic substance
- JUS U.B1. 038 - determining the optimal water content.

Determination of the content of organic and combustible materials, as well as the application of soil volume will be done only in case of suspicions materials.
The regulation according to which the quality control of embedding layers of the embankments by the method is performed by the test plate is tested, the modulus of compressibility of layers of dykes is examined for every 50-100 m.

3.18. Disposal on the land

All quantities of extracted material and rock mass, as envisaged in the Main Design, are deposited at landfills near the road.
If this type of landfill is not allowed, the total amount of surplus of excavated material and rock mass will be transported to the landfill in accordance with the approval of the local authorities of Podgorica and Danilovgrad.

3.19. Radiation

Works envisaged by the design, nor the technical solutions to be used for the safe traffic do not produce radiation that would threaten traffic participants or the environment in the immediate vicinity of the road in question.

3.20. Overview of types and quantities of waste materials, noise levels and vibrations emitted during the exploitation stage of the relevant traffic road

This chapter provides an overview of the types and quantities of gases, liquid and solid substance emitted by motor vehicles in a regular process of traffic, including discharges into surface and groundwater, landfill and noise, vibration, heat and ionizing and non-ionizing radiation.

Due to the adopted immission modelling methodologies, it is appropriate to divide the emissions from these sources into three groups:

- gaseous substances,
- solid and liquid phase,
- noise.

From the aspect of time character of emission, pollution in the wider sense can be permanent, seasonal and accidental.

Continuous (systematic) pollution is primarily related to the volume, structure and characteristics of the traffic flow, the characteristics of the road and the climatic conditions. As a result of traffic flow, permanent emissions of harmful substances into the atmosphere, on the pavement surface and the surrounding environment are formed - soil, surface waters, vegetation and other objects. cross-section profiles that wash off during precipitation.

Seasonal pollution is related to a certain period of a year. A typical example of this type of pollution is the use of salt to maintain the road during winter months. This type of pollution is characteristic of the fact that in a very short period of time, which involves spreading salt on carriageways and solubilisation, there are large concentrations of sodium and calcium chloride. Due to the location of the route of the road in question, these pollution can be ignored.
Accidental pollution is most often due to the transport of hazardous materials.

Most often, we are talking bout about oil and its derivatives, although it is not uncommon for vehicles to transport very dangerous chemicals that are liquid or easily volatile. What is a special problem in this case is the fact that these are almost instantaneous very high concentrations that cannot be predicted temporarily or spatially. Consequently, often very wide areas, most common water supply areas, but often also superficial waters of high category, as the most risky places on the roads in the mentioned sense, must be protected from the point of view of protection.

In addition to the noise, due to its intangible nature, and easily volatile substances that remain permanently in the atmosphere, other substances, depending on the numerous environmental conditions, they eventually go to the soil, surface and ground waters or accumulate in the living tissues of the living organisms. Due to the stochastic nature of these processes, it is very difficult, with a satisfying reliability, to predict the changes that pollutant emissions cause in living and non-living elements of the ecosystem, and what is the ultimate goal of such research in humans. Regardless of the above-mentioned views, the presentation of the types

and quantities of discharged materials is the starting point for the approximate quantification of the effects of traffic flows on ecological potentials.

Gaseous substances

Emissions of pollutants that are permanently retained in the atmosphere form as a product of combustion of fuels in motor vehicle aggregates. Although vehicles in exhaust gases emit about 200 different substances, only those that are legally sanctioned and whose concentrations are monitored in the environment are analysed.

Liquid and solid phase

In the regular exploitation phase, emissions of solid and liquid particles can be expected due to the following processes: fuel, oil and lubricant leaking, settlement of exhaust gases, tire wear, wear of the construction, vehicle body degradation and cargo decay, spillage and rejection of organic and inorganic waste. As far as the chemical composition of these materials is concerned, it is primarily concerned with fuel components such as hydrocarbons, organic and inorganic carbon, nitrogen compounds (nitrates, nitrites, ammonia). A special group of elements represents the so-called heavy metals such as lead (fuel additive), cadmium, copper, zinc, mercury, iron and nickel. A significant part is the solid substance of different structures and characteristics that occur in the form of precipitated, suspended or dissolved particles. It is also possible to register substances that are result of the use of specific corrosion protection materials. Another group of very carcinogenic materials is polyaromatic hydrocarbons (benzopyrene) which are the product of incomplete combustion of fuel and used engine oil.

Traffic noise

Noise, as the most important intangible source of pollution in road traffic, is of a very complex origin and has a stochastic character. The level of noise in the moving vehicle is the result of a collection of a number of factors, of which the most significant are the following:

- exhaust system,
- the suction system of the vehicle,
- engine - combustion and mechanical noise of aggregates,
- cooling system,
- contact tire - carriageway surface,
- air resistance.

The characteristic noise levels for vehicles per category are given in the following table.

Table 3.20/1. *Characteristic noise levels for vehicles per category*

Type of vehicle	**Middle level of noise dB(A)**	**Noise level interval dB(A)**
Passenger's vehicle up to 1100 cm^3	70	67 - 75
Passenger's vehicle up to 1600 cm^3	71	67 - 75
Passenger's vehicle over 1600 cm^3	72	68 - 77
Delivery vehicle	73	68 - 77
BUS, cargo vehicle	81	76 - 86

The calculated traffic noise levels during traffic flows on the section of the main road are given in chapter 6.2.2.

Vibrations

Vibration, as one of the criteria that characterizes the relationship between the road and the environment, is a consequence of the oscillatory movement of vehicles in the course of road traffic. Vehicle oscillations that occur as a consequence of movement through the unevenness of the carriageways cause the appearance of vertical dynamic reactions on the contact surface of the tire and pavement that are vibration generators in the ground, which extend most in the form of surface waves causing negative effects on people and objects. Generated vibrations are essentially the result of the vibration of three main systems that can be described as:

• vehicle system as a whole whose own frequencies, depending on the vehicle type, range from 1-10 Hz,
• system of elastic hanging masses (wheels, shafts ...) with own frequencies of 10 - 20 Hz,
• a system of individual constructive circuits that oscillate at much higher frequencies.

The basic nature of the vibrations generated by road traffic gives the vibrations caused by the oscillatory movement of the vehicle as a whole. Three types of wave motion realize the propagation of these vibrations essentially. Surface (Raleigh) waves that account for about 70% of the total energy, scattering waves to which

about 25% of the energy and compression waves spread through the soil and which accounts for about 5% of the energy.

3.21. Overview of the treatment technology (processing, recycling, disposal, etc.) of all types of waste materials

In the section of the main road M-18, which is intended for reconstruction in the stretch from the Komanski ski most in Podgorica to the roundabout in Danilovgrad, for the disposal of surplus material, temporary locations along the road are planned, from which all the surplus material will be transported to the locations defined by local governments of Podgorica and Danilovgrad.

The waste generated in the process of executing construction works on the reconstruction of the relevant section of the main road M-18 shall be handled by the Contractor, in accordance with the procedures defined in the Plan for the management of construction (non-hazardous) waste and the Hazardous Waste Management Plan, which it is obliged to perform in accordance with the Law on waste management (Official Gazette of Montenegro 64/11, 39/16).

Through the development of the aforementioned waste management plans, the Contractor is obliged that all types of waste materials are to be handed over to the authorized enterprises with which they will be obliged to sign the Contract on taking over the waste material. Plans for managing non-hazardous construction waste and hazardous waste are not the subject of this study.

4. DESCRIPTION OF REVIEWED ALTERNATIVES

According to the plans of the Spatial Plan of Montenegro until 2020, and the guidelines from the Spatial-Urban Plan of the City of Podgorica, by 2025, the project owner planned the reconstruction of the existing main road M-18, the Podgorica-Danilovgrad section. Based on the aforementioned planning documents, the Ministry of Sustainable Development and Tourism, i.e. the Directorate for Civil Engineering, on 11.08.2014, has issued the urban-technical conditions number 0503-1660/11.
The project documentation has elaborated in detail all the phases of project implementation with the application of appropriate technical and technological solutions for the construction of facilities for this purpose.

Location-route. Considering that the project owner received the urban-technical conditions for the subject route, through the reconstruction of the existing main road M-18, the Podgorica-Danilovgrad section, no alternative solutions were considered, except in the part of the possibility of realization of the reconstruction, which will be executed in accordance with the conditions in the field and near the existing facilities partially from the left and to the right side of the existing main road. The position of the planned route is defined through the Main Design, so that it meets the conditions for the intended purpose, whereby they must meet the conditions and standards in terms of environmental protection.

Production processes or technology. The project of reconstruction of the existing main road M-18, the Podgorica-Danilovgrad section (from the Komanski ski most to the roundabout in Danilovgrad) was defined through urban-technical conditions, where materials were selected in the technological sense that fully meet the criteria necessary for safe operation of traffic.

Type and selection of materials for the execution of the project. Through the Main Design, materials that will be used in the execution of works are defined. Standard materials are used for the execution of this type of project, and the Main Design did not process variant solutions for the use of other materials.

Timeframe for the execution and termination of the operation of the project. It was established that 624 working days or 24 calendar months are required for the construction of the object, from the day the contractor was introduced to work. Namely, the termination of the functioning of the project, due to its purpose, is not planned, so that any possible change in the area will include the subject area (route) from the perspective of possible environmental impacts in a separate study on the removal or modification of spatial planning documentation.

Treatment of atmospheric waters. When it comes to the treatment of atmospheric water from the carriageway, it is envisaged that the atmospheric waters are taken to collectors of atmospheric sewage with drains, drain channels, and then into gravity separators of oil derivatives with bypass, precipitators and coalescence filters that provide water purification according to the standards SIST-EN 858 -1. This solution has been selected to eliminate soil contamination, as atmospheric waters in the separators are purified.

Disposal of waste including recycling, reuse, and final disposal. The project envisages that construction waste is deposited at a municipal landfill in Podgorica. Occasional landfills used for the construction of a future roadway will be

organized along the route of the existing road, at all sites where excavations are made and the embankments are expanded, as defined by the Main Design.

Removal of the project and bringing the site to its original state. Namely, the termination of the functioning of the project, due to its purpose, is not planned, so that any possible change in the area will include the subject area (route) from the perspective of possible environmental impacts in a separate study on the removal or modification of spatial planning documentation. The project life of use of the main road is in accordance with the rules of the profession and standards, after which it is necessary to renew it.

Responsibility and procedures for environmental management. During the implementation and functioning of the project, it is necessary to comply fully with the applicable laws and measures given by this study concerning environmental management at a given site. The Project Holder has the full responsibility for implementation of the given measures and compliance with the applicable laws.

Method of work during the functioning of the project. Functioning of the project is in accordance with the conditions prescribed by the legislation, but on the other hand, it is adjusted to the specifics of the project. Legislation includes certain legal provisions related to different areas in the field of environmental protection.
In order to achieve the objectives of the environmental protection, the functioning of the project in question must be in compliance with all environmental regulations. Based on this, there must be a unique methodological basis with clearly defined steps for analysing these relationships, which arises from the necessity of meeting the basic principles of compatibility, harmonization of the level of analysis and successive information exchange.
In terms of general methodological principles, the Impact Assessment Study has been prepared in such a way that they are previously defined: basics for impact analysis, baseline data, planning and project documentation.

Monitoring During the operation of the project concerned, all measures envisaged to reduce the impact on the environment should be monitored and implemented by an authorized institution. In this respect, it is necessary to define possible environmental impacts and thus assess the effectiveness of the measures envisaged.

5. DESCRIPTION OF ENVIRONMENT SEGMENTS

5.1. Population

As already mentioned the planned route of reconstruction of the existing main road M-18, the Podgorica-Danilovgrad section is almost in the entire length passing through an area that has built objects for both individual housing and business on both sides of the road. However, it should be noted that the construction density is the largest on the section from the Iveco business facility to the roundabout in Danilovgrad. By building the planned road, traffic conditions will be significantly improved, i.e. better traffic flow will occur. Impacts on residents in addition to the existing main road during works will be evident, but these impacts will be significantly reduced after the completion of works and during the exploitation of this section of the road. Namely, the increased noise level during the execution of the works will be reduced during the operation of this road and will exclusively depend on the traffic frequency. This also applies to the emission and immission levels of fuel combustion products, which will also depend on the frequency of traffic.

5.2. Flora and fauna

Flora and fauna along the main road M-18, the section planned for reconstruction from Podgorica to Danilovgrad (Komanski most - roundabout in Danilovgrad) is described in detail in Chapter 2.4.

5.3. Land quality

In order to monitor the state of the land, i.e. to determine the content of hazardous and harmful substances in the land during 2017, sampling and analysis of the land from 33 locations were executed, in 10 urban settlements in Montenegro.
In these samples, the analysis of the possible presence of inorganic substance (cadmium, lead, mercury, arsenic, chromium, nickel, fluorine, copper, molybdenum, boron, zinc and cobalt) and organic substance (polycyclic aromatic hydrocarbons, polychlorinated biphenyls - PCB congeners, organocalic compounds, triazines, dithiocarbamates, carbamates, chlorophenoxy and organochlorine pesticides). Soil samples near the substations were examined for the possible content of PCB congeners and at certain sites of dioxins and furans.

The results of the tests were compared with the maximum allowable concentrations (MAC), normed by the Rulebook on the permitted quantities of dangerous and

harmful substances in the soil and methods for their examination (Official Gazette of the Republic of Montenegro 18/97).
In 2017, in the area of the capital of Podgorica, the sampling was executed in 4 locations:

- Donja Gorica - land near the road,
- Ćemovsko polje - land near the road,
- Srpska, and
- Children's playground (Njegoš's park).

In 2017, as in the previous period, on the territory of Danilovgrad municipality, no testing of hazardous pollutants in the soil was preformed.

Regarding the reconstruction of the existing main road M-18, as for the section from the Komanski ski most to the roundabout in Danilovgrad, it can be concluded that no measurement of the soil quality has been performed in this zone.

5.4. Climate characteristics

Climate characteristics of the section of the main road from Podgorica to Danilovgrad have been described in details in chapter 2.3.

5.5. Air quality

Air quality control and monitoring in Montenegro is done in order to assess, plan and manage the quality of air. The analysis of the obtained results serves as a basis for the proposal of measures for improving and enhancing air quality.
The implementation of the Air Quality Monitoring Program was executed in accordance with the Rulebook on the manner and conditions for monitoring the quality of air (Official Gazette of Montenegro 21/11), which stipulates the method of monitoring the quality of air and data collection, as well as the reference methods of measurement, criteria for achieving data quality, data quality assurance and validation.

Pursuant to Article 7 of the Law on Air Protection (Official Gazette of Montenegro 25/10, 43/15), the Air Quality Monitoring Program in 2017 was implemented by D.O.O. “Centre for Eco toxicological Testing”.

On automatic stationary stations the air quality was monitored in Podgorica, Nikšić, Pljevlja, Bar, Tivat, Golubovci and Gradina (Pljevlja). The concentrations of the following parameters were measured: sulfur dioxide (SO_2), nitrogen monoxide (NO), nitrogen dioxide (NO_2), total nitrogen oxides (NO_x), carbon monoxide (CO), methane (CH_4), nonmethane hydrocarbons (NMHC), total hydrocarbons (THC), PM10 particles, terrestrial ozone (O3), benzene, toluene, ethylbenzene, o-m-p xylene (BTX).

Air quality assessment was executed in accordance with the Decree on determining the type of pollutants, limit values and other air quality standards (Official Gazette of Montenegro 45/08, 25/12).

Pursuant to the Regulation on the Establishment of a Network of Air Quality Monitoring Points (Official Gazette of Montenegro 44/10, 13/11), the territory of Montenegro has been divided into three zones, which are determined by the preliminary assessment of air quality in relation to the boundaries of the assessment of pollutants based on available data on concentrations of pollutants and modelling of the existing data. The boundaries of air quality zones coincide with the external administrative boundaries of municipalities located within these zones. The area of Podgorica belongs to the Southern zone where air quality improvement is necessary, and the Danilovgrad Municipality belongs to the Air Quality Maintenance Zone.

In Podgorica, air quality measurements were made at the automatic stationary station "NOVA VAROŠ" located at Bulevar Sv. Peter Cetinjski.

In 2017, the Capital city of Podgorica has executed indicative measurements of air quality at 6 locations (during two measurement cycles) by conducting local monitoring:

- At the mall DELTA CITY
- Bul. Ivan Crnojević, close to the Pension and Disability Fund building
- The city centre of Tuzi
- City centre ofGolubovci
- Crossroads of Kralja Nikole Street and Crnogorskih serdara
- Zagorič - Piperska Street

In 2017, as in the previous period, on the territory of the Danilovgrad municipality there were no measurements of concentrations of pollutants in the air.

The basic network (so-called semi-automatic stations) of air quality monitoring executed by the Hydro-meteorological Institute (HMI) comprises 15 stations, one of which is located in Danilovgrad. The content of sulphur dioxide in the samples is usually very low, mostly below the detection limit of the method used. The maximum values of this pollutant were recorded during the summer time, indicating the impact of the emissions from traffic. Low values of smoke content were measured. The maximum values of these particles were recorded during the colder part of the year, indicating the existence of the effect of the heating emission (*Source: Local Environmental Protection Plan of the Municipality of Danilovgrad*).

According to all of the above, it can be noted that on the section of the main road from the Komanski ski most to the roundabout in Danilovgrad, no air quality measurements were made.

5.6. Water Quality

5.6.1. Water quality of the River Zeta

The Zeta is sampled at 4 measuring points and according to the classification of its water should belong to the A_1SK_1 class upstream from Brezovik (Vidrovan), and downstream from Brezovik to the confluence of Morača A_2CK_2 class (Duklov most, Danilovgrad and Vranjske njive).

The waters of the measured profile Vidrovan should be in the high-required level, and as this part of the Zeta passes through the settlement and is exposed to anthropogenic influence, this condition is disturbed, especially at low water levels. This year, there were 68.8% of the classes in their required bonitet, and 3.1% of the classes were HC (Ca/Mg ionic ratio). The content of ammonia, detergents and phosphate belonged to the A3 class, while the temperature and contents of TOC and e-coli bacteria in the A2 class.
Going further, the quality of water of the Zeta River is changing, at the measuring point at Duklov most, 62.4% of the classes were in their class, and 18.8% of the HC, by Ca/Mg ratio and by the content of nitrite, TOC and a number of faecal bacteria (class W). This is the most polluted profile on the Zeta River.

In the lower stream of the Zeta, after it sinks, and receiving water from the hydroelectric power plant and other tributaries, the quality of water is improving, the Danilovgrad profile was 71.9% in its class, and 12.5% out of its class, and on the profile of Vranjske njive 81, 3% in its class, 6.2% were out of their class. It is

important to note that the contents of any and faecal bacteria in relation to the class of drinking and bathing water classes at the Duklov most – Vranjske njive were in the prescribed A_2K_2 class.

Data on the quality of the Zeta River for 2017 for the measuring profile of Danilovgrad were taken from the Ecological Yearbook VIII-17 of the Institute for Hydrometeorology and Seismology of Montenegro.

Table --- *The Zeta River Class Quality Classes - the Danilovgrad measurement profile in 2017*

Parameter	**Class found**
pH	A
Elect. cond.	A_1
Ca / Mg ratio	VK
Suspen. substance	A, S
Turbidity	A_1
Temp.	A_2
% Sat.	A_2
O_2	S, Š
BOD_5	A
COD	A_2
Iron	A_1
Ammonia	A_3, C
Chlorides	A
Sulphates	A
Phosphates	VK
Nitrates	A_1
Nitrite	A_3, C
TOC	A_3
Phenols	A_2, C
Detergents	A_3
Total e-coli	A_2, C, VK, K_2
Faecal germs	A_2, VK, K_2

Note: required classes for the presented measurement profile are: A_2, C, K_2

Table -- *Relevant values of the parameters of the quality of the Zeta River - measuring profile of Danilovgrad in 2017 (date of measurement 16.05-21.11)*

Parameter	**Value**
$T_{H2O}{}^oC$	9.5-16.0
$T_{VAZ}{}^oC$	5.0-21.0
pH	8.0

Turbidity	1.61
El. cond. µS/cm	373
dry remain mg/1	255
sus.mat. mg/1	4
O_2 mg/l	8.8
sut. O_2 mg/l	89
BOD_5 mg/l	1.4
COD mg/1	2.2
TOC mg/l	2.02
HCO_3^- mg/l	274
hardness H^o	11.5
Ca^{2+} mg/l	72.3
Mg^{2+} mg/l	6.3
Ca^{2+}/ Mg^{2+}mol	6.89
Na^+ mg/l	5.5
K^+ mg/l	2.5
Fe^{2+} mg/l	0.02
NH_4^+ mg/l	0.15
Cl^- mg/l	7.0
SO_4^{2-} mg/l	8.4
PO_4^{3-} mg/l	0.34
NO_3^- mg/l	15.00
NO_2^-mgN/l	0.006
TN mg/1	3.37
fenols mg/l	0.003
deterg. mg/l	0.024
aer.-live bact. on 1 ml	313
Total amount of e-coli on 100 ml	2885
Total faecal bacteria on 100 ml	690

5.7. Landscape and Topography

From the aspect of topography, the envisaged part of the route can be characterized as a flatland, with a small part of the hilly region.

5.8. Existing and Infrastructure Objects

Of the existing objects, the largest numbers of them are individual residential buildings, among which the ground floor objects are prevalent, followed by one-storey objects, and some of them have the attic as well.
In addition to housing objects, there are a number of facilities intended for business, ranging from those that are catering-hospitality type, to those that are have warehouse, service or production character. It should be noted that on this

section, whose reconstruction is planned on the left and right sides, there are two gas stations as well.

The main infrastructure facility is the Main Road M-18, which is the main road and connection with Nikšić and where a significant part of the traffic towards this part of the north of Montenegro is taking place, as well as towards Bosnia and Herzegovina. Considering the fact that the cross section of the section in question is 2 x 3.5 m, and since the traffic frequency from Podgorica towards Danilovgrad and Nikšić is growing every day, it suffices to say that its transmission capacity is small and does not meet the reached traffic flows, and that its reconstruction is inevitable.

5.9. Immovable cultural property and protected natural property

Based on the examination of the available data for the area of the route itself, which includes the reconstruction zone, there is no data that there are immovable cultural properties and therefore no protected natural properties as well.

6. DESCRIPTION OF POSSIBLE SIGNIFICANT IMPACTS

Any works, of smaller or larger scale, may affect the environment. Their influence may be of a temporary or durable nature arising during the execution of works, exploitation of the designed procedure or in the event of an accident.
In this particular case, special attention is paid to possible effects on: air, water and land, as well as population, flora, fauna, etc.

6.1. IMPACT DURING EXECUTION OF WORKS

Possible impacts on the air are examined, as already mentioned, on the impacts during the construction of the planned operation and during its use or exploitation.

6.1.1. Impacts on air during execution of works

6.1.1.1. Drilling and mining

The most important “mining works” will be performed in the construction of the cuttings. This type of work, it could be said, is executed in two basic stages: selection and opening of cuttings, and then execution the drilling and mining.

Technology of mining wells

Successfulness of mining the mining fields and its performance is largely dependent on the mining well technology. The extent of rock mass dissipation is directly dependant on diameter of the mine well.

- Drill hole drilling mines ..... $\alpha = 75^{o}$
- Drilling speed ..... 20.0 m / h
- Drilling diameter ..... f = 89 mm
- Drilling depth ..... 2 m, 4 m, 6 m, 8 m and 10 m

Drilling of mine wells, minefield production on this route, and appropriate emission and concentration calculations, were made for Atlas Copco ROC F6 pneumatic and hydraulic impact-rotary drill. The drill is diesel-hydraulic with a "COP-32" drill hammer.

The characteristics of the drill rig relevant for the calculations of the duration of the borehole and emission of pollutants during its work are:

- drill diameter is 85-100 mm.
- drilling depth 36 m
- drilling performance 20 m/h
- Atlas Copco compressor, working pressure 14 bar, capacity 213 l/s or 12.78 m3/min.
- Fuel consumption 1 l/h
- machine for blowing off dust, DCT 1810 for BBC100F, filter surface of 14 m^2
- The dust particle concentration at the output from the filter unit, the guarantee of the equipment manufacturer, is 20 mg/m^3.

Mining technology

In order to successfully execute mining, and to have certain granulometric composition of the sealed material, and to gain control of the accompanying mining effects, it is necessary to agree: control of the energy of the explosive for the required granulometry of the mined material, the spatial distribution of energy in the mines field and the time schedule for the activation of the explosive energy in the mass, defined by the initiation scheme and the slowdown times.

The mining will take place with cartridge-type AMONEKS-1 type dust explosives or similar. The initiation of an explosion is executed with a Nonel system in combination with a detonating cord.

General characteristics of selected explosive devices:

- Type of explosives AMONEKS-1
- Gas volume .....955 dm^3/kg
- Cartridge diameter (f) ..... 70 mm
- Cartridge length (lp) 28-31cm
- Cartridge Weight (Gp) ..... 1000 g
- Pattern cover ..... PE hose

The average explosive charge used is 1.05 kg/dm³, the amount of explosive per meter of the borehole is 3.3 kg, the minimum resistance line is 2.0 m, the distance between the borehole in a line is 2.5 m, the distance between the rows of boreholes 2.0 m, the number of boreholes is 1 (at 2 m from the edge of the slope), piercing of the level is 0.3 m.
The depth of mine wells depends on the height of the level (height of the ground) intended for drilling and mining. As the size of this entire route changes, this will change the depth of mine wells as well.
For this level of design preparation, we have processed five types of minefields, i.e. five work zones that can be combined with each other depending on the field conditions.
For calculations for mining well technology and mining technology, literature was used (*Purtić N. 1991: Drilling and mining, Belgrade. Trajković S., 2005: Blasting and Quarrying Technique, Belgrade.)*

Zone I

Zone I covers a 2 m wide field, 10 m long and an average height of 2 m.
The mining parameters are as follows:

- borehole length: 2 m
- floor length: 0.3 m
- total length of borehole: 2.3 m
- drilling angle: 75^0 (4: 1)
- mined mass per single borehole: V = 10 m^3
- total length of borehole plug length: Lc = 0.8 m
- total length of the explosion filling pile: L_p = 1.5 m
- total amount of explosives in the borehole: Q_e = 5 kg (5 cartridges)

- specific consumption of explosives: q = 0.5 kg/m^3
- required number of boreholes for one mining is 4 (one mining covers a surface of 2 m x 10 m)
- total drilling length for one mining: 9.2 m
- required amount of explosives for one mining: 20 kg
- mining deceleration interval in queue is 25 milliseconds.

With this kind of connection, one mining requires 4 Nonels of 10 m with two detonators with 500 ms decelerations.

Zone II

Zone II encompasses a field of 2 m wide, 10 m long and an average height of 4 m. The mining parameters are as follows:

- borehole length: 4 m
- floor length: 0.3 m
- total length of borehole: 4.3 m
- drilling angle: 75^0 (4: 1)
- mined mass per borehole: V = 20 m^3
- total length of borehole plug length : Lc = 1.4 m
- total length of the explosion filling line: L_p = 2.9 m
- total amount of explosives in the borehole: Q_e = 10 kg (10 cartridges)
-specific consumption of explosives: q = 0.5 kg/m^3
- the number of boreholes required for one mining is 4 (one mining covers a surface of 2 m x 10 m)
- total drilling length for one mining: 17.2 m
- required amount of explosives for one mining: 40 kg
- mining deceleration interval in queue is 25 milliseconds.

With this kind of connection, one mining requires 4 Nonels of 10 m with two detonators with 500 ms decelerations.

Zone III

Zone III encompasses a field of 2 m wide, 10 m long and an average height of 6 m. The mining parameters are as follows:

- borehole length: 6 m
- floor length: 0.3 m
- total length of borehole: 6.3 m
- drilling angle: 75^0 (4:1)
- mined mass per single well: V = 30 m^3
- total length of borehole plug length: Lc = 1.8 m
- total length of the explosion filling line: L_p = 4.5 m
- total amount of explosives in the borehole: Q_e = 15 kg (15 cartridges)

- specific consumption of explosives: q = 0.5 kg / m^3
- the number of boreholes required for one mining is 4 (one mining covers a surface of 2 m x 10 m)
- total drilling length for one mining: 25.2 m
- required amount of explosives for one mining: 60 kg
- mining deceleration interval in queue is 25 milliseconds.

With this kind of connection, one mining requires 4 Nonels of 10 m with two detonators with 500 ms decelerations.

Zone IV

Zone IV encompasses a 2 m wide field, 10 m long and an average height of 8 m.

The mining parameters are as follows:

- borehole length: 8 m
- floor length: 0.3 m
- total length of borehole: 8.3 m
- drilling angle: 75^0 (4:1)
- mined mass per single borehole: V = 40 m^3
- total length of borehole plug length: Lc = 2.2 m
- total length of the explosive charge length: L_p = 6.1 m
- total amount of explosives in the borehole: Q_e = 20 kg (20 cartridges)
- specific consumption of explosives: q = 0.5 kg/m^3
- the number of boreholes required for one mining is 4 (one mining covers a surface of 2 m x 10 m)
- total drilling length for one mining: 33.2 m
- required amount of explosives for one mining: 80 kg
- mining deceleration interval in queue is 25 milliseconds.

With this kind of connection, one mining requires 4 Nonels of 10 m with two detonators with 500 ms decelerations.

Zone V

Zone V comprises a field of 2 m wide, 10 m long and an average height of 10 m.
The mining parameters are as follows:

- borehole length: 10 m
- floor length: 0.3 m
- total length of well: 10.3 m
- drilling angle: 75^0 (4:1)
- determined mass per single well: V = 50 m^3
- total length of borehole plug length: Lc = 2.6 m

- total length of the explosion filling line: L_p = 7.7 m
- total amount of explosives in the well: Q_e = 35 kg (35 cartridges)
- specific consumption of explosives: q = 0.5 kg / m^3
- the number of boreholes required for one mining is 4 (one mining covers a surface of 2 m x 10 m)
- total drilling length for one mining: 41.2 m
- required amount of explosives for one mining: 140 kg
- mining deceleration interval in queue is 25 milliseconds.

With this kind of connection, one mining requires 4 Nonels of 10 m with two detonators with 500 ms decelerations.

As already mentioned, drilling is performed according to a particular scheme. After drilling, filling of mining boreholes with explosives is preformed, then connection, and mining. For the limestone mining, a patronized ammonium nitrate TNT powder explosive of type AMONEX-1 will be used.
The following data were used for the calculation of emission and concentration of harmful components that occur during mincing: minefield length, minefield field width, minefield surface, number of rows of boreholes in minefield and number of boreholes in a queue, distance between boreholes in queue, distance between the rows of boreholes, the total number of boreholes in the minefield, the total length of drilling for one mining, the lowest resistance line, the length of the boreholes, the quantity of explosives per well and the required quantity of explosives.
The dust emission, when drilling the mining boreholes, depends on the way and speed of drilling, the diameter of boreholes and the mechanical characteristics of the rocks.
In the specific case, the determination of the dust emission at drilling of mine boreholes described above, the following expression is used:

$E = Q_v(N_{izl.} – N_p)$, mg/s, ...(1)
where:
E - Dust emission at drilling (mg/s)
Q_v- Capacity of the aspiration device (m^3/s)
N_{izl} - Concentration of dust at the outlet pipe (mg/m^3)
N_p - Natural dust background in the atmosphere (mg/m^3)

It is known that when blasting, on the surface of the terrain, a cloud occurs when the gases formed as the chemical product of the activation of explosives and the dust resulting from the crushing of the rock mass. These blasting products are harmful and toxic to the living world in the area.

During detonation of explosives and explosive mixtures there is a rapid change in the state of the unstable chemical components of explosives and their transition to more stable detonation oxides that occur in all three aggregate states, most often in the form of gases and dust.

Which products, when mining, will appear depends on:

- the chemical composition of the components of which the explosive consists of
- ways of patronizing, packaging of explosives and chemical composition of packaging
- the method of initiation and flow of chemical reactions, decomposition of explosives which depends on initiation, rock solidity, mining techniques, age of explosives, temperature of surrounding rock mass, humidity, etc.
- the chemical composition of the rock mass that is mined and the content of substance in them that could enter into a chemical reaction with the blasting products or with the explosive itself.

When blasting, as it is said, a certain amount of gases is generated. The average amount of gases produced during mining is about 1000 dm3/kg of explosives. In these gases there are toxic gases such as carbon monoxide, nitrogen oxides, sulphur dioxide, etc., which depends on the composition of explosives, the type of rock mass, that is, its mineralogical and chemical composition.

By blasting on the surface of the ground, or after an explosion (detonation), a cloud of gases and dust is formed, which can pollute the wider area of the mining site by the wind blowing.

It should be emphasized that 50% of the gases reach the atmosphere in the explosion detonation, 20% is absorbed by the rock mass, while the remaining 30% are lagging behind in the pores and cavities of decayed rock mass from which it is distinguished during its loading and trans-shipment.

The initial volume of the “cloud” composed of blasting, gas and dust products is increased due to the detonation temperature of the explosive ”T” and is calculated by the expression:

$$V_t = b \cdot \frac{T}{273} \cdot A; \text{.....(2)}$$

where:

V_t – Cloud volume (dm^3)

A - Amount of explosives in the minefield (kg)

b - Amount of gases released when detonating one kilogram of explosive.

T - Temperature of gaseous products after blasting (K^0)

The initial amount of poison gas in the cloud of gaseous mining products is calculated according to the form:

$$Q_{ig} = \frac{A \cdot V_{ig}}{1000}; (m^3) \text{.....3}$$

where:

Q_{ig} - The initial amount of gas in the "cloud" of gaseous products

A - Quantity of explosives (kg)

V_{ig} - The amount of gases released during the detonation of 1 kg of explosives

The concentration of i-th gas, in volume percentages, in the "cloud" of gaseous mincing products is obtained forms the expression:

$$C_{ig} = \frac{A \cdot V_{ig}}{Vt} \cdot 100\%; \text{.....(4)}$$

where:

C_{ig}- Concentration of a gas expressed in volume percentages in the "cloud" of gaseous mining products

A - Amount of explosives in a minefield

V_{ig} - Quantity of gases at detonation of 1 kg of explosive

V_t - The initial volume of "clouds"

Emission of gasses during mining is determined based on expression:

$$E = \frac{d \cdot Vig \cdot A \cdot \rho}{t_f} kg/s; \text{.....(5)}$$

where:

d - coefficient for a part of the gases and dust that are lifted up in the air

V_{ig} - volume of " i_{te}" quantities of gas in the form of gaseous mining products (m^3)

A - quantity of explosives at one mining (kg)

ρ - density of gases (kg/m^3)

t_f - actual mining time (s)

The total amount of dust, which is lifted by the cloud of gaseous mining products due to detonation of explosives, is the emission of dust during the time interval of the duration of the explosion and is calculated on the basis of the expression:

$$I = \frac{0.149 \cdot a^2 \cdot V_b}{T_f} \text{(kg/s) .....(6)}$$

where:

a = Specific explosive consumption (kg/m^3)
Vb = Mining block volume (m^3)
tf = Duration of explosion (s)

The initial dust concentration is calculated on the basis of the expression:

$$Z = \frac{I}{V_t} (\text{kg/m}^3) \quad .....(7)$$

where:
Z - Initial dust concentration (kg/m^3)
I - Total quantity (emission) of dust (kg/s)
V_t - The initial volume of the cloud (m^3)

6.1.1.2. Estimation of the amount of pollutants during drilling and mining

As has already been stated regarding drilling the mining boreholes, detonation of explosives, loading, transport and unloading of rock material in the external environment, a certain amount of mineral dust, gases caused by detonation of explosives and exhaust gases of machines for loading and transporting the excavated material is emitted.
In the previous section, a division was made to 5 zones, because it is not easy to make a partition for the road in question, which zone will be applied since the height of the cuttings is variable. Therefore, in this section, calculation for all 5 zones will be shown, to show the potential impact of drilling and mining on the environment, since in the immediate vicinity of individual locations there are built individual residential and business objects, which can be seen from the displayed pictures.

Assessment of dust emission during drilling

Drilling of mining boreholes is executed with the Atlas Copco ROC F6 drill. The emission calculation was made for a single drill set and for a 10 m long minefield, 2 m wide and an average depth of drilling for the specific Zone.

Forecast calculations for the first (I) zone (mining)

Drilling of mine wells for this zone by the Atlas Copco ROC F6 drill will produce dust emissions of:
E = 177.76 mg/s

Detonation of the explosive of carbon monoxide and nitrogen oxide emissions are:

E_{CO} = 0.678 g/s
E_{NOx} = 0.0732 g/s

During detonation of explosives, along with gases in the cloud of detonation, a certain amount of mineral dust was produced by the crushing of rock material. The total amount of dust, which is raised with the cloud of gaseous mining products due to explosion detonation, is the emission of dust during the time interval of the duration of the explosion. The calculation is based on the expression (6) and it is:

I = 24.3 g/s

The initial concentration of dust in the cloud is calculated on the basis of expression (7) and is:

$Z = 1.217\ g/m^3$

Forecast calculations for the second (II) zone (mining)

Drilling of mining boreholes for this zone by the Atlas Copco ROC F6 drill will produce dust emissions of:

E = 220.16 mg/s

Detonation of the explosive of carbon monoxide and nitrogen oxide emissions are:

E_{CO} = 1.3561 g/s
E_{NOx} = 0.1464 g/s

In the detonation of explosives, along with gases in the cloud of detonation, a certain amount of mineral dust was produced by the crushing of rock material. The total amount of dust, which is raised with the cloud of gaseous mining products due to explosion detonation, is the emission of dust during the time interval of the duration of the explosion. The budget is based on the expression (6) and it is:

I = 49.46 g/s

The initial concentration of dust in the cloud is calculated on the basis of expression (7) and is:

Z = 1.220 g/m^3

Forecast calculations for the third (III) zone (mining)

Drilling of mining boreholes for this zone by the Atlas Copco ROC F6 drill will produce dust emissions of:

E = 322.56 mg/s

Detonation of the explosive of carbon monoxide and nitrogen oxide emissions are:

E_{CO} = 2.0341 g/s
E_{NOx} = 0.2196 g/s

In the detonation of explosives, along with gases in the cloud of detonation, a certain amount of mineral dust was produced by the crushing of rock material. The total amount of dust, which is raised with the cloud of gaseous mining products due to explosion detonation, is the emission of dust during the time interval of the duration of the explosion. The calculation is based on the expression (6) and it is:

I = 74.5 g/s

The initial concentration of dust in the cloud is calculated on the basis of expression (7) and is:

Z = 1.2197 g/m^3

Forecast calculations for the fourth (IV) zone (mining)

Drilling of mining boreholes for this zone by the Atlas Copco ROC F6 drill will produce dust emissions of:
E = 424.96 mg/s

Detonation of the explosive of carbon monoxide and nitrogen oxide emissions are:

E_{CO} = 2.7122 g/s
E_{NOx} = 0.2928 g/s

In the detonation of explosives, along with gases in the cloud of detonation, a certain amount of mineral dust was produced by the crushing of rock material. The total amount of dust, which is raised with the cloud of gaseous mining products due to explosion detonation, is the emission of dust during the time interval of the duration of the explosion. The calculation is based on the expression (6) and it is:

I = 1.626 g/s

The starting concentration of dust in a cloud was calculated based on expression (7) and it is:
Z = 1.6263 g/m^3

Forecast calculations for the fifth (V) zone (mining)

Drilling of mining boreholes for this zone by the Atlas Copco ROC F6 drill will produce dust emissions of:

E = 526.33 mg/s

Detonation of the explosive of carbon monoxide and nitrogen oxide emissions are:

E_{CO} = 9.4927 g/s
E_{NOx} = 1.0250 g/s

In the detonation of explosives, along with gases in the cloud of detonation, a certain amount of mineral dust was produced by the crushing of rock material. The total amount of dust, which is raised with the cloud of gaseous mining products due to explosion detonation, is the emission of dust during the time interval of the duration of the explosion. The calculation is based on the expression (6) and it is:

I = 124.1 g/s

The initial concentration of dust in the cloud is calculated on the basis of expression (7) and is:

Z = 8,7302 g/m^3

Calculation of the mean values of emissions of pollutants arising from the drilling and detonation of explosives

For the calculation, the mean value for these five zones, both for the depth of drilling and for the amount of explosives, and consequently for the emission values and calculation of the time required to execute the drilling works as well as the number of drilling machines required was used.
The emission calculation was made for a single drill set, and for a minefield 10 m long, 2 m wide and an average drilling depth of 6.3 m. Drilling of mine wells with Atlas Copco ROC F6 drill will produce dust emissions of:

E = 80.64 mg/s.

The total amount of dust raised with the cloud of gaseous products of detonation of explosives is a dust emission in the time interval of the mining duration (10-40 s). Considering the height of the cloud after the detonation of the explosion and the duration of the explosion in the objects concerned, the concentration of mineral dust is negligible given the increase in speed at altitudes greater than 10 m.

Accordingly, mass emissions of pollutants in the execution of drilling and mining operations are:

CO = 2.03415 mg/s
NO_x = 0.21965 mg/s

Emissions of harmful gases from mining-explosives

Ammonium nitrate dynamites are powdered explosives, in which the explosive base instead of nitro-glycerine makes trotiles containing up to 20%, and contain ammonium nitrate from 60 to 85%. These are non-waterproof explosives, the weakest explosives from the group of dynamites and the least sensitive, so they are the safest to handle and transport.

Mining the rock mass during the construction of the cuttings is a source of air pollution, since due to the composition of the explosives, when activating it in the atmosphere, certain quantities of gases are emitted. The composition and quantity of mining products depends primarily on the type of explosive used, that is, the oxygen balance and the amount of explosives used in the minefield.

Industrial explosives will be used for mining. The decomposition of ammonium nitrate occurs according to the formula:

$2NH_4NO_3 \rightarrow 2N_2 + 4\,H_2O + O_2$

Basically, ammonium nitrate explosives represent a mixture of granulated porous ammonium nitrate and fuel oil in a particular ratio: 94% ammonium nitrate, which has the role of oxidizing and 6% diesel fuel. The stoichiometric ratio is 94.5% AN and 5.5% of the fuel oil, but a ratio of 94: 6 is applied to provide a complete chemical reaction of ammonium nitrate:

$3NH_4NO_3 + CH_2 \rightarrow 7H_2O + CO_2 + 3N_2$

Explosion products are toxic, but CO and NO2 occur in very small quantities.

Vibrations-seismic earthquakes caused by detonation of explosives

During explosion detonation, sudden energy is being released, which is consumed by crushing the rock mass, breaking up the fragmented mass, warming the immediate environment as well as creating seismic waves.
The energy of seismic waves is manifested in the form of oscillation of soil or earthquake. Earthquakes have a weaker or stronger intensity, which depends on the distance and the amount of explosives activated in a single time interval. In addition, the intensity of the earthquake depends on the method of mining, the physical-mechanical properties of the soil and the characteristics of the damping of seismic earthquakes.
The seismic oscillations of soil caused by blasting are very similar to earthquake-induced oscillations, and the difference between them is manifested mainly in time and duration of oscillation. In the event of an earthquake, oscillations that last for a long time and have the duration of the oscillation period from 0.5 to 5s, while in the mining, the oscillation length is significantly shorter and ranges from 0.004 to 0.25s.
To assess the seismic effect, nowadays the most commonly used is Mercalli-Cancani-Seiberg (MSC) scale, which contains 12 seismic degrees, is used to assess the shaking of the earth due to earthquake. As can be seen from the following table, damage to buildings is not expected for earthquakes whose intensity is less than the V^{th} degree of the seismic scale.

Table 6.1.1.2/1. *Mercalli-Cancani-Seiberg (MSC) scale*

Speed of ground oscilaiton (cm/s)	**Level of seismical intensity**	**Description of seismic activity**

	I	The earthquake is felt only by instruments (measurement)
0.2-0.4	II	The earthquake felt only in some cases in complete silence
0.4-0.8	III	The earthquake felt only by a small number of people or those expecting it
0.8-1.5	IV	The earthquake felt by many people, clatter of window glass is heard
1.5-3.0	V	Decay of lime from plaster, damage to buildings in poor condition
3.0-6.0	VI	Cracks in plaster occur, damages in objects which already have permanent deformations
6.0-12.0	VII	Damage to buildings in good condition, cracks in plaster, parts of plaster fall off, fine cracks in the walls, cracks in wall stoves, collapse of chimneys
12.0-24.0	VIII	Significant damage to buildings, cracks in the supporting structure and walls, bigger cracks in the partition walls, factory chimneys fall, ceilings colapse
24.0-48.0	IX	Collapsing of objects, larger cracks in walls, walls are splitting into layers
Greater than 48	X-XI	Great destruction of objects, whole objects are collapsing

6.1.2. Immission concentrations of pollutants during execution of works

As already stated in the design description, when reconstructing the existing main road M-18, the Podgorica-Danilovgrad section, the said mechanization will be used. The imission values of pollutants from mechanization, which will be engaged in the execution of works on this section, are shown in the following tables, although it should be noted that directions and the wind speeds for Podgorica were used in the tables.

Table 6.1.2/1. *Immission concentrations of pollutants from exhaust gases when operating the bulldozer CAT D8H*

Distance from the place of the immision	***Immision concentration (μg/m^3), during wind from E, V=1.5m/s***			***Immision concentration (μg/m^3), during wind from SE, V=1.9m/s***			***Immision concentration (μg/m^3), during wind from S, V=2.4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	552	29.93	315.43	436.19	23.65	249.25	345.31	18.72	197.32
20	1079.2	58.51	616.69	852.02	46.19	486.87	674.51	36.57	385.43
25	1230.9	66.73	703.37	971.77	52.68	555.30	769.31	41.71	439.61
30	1171.4	63.51	669.37	924.82	50.14	528.47	732.15	39.69	418.37
35	1041.3	56.45	595.03	822.13	44.57	469.79	650.85	35.29	371.91
40	902.9	48.95	515.94	712.88	38.65	407.36	564.36	30.60	322.49
45	777.4	42.15	444.23	613.88	33.28	350.79	485.91	26.34	277.66
50	669.9	36.32	382.80	528.93	28.68	302.25	418.74	22.70	239.28

Table 6.1.2/2. *Immission concentrations of pollutants from exhaust gases when operating the loader Volovo L120*

Distance from the place of the immision	***Immision concentration (μg/m^3), during wind from E, V=1,5m/s***			***Immision concentration (μg/m^3), during wind from SE, V=1,9m/s***			***Immision concentration (μg/m^3), during wind from S, V=2,4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	613.9	33.28	350.80	484.65	26.28	276.94	383.6	20.80	219.20
20	1199.1	65.01	685.20	946.69	51.33	540.97	749.4	40.63	428.23
25	1367.6	74.14	781.49	1079.74	58.54	616.99	854.9	46.35	488.51

30	1301.6	70.57	743.77	1027.57	55.71	587.18	813.5	44.10	464.86
35	1157.0	62.73	661.14	913.49	49.53	521.99	713.1	38.66	407.49
40	1003.3	54.39	573.31	792.09	42.94	452.62	627.0	33.99	358.29
45	863.84	46.83	493.62	681.98	36.97	389.70	539.9	29.27	308.51
50	744.43	40.36	425.39	587.7	31.86	335.83	465.2	25.22	265.83

Table 6.1.2/3. *Immission concentrations of pollutants from exhaust gases when operating the lorry MERCEDES BENZ Axor2633*

Distance from the place of the immission	***Immission concentration (μg/m^3), during wind from E, V=1.5m/s***			***Immission concentration (μg/m^3), during wind from SE, V=1.9m/s***			***Immission concentration (μg/m^3), during wind from S, V=2.4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	552	29.93	315.43	436.19	23.65	249.25	345.31	18.72	197.32
20	1079.2	58.51	616.69	852.02	46.19	486.87	674.51	36.57	385.43
25	1230.9	66.73	703.37	971.77	52.68	555.30	769.31	41.71	439.61
30	1171.4	63.51	669.37	924.82	50.14	528.47	732.15	39.69	418.37
35	1041.3	56.45	595.03	822.13	44.57	469.79	650.85	35.29	371.91
40	902.9	48.95	515.94	712.88	38.65	407.36	564.36	30.60	322.49
45	777.4	42.15	444.23	613.88	33.28	350.79	485.91	26.34	277.66
50	669.9	36.32	382.80	528.93	28.68	302.25	418.74	22.70	239.28

Table 6.1.2/4. *Immission concentrations of pollutants from exhaust gases when operating the roller LiuGong 6116E*

Distance from the place of the immission	***Immission concentration (μg/m^3), during wind from E, V=1,5m/s***			***Immission concentration (μg/m^3), during wind from SE, V=1,9m/s***			***Immission concentration (μg/m^3), during wind from S, V=2,4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	399.0	21.63	228.00	315.0	17.08	180.00	249.3	13.52	142.46
20	779.4	42.26	445.37	615.3	33.36	351.60	487.1	26.41	278.34
25	888.9	48.19	507.94	701.8	38.05	401.03	555.6	30.12	317.49
30	846.0	45.87	483.43	667.9	36.21	381.66	528.7	28.66	302.11
35	752.0	40.77	429.71	593.7	32.19	339.26	470.0	25.48	268.57
40	652.1	35.35	372.63	514.8	27.91	294.17	407.5	22.09	232.86
45	561.4	30.44	320.80	443.7	24.06	253.54	350.9	19.02	200.51
50	483.8	26.23	276.46	382.0	20.71	218.29	302.4	16.39	172.80

Table 6.1.2/5. *Immission concentrations of pollutants from exhaust gases when operating the bulldozer CAT D8H*

Distance from the place of the immission	***Immission concentration (μg/m^3), during wind from E, V=1,5m/s***			***Immission concentration (μg/m^3), during wind from SE, V=1,9m/s***			***Immission concentration (μg/m^3), during wind from S, V=2,4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	251.1	13.61	143.49	376.7	20.42	215.26	552	29.93	315.43
20	490.5	26.59	280.29	735.8	39.89	420.46	1079.2	58.51	616.69
25	559.5	30.33	319.71	832.2	45.12	475.54	1230.9	66.73	703.37
30	532.4	28.86	304.23	798.7	43.30	456.40	1171.4	63.51	669.37
35	473.3	25.66	270.46	710.0	38.49	405.71	1041.3	56.45	595.03
40	410.45	22.25	234.54	615.6	33.37	351.77	902.9	48.95	515.94
45	353.3	19.15	201.89	530.0	28.73	302.86	777.4	42.15	444.23
50	318.3	17.26	181.89	477.5	25.89	272.86	669.9	36.32	382.80

Table 6.1.2/6. *Immission concentrations of pollutants from exhaust gases when operating the loader Volovo L120*

Distance from the place of the immission	***Immission concentration (μg/m^3), during wind from E, V=1.5m/s***			***Immission concentration (μg/m^3, during wind from SE, V=1.9m/s***			***Immission concentration (μg/m^3), during wind from S, V=2.4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	279.0	15.13	159.43	418.5	22.69	239.14	613.9	33.28	350.80
20	545.0	29.55	311.43	817.5	44.32	467.14	1199.1	65.01	685.20
25	621.6	33.70	355.20	932.5	50.56	532.86	1367.6	74.14	781.49
30	591.6	32.07	338.06	887.45	48.11	507.11	1301.6	70.57	743.77
35	525.9	28.51	300.51	788.9	42.77	450.80	1157.0	62.73	661.14

40	456.0	24.72	260.57	684.0	37.08	390.86	1003.3	54.39	573.31
45	392.0	21.25	224.00	588.9	31.93	336.51	863.84	46.83	493.62
50	338.3	18.34	193.31	507.5	27.51	290.00	744.43	40.36	425.39

Table 6.1.2/7. *Immission concentrations of pollutants from exhaust gases when operating the lorry MERCEDES BENZ Axor2633*

Distance from the place of the immission	***Immission concentration (μg/m³), during wind from E, V=1.5m/s***			***Immission concentration (μg/m³), during wind from SE, V=1.9m/s***			***Immission concentration (μg/m³), during wind from S, V=2.4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	613.9	33.28	350.80	418.5	22.69	239.14	613.9	33.28	350.80
20	1199.1	65.01	685.20	817.5	44.32	467.14	1199.1	65.01	685.20
25	1367.6	74.14	781.49	932.5	50.56	532.86	1367.6	74.14	781.49
30	1301.3	70.55	743.60	887.45	48.11	507.11	1301.6	70.57	743.77
35	1157.0	62.73	661.14	788.9	42.77	450.80	1157.0	62.73	661.14
40	1003.32	54.40	573.33	684.0	37.08	390.86	1003.3	54.39	573.31
45	863.84	46.83	493.62	588.9	31.93	336.51	863.84	46.83	493.62
50	744.43	40.36	425.39	507.5	27.51	290.00	744.43	40.36	425.39

Table 6.1.2/8. *Immission concentrations of pollutants from exhaust gases when operating roller LiuGong 6116E*

Distance from the place of the immission	***Immission concentration (μg/m³), during wind from E. V=1.5m/s***			***Immission concentration (μg/m³), during wind from SE. V=1.9m/s***			***Immission concentration (μg/m³), during wind from S, V=2.4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	181.3	9.83	103.60	272.0	14.75	155.43	399.0	21.63	228.00
20	354.2	19.20	202.40	531.4	28.81	303.66	779.4	42.26	445.37
25	404.0	21.90	230.86	606.13	32.86	346.36	888.9	48.19	507.94
30	384.5	20.85	219.71	576.8	31.27	329.60	846.0	45.87	483.43
35	341.8	18.53	195.31	512.7	27.80	292.97	752.0	40.77	429.71
40	296.4	16.07	169.37	444.6	24.10	254.06	652.1	35.35	372.63
45	255.2	13.84	145.83	382.8	20.75	218.74	561.4	30.44	320.80
50	219.9	11.92	125.66	329.9	17.89	188.51	483.8	26.23	276.46

Table 6.1.2/9. *Immission concentrations of pollutants from exhaust gases when operating drill Atlas Copco ROC F6*

Distance from the place of the immission	***Immission concentration (μg/m³, during wind from E, V=1.5m/s***			***Immission concentration (μg/m³, during wind from SE, V=1.9m/s***			***Immission concentration (μg/m³), during wind from S, V=2.4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	316.4	17.16	180.79	474.6	25.73	271.18	696.2	37.74	397.81
20	618.0	33.51	353.16	927.0	50.26	529.74	1359.8	73.72	777.02
25	704.9	38.22	402.80	1057.5	57.34	604.26	1550.9	84.07	886.21
30	670.9	36.37	383.36	1006.4	54.56	575.06	1476.0	80.03	843.44
35	596.4	32.33	340.78	894.6	48.50	511.21	1312.0	71.14	749.73
40	517.1	28.03	295.49	775.7	42.05	443.24	1137.7	61.68	650.13
45	444.5	24.10	254.02	667.8	36.21	381.60	979.6	53.11	559.77
50	383.6	20.80	219.21	575.5	31.20	328.86	844.2	45.77	482.39

Table 6.1.2/10. *Immission concentrations of pollutants from exhaust gases when operating the concrete mixer MERCEDES BENZ ACTROS 4141B*

Distance from the place of the immission	***Immission concentration (μg/m³), during wind from E, V=1.5m/s***			***Immission concentration (μg/m³), during wind from SE, V=1.9m/s***			***Immission concentration (μg/m³), during wind from S, V=2.4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	681.2	36.93	389.24	538.3	29.18	307.57	426.1	23.10	243.49
20	1331.7	72.20	761.00	1051.4	57.00	600.80	832.3	45.13	475.62
25	1518.9	82.34	867.96	1199.2	65.01	685.24	949.3	51.47	542.48
30	1445.5	78.37	826.00	1141.2	61.87	652.13	903.5	48.98	516.27
35	1285.0	69.66	734.27	1014.5	55.00	579.72	803.1	43.55	458.94
40	1114.2	60.40	636.67	879.7	47.69	502.68	696.4	37.76	397.95
45	959.3	52.01	548.18	757.5	41.07	432.87	599.6	32.50	342.63

50	826.7	44.82	472.38	652.7	35.39	372.98	516.7	28.01	295.27

Table 6.1.2/11. *Immission concentrations of pollutants from exhaust gases when operating the concrete pump MERCEDES BENZ MB 2632*

Distance from the place of the immission	***Immission concentration (μg/m³), during wind from E, V=1.5m/s***			***Immission concentration (μg/m³), during wind from SE, V=1.9m/s***			***Immission concentration (μg/m³), during wind from S, V=2.4m/s***		
	CO	***HC***	***NO_x***	***CO***	***HC***	***NO_x***	***CO***	***HC***	***NO_x***
15	533.8	28.94	305.02	421.8	22.87	241.02	333.9	18.10	190.81
20	1043.6	56.58	596.34	823.9	44.67	470.80	652.3	35.36	372.71
25	1190.3	64.53	680.16	939.7	50.94	536.98	743.9	40.33	425.10
30	1132.7	61.41	647.28	894.3	48.49	511.03	708.0	38.38	404.56
35	1006.9	54.59	575.39	795.0	43.10	454.29	629.4	34.13	359.64
40	873.1	47.33	498.91	689.4	37.37	393.92	545.7	29.59	311.85
45	751.7	40.76	429.57	593.6	32.18	339.21	469.9	25.47	268.50
50	647.8	35.12	370.17	511.5	27.73	292.28	404.9	21.95	231.38

Limit values:
CO: Max. 8h. mean value 10mg/m^3
HC: 1. mean value. 200 μg/m^3, annual mean value 40 μg/m^3
NOx: 1h, mean value 300 μg/m^3, daily mean value 110 μg/m^3

The limit values are taken from the Regulation on the Determination of Types of Pollutants, Limits and Other Air Quality Standards (Official Gazette of Montenegro 25/12).

Based on the presented data of the calculation of the emission concentrations, it can be concluded that the exhaust gases of the construction machinery, either in individual work or in the simultaneous operation of two machines (for example: excavator and lorries, do not produce a concentration whose emissions value exceed the legally limited limit values.
When doing earthworks on the removal of humus and part of the soil replacement material and its loading, dust is emitted. Significant emissions of dust relate to manipulation with the excavated (loading and pushing) or transported material, that is, the unloading of the material for the buffer layer and the manipulation of the material.
Unloading the material (tipping) is done on average for 30s. In this process, according to data from literature, dust is emitted in about 15mg/s. In the next stage of work, a bulldozer or other machine needs to spread this material to a certain location. With this work, there is the possibility of prolonged emission of dust particles, or particle size PM10. In this operation, using bulldozers, about 12.19mg/s of this type of dust is emitted. The emission dust concentrations of PM10, in the most unfavourable conditions, or at winds from: Eastern (E),

Southeast (SE), Southern (S), North (N), North-western (NW) and Western (W) quadrants are given as follows.

Table 6.1.2/12. *Expected immission concentrations of PM10 dust in the immediate vicinity of the route of the relevant section in the execution of works*

Distance from the place of the immission(m)	***Immission concentration (μg/m^3) of dust (PM10) during loading and unloading of loose material***					
	E, V=1.5m/s	***SE, V=1.9m/s***	***S, V=2.4m/s***	***N, V=3.3m/s***	***NW, V= 2.2m/s***	***W, V=1.5m/s***
15	102.6	80.07	64.18	46.67	70.01	102.6
20	128.2	101.2	80.12	58.27	87.41	128.2
25	118.8	93.81	74.27	54.01	81.02	118.8
30	101.0	79.75	63.14	45.92	68.88	101.0
35	83.90	66.23	52.43	38.13	57.20	83.90
40	69.61	54.95	43.50	31.64	47.46	69.61
45	58.14	45.90	36.33	26.42	39.64	58.14
50	49.02	38.70	30.64	22.28	33.42	49.02
Distance from the place of the immission(m)	***Immission concentration (μg/m^3) of dust (PM10) during work of a bulldozer***					
	E. V=1.5m/s	***SE, V=1.9m/s***	***S, V=2.4m/s***	***N, V=3.3m/s***	***NW, V= 2.2m/s***	***W, V=1.5m/s***
15	83,45	65,88	52,15	37,93	56.89	83.45
20	104.18	82.25	65.11	47.35	71.03	104.18
25	96.57	76.24	60.35	43.89	65.84	96.57
30	82.09	64.81	51.31	37.31	55.97	82.09
35	68.18	53.83	42.61	30.99	46.49	68.18
40	56.57	44.66	35.35	25.71	38.57	56.57
45	47.25	37.30	29.52	21.47	32.21	47.25
50	39.84	31.45	24.90	18.11	27.16	39.84
Median daily limit value	50μ/m^3					

Data obtained by calculating the absorption dust concentrations of PM10 indicate that during works. mainly movable machines. in slow-wind conditions up to 2.0 m/s. concentrations above the permitted daily mean values can be achieved in the workplace, at distances up to 30 m from the site.
In order to eliminate or mitigate the consequences, as far as possible, it is necessary to take appropriate measures such as moistening used material, or during the period of blowing the wind from the "unfavourable" direction ("unfavourable" direction of the wind is the wind that, through the site, blows towards houses, or residential and commercial buildings). In such cases, to suspend the works or to work along the route in an area which on the side of the wind has no facilities that would be endangered.

6.1.3. Impact of noise during the execution of works

Noise emissions generated by open-air machines are defined by EU Directives (2000/14/EC and 2006/42/EC), and are applied in the specific case of the design.

Also, the applicable legal regulations have been applied: the Law on Protection against Noise in the Environment (Official Gazette of Montenegro 28/11, 28/12 and 1/14) and the Rulebook on Environmental Noise Limits, the manner of determining the indicators noise and acoustic zones and methods for assessing the harmful effects of noise, the noise limit value in acoustic zones (Official Gazette of Montenegro 60/11).

The work of the construction machinery at the location of the planned design will generate a certain level of noise. Calculation of the noise level generated by the work of engaged construction machines was executed, and the comparison was made in relation to the Decisions on determining the acoustic zones in the Capital city - Podgorica and the Municipality of Danilovgrad.

Table 6.1.3/1 gives the calculated Leq values (equivalent continuous sound pressure level) for the equipment used and for different distances from the place of performance.

Table 6.1.3/1. *Calculated values Leq on various distances*

Type of equipment	***Noise level in dB(A)***	***Noise level in dB(A), 25 meters***	***Noise level in dB(A), 50 meters***	***Noise level in dB(A), 100 meters***	***Noise level in dB(A), 150 meters***
Bulldozer	104	64	57	50	45
Loader	106	66	59	52	47
Lorry	97	57	50	43	38
Roller	92	52	45	38	33
Excavator	73	33	26	19	14
Finisher	90	50	43	36	31
Bulldozer + roller	104,26	65	58	51	45
Loader + roller	106,17	67	60	53	48
Drill	123	79	72	65	60
Mixer + pump	100,539	59	53	45	41

Pursuant to the Decisions on the determination of acoustic zones in the City of Podgorica - Podgorica and the Danilovgrad Municipality, the given area belongs to the Zone under the strong influence of noise from road traffic, for which the noise limits are 60 dB (A) for day and night, i.e. 55 dB (A) for the night. On the basis of the calculation (Table 6.1.3/1), it can be concluded that the noise levels, in the given conditions, will be above the limit values in the diameter of about 50 m from the source of noise during the execution of the works, except when the drilling machine is operating - 150 meters. In this case, the calculation of the noise level is

given, in the operation of stationary and slow moving machines, as well as the simultaneous operation of two machines, in both cases, the distance from the site where the noise level is within the limits of the allowed values. Of these works, since the works are not performed in the night, there is no threat from the noise.

6.1.4. Influence on water quality during execution of works

Issue of surface water pollution is an aspect that does not have significant weight during construction, except in accidental situations. The essential fact is that issues of pollution of surface and groundwater must be analysed through all phases of construction of the section of the road in question, bearing in mind that we are talking about rivers the Sitnica, Matica and Sušica. The construction of significant infrastructure corridors always has negative impacts on the environment, and a particularly sensitive segment is surface and groundwater.

The basic requirement for water protection is the application of good engineering practice during the execution of construction works so as not to endanger the quality of underground and surface waters in the zone of influence.

Based on that, we distinguish three types of impacts that are caused by the construction, namely:

- Water pollution - accidental pollution,
- Changing the regime of surface and groundwater,
- Water consumption

a) Based on the above mentioned, during the execution of works there is a possibility of influencing the underground and surface waters, located in the immediate vicinity of one part of the road section in question. The quality of underground and surface waters on the route of the Podgorica-Danilovgrad road could be compromised if the servicing of machinery was executed on that part, and the endangerment could be achieved through the discharge of oil, lubricants and fuel from engaged machinery. It is necessary to completely eliminate these activities on the part of the route Podgorica-Danilovgrad, where surface and groundwater may be endangered.

Changes in the physical and chemical characteristics of the water, provided that the organization of the site and the procedures during the execution of the works have complied with the environmental protection requirements prescribed in the project documentation and this Survey, can only cause accidental pollution of the

discharge of dangerous and hazardous substances into open streams. For this reason it is necessary to provide a controlled approach of mechanization to watercourses and other surface waters.
The change in flow, velocity and surface flow itself can only occur if the works are executed beyond the designed limits. In addition, potential pollution of soil and water can result from inadequate maintenance of the machinery and their fuel supply.

Accidental pollution that may occur as a result of spilling and spillage of oil and oil derivatives can pose a potential risk for pollution of surface and ground waters as well as for soil contamination. The probability of this accident depends on several factors, the most important of which are the quality of materials, the type and quality of the construction and the method of construction, the type and manner of waterproofing, etc. The scope of the consequences in such cases depends essentially on the specific location characteristics, and is primarily conditioned by the proximity of the recipients, the soil sorption characteristics, the filtration coefficient and the hydraulic gradient.

Based on all mentioned above and by applying the technological discipline, it can be concluded that the activities in question will not have a significant negative impact on the underground and surface waters and land, during regular operations.

b) There is no possibility of influencing the execution of works on the route of the Podgorica-Danilovgrad road to cross-border pollution of waters.

6.1.5. Impact on land during execution of works

The basic characteristics of the soil are physical (texture and structure) and chemical. During the construction of the above-mentioned section of Podgorica-Danilovgrad road, negative impacts on the land are evident and can be direct and indirect.

As regards the physical impacts on the land (change of local topography, land erosion, slipping of land, etc.), during the execution of works on the route of the main road Podgorica-Danilovgrad, there will be a change in the part where the embankments and cuttings will be made.

Direct impacts on land are mainly in the process of construction in terms of land acquisition. Negative impacts in terms of pollution can occur only in accidental situations by spillage and spillage of oil and oil derivatives.
Inadequate disposal of waste (construction and excavation material) can lead to devastation of space during the execution of the project. In addition, if at the location of the project is preformed replacement of oil and filling the reservoir of trucks and construction machinery with fuel, land can be polluted due to the spillage of oil or fuel. This impact is of limited duration, that is, until the completion of the project.

The design in question, for the purpose of functioning, will use the complete surface of the land on the planned route in accordance with the urban-technical conditions, with no significant consequences.

On the route of the main road Podgorica-Danilovgrad there are no mineral resources, therefore the design will have no impact on them.

Waste disposal can have an impact on the quality of the environment at the project site, if inadequate disposal is executed. Thus, during the implementation of the project, it is envisaged that all construction waste and the excess of construction material are removed from the section in question.

6.1.6. Potential impacts on flora and fauna during the construction phase

Impacts on Mareza, Sitnica, Matica and Susica watercourses are recognised as site-specific, temporary and occasional impacts which will be completely eliminated after completion of works, especially in the limited project impact area. This will enable natural regeneration of the riverbeds, water and the living organisms in the abovementioned rivers. During the phase of construction of maintenance of the subject area, it is possible to cause degradation of quality (water turbidity, noise, vibrations) and/or loss of smaller area which represent appropriate habitats, disturbance or death of some specimens. Bearing in mind the limited construction area, in relation to the area covered by the environmental network, as well as the temporary nature of the abovementioned impacts, the impacts that may affect the abovementioned species have been defined as acceptable. Thus, it is possible to additionally reduce these impacts through good organisation of the construction sites, compliance with the stipulated Protection measures, as well as by carrying out the construction works outside the spawning period, which means that the works should be carried out in the period from 15th June until 15th October. Susica

River and the Mareza channel dry up during summer, thus it is not rational to compensate for the natural constraints.

Impacts on biodiversity represent the most sensitive aspect of the overall impacts, bearing in mind that biotopes should be regenerated in order to restore them to their previous condition. This means that conditions for return and functioning of the living organisms in the watercourse should be provided. These are also transient effects, which will get stabilised after a certain period of time upon completion of construction works.

According to the Main Design, it is envisaged to set up construction sites at three locations along the designed road route, out of which two will be located in the proximate vicinity to swampy and flood-meadows (Luznica and Mareska swamps) and Matica-Sitnica River (Construction site 2 – intersection to Cafa and Baloci; Construction site 3 – Komanski ski Bridge). Enabling works for the activities planned within the Project will begin by cutting the vegetative cover and earthworks. These will be the direct impacts on the habitats defined within Appendix 1 of the Habitats Directive (92A0 - white ivy and white poplar forest). Single field elm and narrow-leafed ash trees will be cut down at the locations which are going to be used for reconstruction of the existing bridge and construction of the new ones (Susica, Matica, Komanski ski Bridge). At the same time, there is risk of erosion and abrasion of material into the watercourses. Since these rivers have slow flows, low water levels and they are even prone to drying up (Susica and Sitnica) these watercourses may be characterised by higher water turbidity and accumulation of sediments. This is one of the potential negative impacts which may occur in terms of the Natura 2000 habitats (3150 and 3260). This same impact may occur during the process of drilling the riverbed and placing piers. Change in morphology of the riverbed may have a negative impact on biocoenosis in the water. Additionally, the works which are planned to be carried out along the course of Matica-Sitnica, from the current bridge to Komanski ski bridge, also include excavations and cutting down vegetation along the right river bank (Natura 2000 habitat 92A0), especially in the coastal part of Sitnica, in proximity to the Komanski ski Bridge. Susica and Matica-Sitnica may be polluted during the course of carrying all types of works, while pollution may most likely be caused during the process of making excavations, bearing in mind that construction of the subject road is linked to the coastal area itself. The process of building retaining walls along the Susica and Matica-Sitnica river banks may cause higher water turbidity, in case the construction material reaches the watercourses due to inadequate handling of this type of material.

Over the course of carrying out construction works, it is possible to cause pollution of Matica-Sitnica and Susica, which may by caused by oil leaks or spills into the watercourse and the surrounding terrain due to uncareful filling up.

Pollution of Matica-Sitnica may be caused by uncontrolled waste disposal, in case the location designated for waste disposal (general, earthen, construction waste) is not located far enough from the watercourse.

Unwanted impacts on Matica-Sitnica may occur as a consequence of local filling up of watercourses, which may be caused by erosion of riverbanks or uncontrolled or accidental unloading of earthen material.

Particles of dust, generated due to the moving mechanisation, blasting of the Zelenika hill, cutting and removing the old asphalt layer, may by scattered by wind and reach the surface of watercourses. Likewise, during the process of completing earthworks, during rainy periods, the surface dust may be washed off and thus run into the watercourses, which would cause increased turbidity of Matica-Sitnica, in the lower part of its course.

Due to conducting works in an unskilled and inadequate manner, as well as due to inadequate handling of equipment, the following types of material may reach the watercourses: parts of the used formwork, packaging which was used for wrapping and storing the construction material, oil from hydraulic machines, oil used for operation of the machines and mechanisation…

It is also possible to inadvertently bring in and/or spread around invasive plants (*Ambrosia artemisiifolia*, *Ailanthus altissima*, *Robinia pseudoaccacia*). Vegetation clearing, presence of a higher number of people and vehicles creates a new, disturbed habitat which potentially be a suitable for settlement of invasive plants.

Potential impacts on swampy areas and swampy meadows during enabling works and implementation of activities

For the most part, enabling works for vegetation clearing and earth excavations will be carried out in the reed beds area, along both sides of the designed road route. Natura habitat 2000 – 6420 Mediterranean tall humid grasslands is not going to be threatened.

Cutting and removal of asphalt along the embankment may cause increased generation of dust, which will further settle on plant leaves, and thus disturb the process of photosynthesis and consequently reduce their growth and development.

Accidents caused by spilling fuel, oil, hydraulic oil from the machines and mechanisation into the surrounding terrain may occur over the course of carrying out construction works.

Different types of waste may reach the swamps and swampy meadows (earthen, construction, municipal waste).

6.1.7. Impact on loss and damage of geological, paleontological and geomorphological properties

The term geological environment implies: geological structure, lithological composition, mineral raw materials and pedological structure. Given the fact that the road from the Komanski bridge to the Danilovgrad roundabout mostly stretches through the plain terrain, it could be stated that the impact on soil used for agriculture is relatively minor, as the soil is rarely employed for agriculture on the existing M-18 route.
No deposits and occurrences of other new materials which can be utilised as a technical-construction stone are present on the mentioned route section. There are no registered localities of palaeontological value on this section. It is stated in chapter 6.1.1. Impact on Air that the M-18 main road reconstruction from the Komanski bridge to Danilovgrad roundabout that certain dust concentration will be reached so certain amount of dust will be sedimented in that area. Sedimented dust is of the same chemical structure as the surrounding area, whether it is the dust which comes from the limestone or flychs sediments. It means that sedimented amounts of dust cannot have negative effects on the surrounding terrain.
From the geological point of view, there are no special negative effects on this section of the route because the area mentioned has no paleontological value that can be compromised. Also, there are no deposits of mineral raw materials in the indicated corridor. In case of finding any “archeological, paleontological, speleological objects and groundwaters“, construction works shall be stopped and authorities of Montenegro shall be informed without delay.

6.1.8. Impact on municipal infrastructure

In the narrow zone of the M-18 main road route corridor, there are no zones of sanitary protection for public water supply, as well as local water supply and sewage network that is in conflict with the route.

6.1.9. Waste disposal

During the regular reconstruction of the existing M-18 main road, Podgorica-Danilovgrad section, from the Komanski bridgeto the Danilovgrad roundabout, and road facilities, the following types of waste are generated:

- Municipal waste
- Packaging waste from explosives
- Packaging waste from concrete additives, which can be hazardous waste, or hazardous packaging waste

Management of all types of waste must be in accordance with the requirements of Montenegrin legislation, and adequate disposal minimizes potential negative effects.

6.1.10. Impact on local population during construction works

a) Considering the existing M-18 main road reconstruction, (Podgorica-Danilovgrad section) with four traffic lanes, there will be a certain noise level, which will primarily have an impact on the population near the reconstruction site of the part of the road concerned.

b) The visual effects will not be favourable during the project implementation, given that in this period there will be a construction site, especially for the population living nearby, but after the completion of the project implementation and road construction, these impacts will be positive, primarily from the aspect of better traffic flow.

c) Cumulatively, the project cannot cumulate with the effects of other projects if at the same time an accident occurs. Therefore, possible project cumulation with the effects of other projects practically does not exist.

From the technical description of the project implementation, it can be concluded that at this stage an increased level of noise will arise from construction equipment

and hand tools. The highest level of noise can be expected to rise during the excavation stage and during the terrain preparation for the mentioned road reconstruction.

The total noise level will be determined for the working conditions of all the listed machines on this route. It is important to note that these effects will be limited to daily conditions and the period of the main road reconstruction. For the remaining stages of the construction, the noise level is limited to delivering of materials, asphalt and concrete which is transported by trucks, i.e. transit mixers.

During the project implementation, there will be vibrations at the site due to the construction equipment operation and the movement of trucks. However, the vibrations occur during the project functioning as a result of traffic circulation on this part of the road.

Impacts on the population are present from the social aspects due to the private landowners expropriation whose part of the land includes the route Podgorica-Danilovgrad section and whose land surface areas will be expropriated as defined by the Expropriation Study.

The whole route section from the Komanski bridge to the Danilovgrad roundabout the Expropriation study with defined areas of land to buy from the real estate owners designed for the purposes of unobstructed road construction. The Designer has defined the expropriated land by geodetic coordinates, which applies to the existing cadastral maps. As a result, land parcels expropriated from the owners have been determined. The land parcels, the list of applications, the intersecting coordinating points of the expropriation lines and cadastral parcels have been made according to the technical regulations in force.

6.1.11. Visual impact

The landscape will change not only by the newly built route of the section in question, from the Komanski bridge to the Danilovgrad roundabout, but also the construction activities will have much impact on the landscape, but only temporarily. During the construction execution works on the section concerned, there is a significant local impact in the construction works zone on the open route, intersections, bridges, cuts, embankments, etc.
The current situation is that the construction works will cause a series of unfavourable impacts on the landscape, among which the most significant are:

- Execution of works on the open route causes harm to existing landscape, affecting their harmonization and causing their visual disfiguration;
- Noise and dust, as a result of construction works, have a negative visual impact.

6.2. Review of possible and expected impacts on environment by exploitation of the main road section from Podgorica to Danilovgrad

On the Podgorica-Danilovgrad road, in Ćurilac, the traffic flow measurement was conducted according to the vehicle structure. The data have been delivered to the Traffic Directorate for the period of 2009-2012 and shown in table 6.2/1.

Table 6.2/1. *Data on traffic flow during 2009-2012. (source: Traffic Directorate)*

Class	**Vehicle category**	**2009. year**	**2010. year**	**2011. year**	**2012. year**
A0	Motorcycles	16	17	23	27
A1	Passenger cars	8025	7847	7759	7621
A2	Combined vehicles	683	649	650	652
B1	Light-duty vehicles	191	191	142	115
B2	Medium heavy-duty vehicles	133	124	143	148
B3	Heavy duty vehicles	101	102	92	66
B4	Heavy-duty vehicles with a trailer	43	37	35	34
B5	Semi-trailers	157	155	142	133
C	Busses	109	103	109	106
X	Uncategorized vehicles	7	6	2	2
Total		**9465**	**9231**	**9097**	**8904**

Given that from 2009-2012 a decrease in traffic circulation has been noticed, the year 2009 as the year with the highest traffic circulation has been taken for the estimates. The estimated budgets for years 2020 and 2027 are given below, with an increase in vehicle circulation compared to the year of 2009 (the so-called „*the most unfavourable scenario*“)

6.2.1. Impact on air quality

The level and concentration of emissions of polluting substances in the air at the stage of exploitation of the subject section and comparison with the indicators prescribed by norms and standards

Motor road vehicles, whose exhaust gasses contribute to the air quality deterioration, pose significant environment pollutants. Exhaust gasses have an impact on human population, flora and fauna, as well as their material and cultural goods. Their impacts are noticed in areas around roads with high traffic flow (main road and highways).

A great amount of gas emission occurs from internal combustion engines; ozone precursors (CO, NO_x; NMVOCs[1]), greenhouse effect gasses (CO_2, CH_4, N_2O), acidic substances (NH_3, SO_2), particulate matter (PM_2), carcinogen compounds (PAH_s[3] i POP_s[4]), toxic substances (dioxins and furans) and heavy metals.

Emission standards for passenger cars and light-duty vehicles are defined by the gram of substance per kilometer, which is average for a typical driving cycle.

Emission standards for light-duty vehicles (trucks and busses) are defined by the gram of emitted matter per kWh.

Vehicle emissions are regulated for light-duty vehicles (passenger cars and light commercial vehicles) and heavy-duty vehicles (trucks and busses), and according to the EU regulations the abbreviations are used: EURO 1, EURO 2, EURO 3, EURO 4, EURO 5 i EURO 6. In the European Union countries, EURO 5 standard came into force on September 1, 2009 for the approval of a vehicle and it is applicable from 1 January 2001 for the registration and sale of new types of vehicles. EURO 6 standard came into force on September 1, 2014 for the approval of vehicles, and from January 1, 2015 for the registration and sale of new types of vehicles. EURO standards limit the carbon monoxide emission (CO), total hydrocarbons (THC), non-methane hydrocarbons (NMHC), nitrogen oxides (NO_x), as well as particulate matter (PM).

European standard gas emission norms according to vehicle categories are shown in tables 6.2.1/1 to 6.2.1/6.

Table 6.2.1/1. European emission standards for passenger vehicles (Category M*), g/Kwh

Euro standard	**Entry into force**	**CO**	**HC**	**NMHC**	**NO_x**	**HC+NO_x**	**PM**
DIESEL FUEL							
EURO 1	1/07/1992	2.72	-	-	-	0.97	0.14
EURO 2	1/01/1996	1.00	-	-	-	0.70	0.08
EURO 3	1/01/2000	0.64	-	-	0.50	0.56	0.05

EURO 4	1/01/2005	0.50	-	-	0.25	0.30	0.025
EURO 5A	1/09/2009	0.50	-	-	0.18	0.23	0.005
EURO 5B	1/09/2011	0.50	-	-	0.18	0.23	0.005
EURO 6	1/09/2014	0.50	-	-	0.08	0.17	0.005
Euro standard	**Entry into force**	**CO**	**HC**	**NMHC**	**NO_x**	**$HC+NO_x$**	**PM**
GASOLINE							
EURO 1	1/10/1994	2.72	-	-	-	0.97	-
EURO 2	1/01/1998	2.20	-	-	-	0.50	-
EURO 3	1/01/2000	2.30	0.20	-	0.15	-	-
EURO 4	1/01/2005	1.00	0.10	-	0.08	-	-
EURO 5	1/09/2009	1.00	0.10	0.068	0.06	-	0.005**
EURO 6	1/09/2014	1.00	0.10	0.068	0.06	-	0.005**

***Refers to vehicles with direct fuel injection only*

Table 6.2.1/2. *European emission standards for light-duty vehicles ≤1305 kg (Category N_1-I), g/km*

Euro standard	**Entry into force**	**CO**	**HC**	**NMHC**	**NO_x**	**$HC+NO_x$**	**PM**
DIESEL FUEL							
EURO 1	1/07/1992	2.72	-	-	-	0.97	0.14
EURO 2	1/01/1996	1.00	-	-	-	0.70	0.08
EURO 3	1/01/2000	0.64	-	-	0.50	0.56	0.05
EURO 4	1/01./2005	0.50	-	-	0.25	0.30	0.025
EURO 5A	1/09/2009	0.50	-	-	0.18	0.23	0.005
EURO 5B	1/09/2011	0.50	-	-	0.18	0.23	0.005
EURO 6	1/09/2014	0.50	-	-	0.08	0.17	0.005
GASOLINE							
EURO 1	1/10/1994	2.72	-	-	-	0.97	-
EURO 2	1/01/1998	2.20	-	-	-	0.50	-
EURO 3	1/01/2000	2.30	0.20	-	0.15	-	-
EURO 4	1/01/2005	1.00	0.10	-	0.08	-	-
EURO 5	1/09/2009	1.00	0.10	0.068	0.06	-	0.005*
EURO 6	1/09/2014	1.00	0.10	0.068	0.06	-	0.005*

**Refers to vehicles with direct fuel injection only*

Table 6.2.1/3. *European emission standards for commercial vehicles 1305 kg – 1760 kg (Category N_1-II), g/km*

Euro standard	**Entry into force**	**CO**	**HC**	**NMHC**	**NO_x**	**$HC+NO_x$**	**PM**
DIESEL FUEL							
EURO 1	1/07/1992	5.17	-	-	-	1.4	0.19
EURO 2	1/01/1996	1.25	-	-	-	1.0	0.12
EURO 3	1/01/2000	0.80	-	-	0.65	0.72	0.07
EURO 4	1/01/2005	0.63	-	-	0.33	0.39	0.04
EURO 5A	1/09/2009	0.63	-	-	0.235	0.295	0.005
EURO 5B	1/09/2011	0.63	-	-	0.235	0.295	0.005
EURO 6	1/09/2014	0.63	-	-	0.105	0.195	0.005

Euro standard	Entry into force	CO	HC	NMHC	NO_x	$HC+NO_x$	PM
DIESEL FUEL							
EURO 1	1/07/1992	5.17	-	-	-	1.4	0.19
EURO 2	1/01/1996	1.25	-	-	-	1.0	0.12
EURO 3	1/01./2000	0.80	-	-	0.65	0.72	0.07
EURO 4	1/01/2005	0.63	-	-	0.33	0.39	0.04
EURO 5A	1/09/2009	0.63	-	-	0.235	0.295	0.005
EURO 5B	1/09/2011	0.63	-	-	0.235	0.295	0.005
EURO 6	1./09/2014	0.63	-	-	0.105	0.195	0.005

**Refers to vehicles with direct fuel injection only*

Table 6.2.1/4. *European emission standards for commercial vehicles >1760 kg max 3500 kg. (Category N_1-III & N_2), g/km*

Euro standard	Entry into force	CO	HC	NMHC	NO_x	$HC+NO_x$	PM
DIESEL FUEL							
EURO 1	1/07/1992	6.9	-	-	-	1.7	0.25
EURO 2	1/01/1996	1.5	-	-	-	1.2	0.17
EURO 3	1/01/2000	0.95	-	-	0.78	0.86	0.10
EURO 4	1/01/2005	0.74	-	-	0.39	0.46	0.06
EURO 5A	1/09/2009	0.74	-	-	0.28	0.35	0.005
EURO 5B	1/09/2011	0.74	-	-	0.28	0.35	0.005
EURO 6	1/09/2014	0.74	-	-	0.125	0.215	0.005
GASOLINE							
EURO 1	1/10/1994	6.9	-	-	-	1.7	-
EURO 2	1/01/1998	5.0	-	-	-	0.7	-
EURO 3	1/01/2000	5.22	0.29	-	0.21	-	-
EURO 4	1/01/2005	2.27	0.16	-	0.11	-	-
EURO 5	1/09/2009	2.27	0.16	0.108	0.082	-	0.005*
EURO 6	1/09/2014	2.27	0.16	0.108	0.082	-	0.005*

**Refers to vehicles with direct fuel injection only*

Table 6.2.1/5. *European emission standards for heavy-duty vehicles with HD diesel engines, g/kWh*

Euro standard	Entry into force	Test	CO	HC	NO_X	PM
EURO 1	1992 < 85 kW	ECE R-49	4.5	1.1	8.0	0.612
	1992 > 85 kW		4.5	1.1	8.0	0.36
EURO 2	1/10/1996		4.0	1.1	7.0	0.25
	1/10/1998		4.0	1.1	7.0	0.15
EURO 3	1/10/1999 EEVs only	ESC & ELR	1.0	0.25	2.0	0.02
	1/10/2000	ESC & ELR	2.1	0.66	5.0	0.10 0.13*
EURO 4	1/10/2005		1.5	0.46	3.5	0.02

EURO 5	1/10/2008		1.5	0.46	2.0	0.02
EURO 6	31/12/ 2013		1.5	0.13	0.4	0.01

*For *engines with a volume less than 750 cmm per cylinder and rated power at speeds of over 3000 o/min*

Table 6.2.1 /6. European emission standards for heavy-duty vehicles, category *N3, EDC, (to 2000)*

Standard	Period	CO (g/kWh)	NOx (g/kWh)	HC (g/kWh)	PM (g/kWh)
EURO 0	1988–1992	12.3	15.8	2.6	NA
EURO 1	1992–1995	4.9	9.0	1.23	0.40
EURO 2	1995–1999	4.0	7.0	1.1	0.15
EURO 3	1999–2005	2.1	5.0	0.66	0.10
EURO 4	2005–2008	1.5	3.5	0.46	0.02
EURO 5	2008–2012	1.5	2.0	0.46	0.02

(For older) ECE R49 cycle

Standard	Period	CO (g/kWh)	NOx (g/kWh)	HC (g/kWh)	PM (g/kWh)
EURO 0	1988–1992	11.2	14.4	2.4	NA
EURO 1	1992–1995	4.5	8.0	1.1	0.36
EURO 2	1995–1999	4.0	7.0	1.1	0.15

Through the analysis of the abovementioned data a significant difference in gas emissions standards can already be seen between the EURO 3 and EURO 4 engines. Thus, the emissions (NO_x) must be reduced by 30% (from 5 to 3.5 g / kWh), and the emissions of particulate matter (PM) by as much as 80% (0.1 to 0.02 g / kWh). EURO 5 compared to EURO 4, with light-duty vehicles, has 5 times lower emission of particles (PM) and 66% less emission of NO_x.

Gasoline engine emission will not be significantly reduced by 23% NO_x. According to the EURO 4 standard, gasoline engines have about four times less emission of NO_x, negligible particle emission, but have two times more of carbon monoxide (CO) and have HC emission, which diesel motors do not have. The EURO 5 and EURO 6 standards application will considerably contribute to the gas emission reduction.

Estimates of the air polluting substance concentrations are made based on the relevant meteorological conditions, the spatial area of the route and the speed of the most frequent wind in the observed area. Based on the frequency data, the speed and direction of winds in Podgorica and Danilovgrad area, the air polluting substance concentrations have been calculated for the base year of 2009 and year 2027. The permanent and temporary concentration of dominant pollutants - CO, NO, NO_2, C_XH_Y, Pb, SO_2 and particulate matter are calculated at distances from 1m to 300 m from the edge of the roadway.

Air emission due to traffic flow on the road concerned

The air pollution estimate is based on the equation:
Ki (s) = Ki x g (s) x fvi x fu

Whose elements are:
Ki – concentration at the edge of the traffic lane
Ki (s) – surface concentration for any type of emission at 1,5 m and distance (s) from the edge of the lane
g (s) – distance from the edge of the road
f (VI) – function which takes into account specific data on traffic
f (u) – function which defines the impact of wind

Air pollution estimate from the road in question

The air pollution estimate carried out based on the data of the number and vehicle structure, the vehicle speed at 80 km/h with proper corrections due to the road functional dependence due to meteorological conditions, especially wind speed and wind duration. The results are shown in the table 6.2.1 /7.

Table 6.2.1 /7. *The estimate of air pollution from the road Podgorica-Danilovgrad (estimated PGDS: 9607 vehicle/24h, year 2020)*

Pollutant		**Distance from the edge of the road in metres**							**Limit values**
		0	25	50	75	100	200	300	
CO	Average	0,3119	0,1432	0,1083	0,0876	0,0729	0,0372	0,0164	**Max. 8h, ever. Val. 10mg/m^3**
	98 percentile	1,2101	0,5556	0,4203	0,3401	0,2830	0,1447	0,0637	
HC	Average	0,0506	0,0232	0,0175	0,0142	0,0118	0,0060	0,0026	**1h, avrg. Val. 200 µg/m^3, yearly average. Val. 40 µg/m^3**
	98 percentile	0,1695	0,0778	0,0588	0,0476	0,0396	0,0202	0,0089	
NO_x	Average	0,0774	0,0355	0,0268	0,0218	0,0180	0,0092	0,0040	**1h, avrg. Val. 300 µg/m^3, daily average. Val. 110 µg/m^3**
	98 percentile	0,2344	0,1076	0,0814	0,0659	0,0547	0,0280	0,0122	
PM_{10}	Average	0,0008	0,0003	0,0002	0,0002	0,0001	0,0001	0,00004	**Avrg.daily val. 50 µg/m^3**
	98 percentile	0,0032	0,0014	0,0011	0,0009	0,0007	0,0003	0,0001	

Table 6.2.1 /8. *The estimate of air pollution from the road Podgorica-Danilovgrad (estimated PGDS: 9751 vehicle/24h, year 2027)*

As it can be seen in the tables, the vehicle exhaust gas concentration from the traffic flow are considerably lower from the prescribed limit values.

6.2.2. Impact of traffic noise

The traffic noise analysis on this road, in given conditions (the traffic load, the structure and speed of vehicles at 80 km/h, weather conditions, etc.), as its purpose has to determine the relations towards facilities in the corridor of the mentioned road and an ideal solution, and possible necessary protective measures.
The procedure for noise estimating parameters for this road comes down to obtaining the relevant noise parameters based on traffic flows in specific environmental conditions. This level is defined by the term:

$$L_{Aeg} = \Omega \cdot 10\log\left[M_0 \cdot (1 + 0.082 \cdot P)\right] + F_1 + F_2 + F_3 + F_4 + K_F + K_T + K_P : dB(A)$$

Where:

Ω = coefficient of relevant vehicle in the unit of time
M_0 = relevant hourly load
P_t = relevant participation of heavy-duty vehicles (in %)
F_1 = correction factor for the relevant vehicle speed
F_2 = correction factor for roadway surface characteristics
F_3 = correction factor for longitudinal road inclination
F_4 = correction factor for the sound reflection
K_f = function of attenuation level depending on the distance and sound absorption
K_T = soil absorption coefficient
K_P = correction due to obstacles in the cross section

The estimate of the equivalent traffic noise level on the road Podgorica-Danilovgrad

The estimate made for the sound propagating conditions generated from the road. The estimate is made for PG-DS which can be realised in 2020 and 2027.

Table 6.2.2/1. *Estimate of the equivalent traffic noise level in conditions of sound propagation on the mentioned road (estimated PGDS: 9607 vehicle/24h, 2020 and estimated PGDS 9751 for 2027.)*

Year 2020.			**Year 2027.**		
Distance of lanes fron the place of emissions	**Equivalent level in dB(A)**		**Distance of lanes from the place of emissions**	**Equivalent level in dB(A)**	
	Day	***Night***		***Day***	***Night***
25 metres	*63*	*52*	25 metres	*63*	*52*
50 metres	*61*	*50*	50 metres	*61*	*50*
75 metres	*58*	*47*	75 metres	*58*	*47*
100 metres	*57*	*46*	100 metres	*57*	*46*
125 metres	*56*	*45*	125 metres	*56*	*45*
150 metres	*55*	*44*	150 metres	*55*	*44*

Based on the Decision on determining the acoustic zones in the capital city - Podgorica and the municipality of Danilovgrad, the area in question belongs to the Zone under the strong influence of noise, which originates from the road traffic, for which the noise limits are 60 dB(A) during the day and night, or 55 dB(A) during the night. Based on the estimates (table 6.2.2/1), it can be concluded that the noise levels, under sound propagation conditions, due to traffic circulation, will be above the limited values, at about 25 m from the noise source.

6.2.3. Impact on local population

The M-18 main road reconstruction significance, section Podgorica-Danilovgrad, reflects in its geographical position and better traffic and economic connection of these two municipalities, and in that sense represents a stimulation, especially for more intensive economic development.

An increase in the population mobility should be expected at the subject section of Main Road M-18, which creates developmental possibilities for certain actions that can improve social structure.

As the users of the main road, the locals will get several advantages, given that the M-18 reconstruction of the existing road will significantly improve movement and traffic security, which has a positive impact.

A part of the population located near M-18 road section will get unfavourable living conditions, as there will be an increase in negative effects compared to the existing situation, mainly an increase in the noise levels. Favourable effects in

these zones, on the business condition improvement, will appear as a result of an increase in demand for services along the main road.
Also, the price value changes of the surrounding land are expected, primarily due to the new use of the land.

Due to the road reconstruction, changing of the existing road network will occur, i.e. a part of the local roads will be better connected with the road section, which will have favourable effects on local population, and it will enable a better communication at the local level.
The comparison of all the effects leads to the conclusion that the benefits for the social environment, reconstruction of the main road section are greater than the damages, which also appear as a reconstruction consequence and exploitation.

6.2.4. Impact on water quality

6.2.4.1. Impact of polluting substances on quality of surface and groundwater and comparison with indicators prescribed by norms and standards

Taking into account proper relations related to the spatial characteristics of the M-18 main road route from the Komanski bridge to the Danilovgrad roundabout, as well as the characteristics of the possible recipient watercourse of waste storm water and groundwater, there is a need for the analysis of this problem.
Basic characteristics of the pollution source

The main pollution sources from the exploitation of the future M-18 main road section from the Komanski bridge to the Danilovgrad are: vehicles, precipitation and dust.
During the road exploitation stage, it is logical to expect that the water pollution will cause the following processes:

- Sedimentation of gas exhaustion
- Wear of tyres
- Bodywork destruction and spillage of cargo
- Droppage of cargo
- Disposal of organic and non-organic waste
- Stormwater sedimentation
- Wind blowing
- Dispersion due to vehicles passing

Pollution, which is a result of the mentioned processes, based on its weather characteristics can be permanent, seasonal and accidental.

Types of pollution and form of manifestation

Waters which drain from the roadway surfaces have a series of harmful substances in concentrations which are above the maximum limits allowed for drainage into watercourses. Primarily, the causes are fuel components of such as hydrocarbons, organic and non-organic carbon, compounds of nitrogen (nitrates, nitrites and ammonia). A specific group of elements are heavy metals or: lead (fuel additive), cadmium, copper, zinc, mercury and nickel. A real part are also solid substances of different structure and characteristics, appearing in the form of deposited, suspended and soluble substances. It is also possible to see substances which are the results of using the corrosion protection materials. A special group of highly carcinogenic substances are polyaromatic carbohydrates (benzo-a-pyrene and fluoranthene) which are products of incomplete fuel combustion and used engine oil. For the indication of present contaminants that occur in soluble and insoluble forms, there are several macro indicators such as PH, electrical conductivity, suspended and sedimentary substances, COD, BOD, fats and oils, etc.
The type and form of pollution is affected by:

- Traffic characteristics (volume, speed, braking)
- Weather conditions (intensity and form of precipitation, wind, temperature)
- Maintenance procedure (sweeping, mowing, repair, salting, herbicides, dyeing)
- Use of the surrounding soil
- Ratio of sanitary and non-sanitary surfaces
- Age and technical condition of vehicle
- Law regulation on permitted vehicles gas emission
- Use of special additives for the vehicle engine operation
- Types of vegetation in expropriated road parts
- Accidental pollution

From the above listed polluting agents, the traffic characteristics (especially volume), storm water sediments (dry and wet) and local conditions (land use, surface of the road, way of maintenance) have the biggest impact on the type and concentration.

Basics for determining the amount of contaminants

Basic ratios, which are of great importance for the contaminant concentration calculation, are systematized in the form of the following opinions:

- The highest contaminant concentration are registered in the waters draining from the roadways during winter months;
- Concentration of most contaminants depends directly on the drz period duration before rain and traffic load. The highest concentrations are achieved during the first 5 to 10 minutes of rain, followed by a rapid fall;
- Concentration of suspended substances are proportional to the rainfall intensity and the highest concentrations are obtained during the largest flow;
- Water losses, due to the splashing vehicle passing, do not exceed 10% of the total amount
- Dispersion of the substances from the roadway during dry weather, due to air flow when vehicles are passing, do not significantly affect the decrease of concentration;
- Surface waters pollution, i.e. the waters which drain from the roadway surface is significant and in certain conditions appropriate technical protective measures must be applied.

The adopted drainage concept, by which the controlled collection of roadway storm waters is planned, and their purification to the required quality for getting into the recipient – the closest temporary or permanent watercourse or artificial canal, minimizes the negative effects of designed road exploitation on the land quality, surface waters and groundwater in the considered road corridor.

6.2.5. Impact on soil quality

6.2.5.1. Physical impact (change of local topography, ground erosion, landslide, etc.)

During the M-18 main road section exploitation, due to inadequate purification of waste stormwaters, the maintenance and cleaning of the deposits and separators can lead to occurrence of soil pollution.
During the road exploitation no significant elements that can cause landslides, erosion or change of the existing topography of the surrounding terrain are found.

6.2.5.2. Polluting emissions impact at the locations of the planned project and on the surroundings and comparison with the indicators prescribed by norms and standards

Heavy metals and polycyclic aromatic hydrocarbons (PAH) are the most dangerous traffic pollutants, which are accumulated along the road. However, PAH pollutants such as benzopirine are transformed into less hazardous substances for a relativaly short period, while heavy metals stay in the environment longer.

Lately, more than 80 % of automobiles are driven on unleaded fuel. With the help of widespread unleaded gasoline use the lead emission has drastically been reduced. Contrary to lead, cadmium (Cd) comes mainly from diesel fuels, and its emission level has stayed at the earlier level, with a slight decline. Zinc (Zn) is ten times less dangerous for living organisms than lead and cadmium, and comes from automobile tyres and it is carried from the road together with the dust. Certainly, zinc can be accumulated over time and its concentration can reach a critical level. Heavy metals are different from one another based on their solubility and mobility in the soil. Compared to lead and zinc, cadmium has the highest mobility intensity in the soil. Acidic reaction increases the heavy metals ability to move. At a PH reaction less than 4, rinsibility of metals is as twice as high than it is at a neutral reaction (pH=6,0-7,5; Dierkes and Geiger, 1999.). Unlike other metals, cadmium can also be washed at an alkaline reaction of the soil up to pH=8,5. Given the acidic sulphate deposit that is mostly emitted from the diesel fuel vehicles, as well as the nitrogen gas emission, roads and buffer margins (grass overgrown traffic barriers and embankments) always have acidic qualities.

Certainly, this is a rough estimate, but it indicates the potential danger of contamination of a part of the road. Surely, it is possible to expect conflict if comprehensive protective measures are not taken to protect the border areas where agriculture is cultivated.

6.2.6. Impact in case of traffic accident

An emergency that can occur during the road exploitation is a traffic accident, i.e. collision of vehicles. In that case, injuries of drivers and passengers involved in a traffic accident may occur, and if environmental factors are in question, the spillage of fuel or oil from vehicles involved in an accident may occur, as well as the occurrence of fire on vehicles. Each of the mentioned probabilities poses a risk of threatening segments for the environment such as air, waters or soil.

Also, if hazardous substances are transported through the mentioned road, in case of collision (accident), spillage and/or droppage of dangerous cargo from vehicles may occur. The collision may occur due to human error in vehicle management, technical vehicle faults, poor meteorological conditions, poor roadway conditions and signalling or due to interaction of the abovementioned causes.
The basic traffic accident characteristics when transporting hazardous substances are as follows:

- They happen suddenly
- Location cannot be predicted, which makes it difficult for permanent prevention
- Accompanied by damage of transport means and transport routes
- The postponed time of notification in case of accident on open road
- Contamination of the surrounding area with high concentration of dangerous substances happens immediately, and by developing of the contaminated cloud or by penetration into watercourses and groundwater, contaminants may spread to larger areas.

The scope of ecological consequences in case of an accident depend also from the terrain permeability and filtration coefficient of on the nearby road, the groundwater level and the watercourses proximity. Hazardous substances can reach surface and/or groundwaters at a slower or faster rate and contaminate them. Apart from the negative impact on surface waters and groundwaters, the consequences of the hazardous substance release in case of an accident are endangering flora and fauna, human health and material assets.
Despite that different types of materials are transported on roads, the greatest environmental dangers the release of oil derivates from tank trucks.
Oil derivatives, even in small amounts, may contaminate large amounts of water. Overturning tank trucks with oil and its derivatives on road causes spillage of these liquids, which causes disturbance of the soil structure by closing the pores and particle agglomeration by bonding.

As a consequence, these processes change the soil, air regime and groundwater structure and the extinction of aerobic soil organisms occurs, whose symbiotic relation creates a pedologic layer.

The fact is that oil derivatives, after reaching groundwater, because there is no significant dilution in contact with groundwater which would reduce its concentration, stay in water for a long time. Given that in oil polluted groundwaters there is no biodegradation, rinsing from the aquifer layer is very slow.

During traffic accidents, motor fuels spillage (gasoline and oil) from transported oil derivatives from tank trucks occurs. Oil and oil derivatives are highly flammable fluids and they can easily be ignited by the heat, spark or flame as such. Gasoline, which is used as a motor fuel, is one of the most flammable liquids. It manifests in high volatility, does not interfere with water, with specific weight that is lighter than water, which means that water cannot be used for extinguishing burning gasoline. Additionally, gasoline and water vapor or air put together produce an explosive mixture. In certain cases, small amounts of this mixture is enough to create an explosive system. The fires containing gasoline accompanied by explosive occurrences can be very intense. Oil and its derivatives cause certain toxicity when it comes to human population and are classified as „1“ by toxicity. Gas vapours cause headiness in humans, while in large quantities can be even toxic.
The fact is that high concentrations of gasoline vapor (35000-40000 mg/m3) can lead to sudden death and vapours can cause dizziness or suffocation. In these accidents, passengers suffer most from eye and skin burns.

When discussing traffic accident situations listed above, it can be assumed that they are of a temporary character in case of prompt response to their suppression or removal.

6.2.7. Impact on ecosystems and geologic environment

6.2.7.1. Impact of loss and damage to plant and animal species and their habitats

According to the project design, it is necessary to carry out a controlled collection roadway stormwater as well as their purification treatment in separators until the required quality is achieved for getting into the recipient – the closest temporary or permanent watercourse or canal. This is certainly the best way to reduce the negative effects of road exploitation, the land quality, surface and groundwater, flora and fauna in the discussed corridor. The defined project design also reduces the negative consequences on flora and fauna in case of accidental oil derivative spillage or other hazardous fluids or chemicals.

Also, on the mentioned main road section during the exploitation, greater number of new light sources (street lights) that pose a potential environmental disturbance due to light emission will appear. The light emission environmental effects are

reduced by implementing adequate measures to prevent and limit negative effects, which is primarily the choice and use of technically modern lamps.

The lighting on the discussed road section will attract insects, and as its consequence, the predators (bats, night birds), which leads to high mortality of the specimens from both groups.
Road lights will mean a light new source in the environment, which is why direct impacts are expected, and due to the lighting of the sky and surrounding area the remote impact is expected too.
Lights on the intersecting points and on other objects are necessary in order to have as little stray light as possible. Lamp posts must be positioned at an optimal height and projected to direct the light where it is needed. It is inevitable that a small part of light will be reflected to other areas. However, through careful selection of technical solutions and proper installation, light pollution will be reduced to minimum.

One of the ways in which birds navigate is based on the position of stars. (Emlen, 1975). Light pollution from various sources reduces the stars visibility and can make difficult the bird migration. (Ogden, 1996).
This can especially, during adverse weather, lead to bird disorientation, collision and cause mortality.

In order to reduce light pollution, fixated lights along the road should be directed downwards with less power (< watt) and flat glazing to prevent light dissipation. These types of lights not only reduce light pollution and the negative effects on avifauna and bat fauna, but also efficiently save electric energy. In order to reduce the need for the electric light installation, it will be necessary for traffic signs and horizontal signalling on the road to have more reflection. This is especially important for horizontal signalling that needs to have greater reflection and be more vibrational/acoustic, which has become a standard during the work execution on modern roads. This is the way to give drivers a better visibility and reduces the need for electric lighting at the same time. (Hasson, 2000).

In order to prevent insect collision, the use of low-pressure sodium and metal-halogen lamps, which produce almost monochromatic light, wherever possible, and directed light is recommended (shaded lamps). These lamps emit yellow light only in narrow part of the spectrum and are relatively insect repellent. From the environment friendly aspect, high pressure sodium lamps are more unfavorable, which have a wider spectrum of light emitted.

The use of mercury and halogen lamps is not recommended. The reason for this is a strong emission in wide violet part of the spectrum, partly even beyond the visible area, where its light represents a major disturbance to birds and insects. In addition, lead lamps emit light at various wave lengths, so their light is impossible to filtrate. Also, the disadvantage is that the mentioned lamps are of short duration and their characteristics change with time.

For mammals, the road represents a barrier that fragments their habitats. The road impact is somewhat mitigated by the existing main road route planned for the reconstruction, from the Komanski bridge to the Danilovgrad roundabout. On the discussed road section, there are culverts which could be adapted for the passage of animals. Planned road culverts could function as animals if designed so that the land corridor is left. Also, land corridors can be placed underneath the bridges and be used for animal movement. In addition, landscape arrangement around the bridges and culverts is important whereby a natural habitat appearance created represents the possible shelter,and decreases the negative noise and light effects and destruction of the natural landscape appearance.

As far as protective fences are concerned, generally, except in case of a highway, the road should be built only in areas where a great number of dead animals is expected, as a result of collision with vehicles. Fences usually represent traps for small animals (e.g. impact on birds, entanglement in wire meshes, etc.) and at the same time represent an insurmountable barrier for animals, so designing and building them must be adapted to animals, taking into account the specificities of certain area and certain animal species presence as well. When determining the locations for fence installation, it is necessary to take into account the existing locations and possible ecological passage ways, bearing in mind that mentioned fences should not be a barrier.

Recommendation is to set the thicker protective mesh fence with the size of an eye 10x10 mm, the height of 50 mm including 10 cm buried into the ground (according to Hahn, 2015) on sites where during the previous years a significant percent of death of a forest tortoise specimen was encountered when crossing the road route. (a part of the route 3, according to the Vuk Ikovic's report and consultations with him).

The installation of the protective mesh has significantly reduced the death of the forest tortoise on parts of the same route in the proximity of Danilovgrad, which is not a subject of reconstruction now. (Vujovic et al. 2015) (Report on vascular plants, habitats and fauna, fish, amphibians, reptiles, birds and mammals) in the M-18 main road zone of the reconstruction project Danilovgrad-Podgorica).

The degradation of natural habitats will create a possibility of expansion of invasive allochthous species (Ambrosia artemisiifolia, Ailanthus altissima, Robinia pseudoaccacia) and during the reconstruction and the use of discussed road section, there is a possibility of entrance and expansion of new species.

6.2.7.2. Impact on loss and damage of geological, paleontological and geomorphological properties

The term geological environment implies: geological structure, lithological composition, mineral raw materials and pedological structure. Sediments covering periglacial karst field, the Zeta-Bjelopavlići plain, are glaciophluvial (glf) and lake-marsh(Q), with the terraced sediments of gravelly-sandy composition that prevail in the Zeta valley, which are predominantly linked to conglomerates and lake-marsh sediments, and the clay prevalence in the Bjelopavlići plain.
No deposits or occurrence of other raw minerals except for limestone, which can be used as a technical-construction stone are present on the main road. No registered localities of paleontological significance are present in this area. As it has already been said, the reconstruction of the existing M-18 main road, certain amounts of dust particles occur and, similarly, certain concentrations of dust that will be deposited on a surface. Dust sediments will be of the same chemical composition as the surrounding area, whether it is the dust coming from the limestone or from flysch sediments. For this reason, emitted or sedimented dust concentrations cannot have an adverse effect on the surrounding land. The amount of excavated stone mass, which cannot be used for embankments will be deposited on landfills, and protection measures presented in detail in section 7.4.7. „Protection measures“ have defined disposal of surplus material guidelines. Also, in case of the discovery of „archaeological, paleontological objects and groundwater“, the works will be stopped and the Montenegrin authorities will be notified without delay. The contractor is obligated to act on the requirements and procedures determined by the authorities for the facility preservation and protection of groundwaters.

6.2.8. Impact on the purpose and use of surfaces

The purpose of the existing surfaces and use of land which will be permanently occupied during the M-18 reconstruction is shown in detail in the Expropriation Study.

6.2.9. Impact on the use of agricultural soil

Long-term impacts on the use of agricultural soil and changes of land use due to the land parcel reduction or difficult access can be examined from the aspect of traffic flow on the Podgorica-Danilovgrad road section.
The harmful substance concentration in the air and soil is important for the agricultural goods cultivation, and in the road zone, it is related to the fuel component presence: hydrocarbons, organic and non-organic carbon, nitrogen compounds (nitrates, nitrites and ammonia). Specific group of elements are heavy metals such as lead (fuel additive), cadmium, copper, zinc, mercury and nickel.
In the event of precipitation, sedimented harmful road substances and accompanying elements of the cross-section are washed away, leading to land pollution. Lead and cadmium represent the most significant polluting substances in agriculture and food cultivation. A significant level of lead and cadmium ground pollution caused by waste water deposits appears in the first zone of impact (from 1 to 10 m from the edge of the roadway), reaching their highest impact in the zone from 1 to 5m along the road. Taking into account the vehicle fleet modernization in the future, significant restrictions related to exhaust gas and fuel quality, the drainage concept of the Podgorica-Danilovgrad road has been adopted (controlled collection and purification of waste stormwaters until required quality for the recipient is reached). It can be concluded that the negative effects on agricultural soil in the discussed corridor will be reduced to minimum.

7. DESCRIPTION OF MEASURES FOR PREVENTION, REDUCTION OR REMOVAL OF HARMFUL EFFECTS

During the implementation of „The M-18 main road reconstruction, Podgorica-Danilovgrad section“ project, it is necessary to carry out measures to prevent or eliminate possible pollution and to ensure optimum works, the environment protection and human health from the potentially harmful effects of this project.
The objective of establishing reduction or prevention polluting measures is to investigate potential possibilities of pollution elimination or even reduction of identified effects.

The environment protection implies permanent protection of valuable natural and material assets to preserve and improve the environmental quality on the territory of Podgorica and Danilovgrad, as well as on wider areas.

The environmental protection conditions should be achieved at three levels: at the stage of construction design, at the stage of construction works and at the stage of use.

In order to protect the environment, it is important to adhere to the applicable legislative and norms, which include the following areas: urboecology, fire protection, noise protection, thermo-technical facility protection and soil and air pollution protection.

The construction technology and the use of adequate construction equipment must be adapted to the municipal decisions that protect the conditions of the designed facilities, the environmental protection and sanitary and hygienic measures for the space preservation.

At the stage of technical documentation drafting, the contractor has adopted contemporary solutions from the environmental protection field.

At the stage of terrain excavation and its preparation for the described function, the constructor will constantly monitor any possible oil and fuel spillage from the machines working on this project.

7.A. Description of measures for prevention, reduction or removal of harmful effects during construction works

7.1. Measures stated by the law and other regulations, norms and standards and deadline for their implementation

Regardless of the temporary environmental effects, it is necessary to take all legal measures to reduce all the temporary negative effects on the environment.
This category includes all the protection measures to be taken within the conceptual project framework, and whose implementation is a prerequisite for minimizing the possible environmental effects:

1. Implement all the conditions and requirements established by the authorities of Montenegro when issuing approval for executing works and using temporary facilities,
2. Implement all the legal procedures for activities which require licences, approvals and consent, with a special emphasis on the use of surface and ground waters,

3. Make municipal waste management plans (transportation of municipal waste must be entrusted to the competent utility organization),
4. Obtain an approval for storage of non-hazardous building waste, and all the necessary documentation that precedes it

7.2. Measures to be taken in the event of an accident

1. After an emergency related to the spillage of hazardous substances, rehabilitate and bring the terrain into its original state, do a report and take all the corrective and preventative measures,
2. In danger zones substances and devices which could cause fire and explosion, or could cause fire spreading or explosion, must not be present,
3. Provide adequate equipment for fire extinguishing, mobile firefighting equipment and fire hydrants, all according to the approved fire protection Study,
4. The contractor is obligated to maintain firefighting equipment and keep it in a proper condition and inform workers about the fire protection measures, equipment and the methods of using it,
5. If there is a need for the use of hazardous substances in the future, those substances must be stored and disposed of legally, in order to prevent the environmental pollution.

7.3. Plans and technical solutions for the environmental protection

1. Draw Waste management plans, and the transportation of waste materials must be entrusted to the competent organization,
2. Obtain permission for disposal of non-hazardous construction waste, and all the necessary documentation which precedes it,
3. Handle the waste made from the execution of construction works in accordance with the Regulation on Construction Waste Treatment, the Manner of Construction Waste Processing, Conditions and Manner of Asbestos Construction Waste Disposal (Official Gazette of Montenegro 60/10) and defined procedures in the Study design,
4. Construction waste can be temporarily stored in the construction zone site until construction works are finished, and in accordance with the legislation of Montenegro,
5. Generated waste must be sorted according to its origin (waste catalogue), category (waste list) and characteristics,

6. It is strictly prohibited to mix different types of waste
7. The contractor should keep a record of types and amount of construction waste on a monthly basis,
8. The contractor makes a plan for the construction works management, to which the consent is given by the competent authority in accordance with the law.

7.4. Mitigating measures related to the construction stage

The application of materials and technological procedures that are ecologically safe and acceptable can significantly mitigate and sometimes even eliminate the negative environmental impacts of road reconstruction. Temporary and limited impacts caused by noise, dust and vibrations during the execution of extensive construction works should be minimized through protection measures.
The project developer is obligated to define special protection measures for each type of work and to take adequate activities for mitigating the negative construction effects on the site, which are an integral part of construction site management.
Mitigating impact is divided into four phases:

1. Construction site preparation
2. Procurement of materials, i.e. procurement of materials for the embankment construction
3. Management of construction activities
4. Closing the construction site after the completion of works

Procurement of materials – provision of materials and raw materials to be used for construction

The contractor is obligated to use materials from the existing production facilities of asphalt, quarry or sand and gravel separation that have valid environmental and other permits and approvals, i.e. must use controlled and licensed courses for all the necessary materials. It is strictly prohibited to build the route with any type of construction materials for which a valid documentation does not exist.

Protection measures related to the disposal of surplus material

Surplus material that appears during the construction works on the M-18 main road reconstruction, section Podgorica-Danilovgrad, must be temporarily disposed of at precisely defined locations along the discussed route, (in accordance with the

project design) after which it will be permanently disposed of at a location determined by the competent local authority. The contractor must draft a contract on surplus material disposal with a competent local authority. The contractor is obligated to draft a non-hazardous construction waste management plan in accordance with the regulations.
It is strictly forbidden to dispose of excavated surplus materials into river beds, river banks and agricultural soil.

Measures related to material transport

The use of modern and efficient mechanization and the protection of trucks and other bulk material transporting vehicles is mandatory. Also, the contractor should prepare and submit a traffic management plan for the approval to the supervisory body, which defines the routes and time which will be used for the material delivery to and from the construction site. This is especially important when the contractor uses the main road under intense traffic.
Also, the speed limit on unpaved road reconstruction sections is mandatory, as well as the recommendation to avoid „idling“ of the construction machinery.

Noise protection measures

Prior to the start of construction works, the contractor is obligated to prepare a methodology and method of work describing the types of works and suggested measures and methods for noise control.
The work programme should contain locations for each activity, specifying the noise source for each activity, the documentation that defines the noise source levels and estimating the maximum noise levels an specific locations that may be required by the supervisory body.
The contractor's working time will be limited to daily working hours and the use of equipment with sound suppression.
In order to limit a possible negative noise effects on human health in the zone during construction, it is necessary to:

- Meet the standards for the noise emissions caused by construction machines and other equipment
- Regularly monitor the noise level for introducing corrective measures for exceeding allowed levels,
- Bring mining to a minimum.

The contractor must take all the adequate measures to minimize the noise levels and vibrations and must abide by all legal requirements related to employees, people living nearby and fauna in the zone during construction works.

Measures related to greening

During construction works on M-18 reconstruction, it is necessary to carry out greening. Greening is the responsibility of local authorities, whereas some parts of the discussed road belong to the mentioned authorities.

Protection measures of flora and fauna

For the purposes of the project „ THE REPORT ON VASCULAR PLANTS, HABITATS AND FAUNA (FISH, AMPHIBIANS, REPTILES, BIRDS AND MAMMALS) IN THE ZONE OF INFLUENCE OF THE PROJECT OF THE M-18 ROAD RECONSTRUCTION, PODGORICA-DANILOVGRAD SECTION“ has been drafted. This report has provided a detailed description of flora and fauna of the area in question, and its possible impacts as well as its counter measures that need to be implemented during the project implementation and the period of its exploitation. The mentioned report is provided in the enclosure of the Study.
The location of culverts given in the subchapter 3.10. will serve as locations for the passage of mammals, which will allow the undisturbed passage of mammals across the discussed section route.

The Environmental protection law (Official Gazette of Montenegro 51/08, article 85) lists protection measures of migratory animals:

- Public roads and other types of roads, as well as other facilities shall be built in a way to reduce the negative effects on migratory animal roads and allow safe movement of wild animals at appropriate space distances.

- Measures from paragraph 1 of this article are ensured through the application of special construction and technical-technological solutions on the facilities themselves and their proximity.

- Special technical-technological solutions (ecological bridges, constructed passages and crossings, tunnels, discharge pipes, junctions, trenches, safety and directional facilities, fish ladders and lifts, etc.) which ensure undisturbed and safe passage of wild animals enjoy protection as protected natural goods.

- The Ministry of Defence from paragraph 3 of this article shall prescribe protection measures and the maintenance manner, subject to the consent of the state administration body responsible for traffic affairs and the state administration bodies responsible for the affairs spatial planning.

- Prior to the start of construction works, the construction waste disposal places and other waste materials shall be carefully chosen, as well as temporary parking lots and the construction equipment handling, fuel stations, etc., all in order to ensure vegetation protection.

- During the construction of bridges and culverts, it is an imperative to minimize the impact on habitats as during construction, the existing migration corridors will be used for the passage of animals.

Based on the stated legal norms that apply to the migratory animal protection, it is important to note that the project developer, through the contractor, ensures that all the culverts that will be reconstructed or built, shall be prepared in such a way to allow the passage for migratory animals. Also, spaces underneath the bridges shall be built so that they can be used for the mentioned purposes. All the above listed passages, i.e. culvert locations and bridges are designated by survey marks, mentioned in the project design of chapter 3 of this Study.

Soil protection measures

As noted in the previous chapters, for the purposes of construction works execution of the M-18 reconstruction, Podgorica-Danilovgrad section, appropriate mechanization is used for which it is necessary to deliver the required amounts of fuels, oils and lubricants. With that in mind, it is necessary to ensure that all the activities are carried out at special locations during re-fuelling, oil and lubricant changing, by paying special attention to not spill the fuel, oils or lubricants into the surrounding soil. If, however, this happens, then the contaminated soil must be collected and temporarily placed in leakproof containers. Such contaminated soil will then be given to an authorized company licensed by the Nature and Environmental Protection Agency to collect hazardous waste.

Dust protection measures

During the construction works, due to certain weather conditions (dry period), higher concentrations of dust may occur on the route area, which may have a

negative effect on the local population and employees working on the M-18 reconstruction, Podgorica-Danilovgrad section. Regular application of the drainage process and use of available technical possibilities for the increase of humidity, significant effects of dust emission prevention and air protection are achieved in the working and living environment, without interfering with technical requirements for the construction works and material transportation. The contractor is obligated to perform regular drainage on the route where the works are to be performed.

Surface and ground waters protection measures

Considering that on the discussed route of the Study has several localities where the reconstruction of the existing bridges and construction of new ones will be performed (bridges Sušica, Mareza, Matica, Komanski ski bridge-Sitnica), as well as a part of the discussed section, with high groundwater level, it is necessary that the contractor strictly adheres to the technology of the construction works. The contractor must keep in mind that during the construction works no water turbidity when drilling piles is present. It is necessary to enable a controlled access of mechanization to watercourses, that is, nearby surface waters in the construction zone. With that in mind, it is necessary to perform the measurement of surface water turbidity on a daily basis during the construction works.
Also, the excess excavation material will not be disposed of in river beds of the mentioned watercourses, and it is prohibited to do refuelling, oil and lubricant replacement in the proximity of watercourses during construction works. Refuelling, oil and lubricant replacement on the machinery can be performed only at a specified location, and can not be in the proximity of watercourses in the high surface water level zone.

Measures for collection, separation, reuse and recycling of construction waste generated during the demolition of facilities along the route

As already noted, the M-18 reconstruction project design intends the demolition of some facilities in the zone of the discussed section. The project design has not elaborated on the demolition methodology of the mentioned facilities as it has been planned that the Contractor selected on the Tender would carry out an elaboration of the removal of facilities, in accordance with the Law on Space Planning and Construction of Facilities, which was not the subject of this Study. Nevertheless, the authors of the Impact Assessment elaborated briefly in this subchapter on the measures to be taken during the process of facility demolition such as Motel Pejovic or the Europetrol and DAK petrol stations canopy on the M-18 route,

Podgorica-Danilovgrad section. Accordingly, the obligations of the investor, i.e. the producers of waste are the following:

- The contractor is obligated to prevent the mixing of different construction waste. If the mixing of construction waste is not possible, the investor is obligated to ensure the removal of all hazardous substances prior to the commencement of works.
- The contractor is obligated to do construction waste transportation at the location designated by the local authorities, or provide a contract for the construction waste landfilling by the authorized company before the commencement of works.
- Waste producers are obligated to carry out a monitoring and record keeping programme.
- Waste producers and waste owners are obligated to collect, take care of reusable materials and recycle or deposit waste, which is the product of their activities and waste they own.

Mining protection measures (for I, II, III, IV and V zones)

Mining protection measures relate, above all, to safe distances during mining. Determining the safe distances during mining starts from:

- The amount of estimated explosives in boreholes and mine field
- Arrangement of gas cartridges
- Selection of millisecond deceleration and method of deceleration
- Determining safe distances relates to:
- Safe distance due to effects of seismic disturbances caused by mining;
- Safe distance due to effects of air shock waves;
- Safe distance due to flying objects caused by mining;
- Determining gas-hazardous zones

Safe distance due to effects of seismic disturbances

The safe distance estimates (due to seismic disturbances caused by mining) and the amount of maximum explosives allowed for single-time activation is based on the regulations of the 10 cm/sec oscillation speed limit.
The dangerous seismic zone radius of mining activities is obtained using the formula:
Zone I: R= 9,41 m
Zone II: R = 11,83 m

Zone III: R = 13,56 m
Zone IV: R = 14,93 m
Zone V: R = 17,99 m

Safe distance due to effects of air-detonational shock waves

Safe distance due to the air shock waves effects are calculated based on Langefors, Sadovski and Medvedev's formula:

$$R_s = K_v . \sqrt{Q} (m^1)$$

Where:

Kv – the proportionality coefficient depends on the conditions of location and the amount of explosive charge, Kv = 4,

- Zone I: R = 8,94 m
- Zone II: R = 12,65 m
- Zone III: R = 15,50 m
- Zone IV: R = 17,89 m
- Zone V: R = 23,66 m

The danger zone radius per person is:

- Zone I: R = 12 m
- Zone II: R = 16 m
- Zone III: R = 20 m
- Zone IV: R = 23 m
- Zone V: R = 30 m

Determining gas-hazardous zones when mining

The gas-hazardous zone radius due to mining (R_g) is determined according to the allowed concentration of harmful and toxic gasses – converted to carbon monoxide, at the limit of maximum concentration allowed.

$$R_g = K_g . \sqrt{C.Q} (m^1)$$

where:

Kg – experimental coefficient (Kg=1,0-1,5);

C – the amount of gas converted to CO (C=10 l/kg);

Q – total amount of explosives in mining field (Zone I Q =20 kg, Zone II= 40 kg, Zone III=60 kg, Zone IV=80 kg, Zone V=140 kg);

- Zone I: R = 14,14 m
- Zone II: R = 20 m
- Zone III: R = 24,50 m
- Zone IV: R = 28,28 m
- Zone V: R = 37,42 m

It should be noted that in the event of air currents in the direction of inhabited areas, this radius is increased several times (3-5 times), so in case of strong winds, mining should be halted, or performed in the reduced extent, or in order to reduce possible effects on the facilities and population nearby, the amount of explosives to be used should be adjusted.

7B. Description of measures for prevention, reduction or removal of long-term harmful effects during exploitation

Measures stated by the law and other regulations, norms and standards and deadline for its implementation

Protection measures prescribed by the Law and other regulations define procedures and rules of conduct that all the participants in the realisation of this project should follow.

- In the event of route adjustment as well as its technical solutions and accompanying infrastructure during the project finalization stage and/or execution of works related to the road and technical solutions contained in the approved Study, the project developer (the contractor and the future road controller) are obligated to contact the Nature and Environmental Protection Agency of Montenegro in order to determine whether this adjustment has a negative environmental impact;
- In the event that some designed activities are to be realised, for which the Environmental Impact Assessment (construction of new and existing access road reconstruction, relocation of existing local roads, building construction roads, construction of temporary facilities for the accommodation of employees, cleaning of the terrain, depositing excavated surplus material, etc.) has no been planned and are found in the protected area, the investor is obligated, according to article 11 of the Environmental Protection Law (Official Gazette of Montenegro 51/08, 21/9, 40/11, 62/13, 06/14) to obtain approval for the execution of works from the Nature and Environmental Protection Agency.
- According to article 141 of the Law on Waters (Official Gazette of Montenegro 32/11, 47/11 and 48/15) for the purposes of preservation and

maintenance of natural and artificial water bodies and protective and other water facilities, prevention of water regime deterioration, securing the passage of large waters and the implementation of protection from the harmful water effects, as well as the environmental protection, it is forbidden to:

1) Excavate and deposit waste material on embankments and other water facilities, graze livestock, pull cut-down trees, drive motor vehicles, except in places where it is allowed to perform other activities which may endanger the stability of those facilities;
2) On water resources:

a) construct temporary and permanent facilities that reduce the permeability of riverbeds
b) deposit solid waste and hazardous and harmful substances,
c) store wood and other solid material in such a way to interfere with the passage of great waters,
d) exploit river sediments without proper consent,
e) perform other activities, except in case of:

- construction of public infrastructure facilities in accordance with this or other laws;
- implementing measures for the preservation of natural resources;
- construction of facilities, in accordance with this law, for the use of waters, regulation of watercourses, secure safe navigation and protective measures on natural bathing areas;
- construction of facilities for the protection of waters from pollution and construction of facilities intended for the state defence;
- construction of temporary gravel and sandy landfill in such a way to not interfere with the passage of great waters, at a distance of at least 30m from the embankment;
- preforming activities in order to protect people, animals and property;

3) build facilities in flooding areas in such a way to disrupt the watercourse or contrary to the requirements for construction in the flooded areas;
4) plant trees on dikes, in floodplains at a width of 10 m from the embankment toe to the watercourse and in the forbidden zone at a distance of 50 m from the toe of the embankment;
5) dig wells, trenches and canals next to the embankement in the width area of at least 10 m from the embankment toe to the watercourse, i.e. 50 m from the forbidden area, except if their function is the protection from harmful water effects, i.e does not disrupt the embankment stability;

6) change or cut the ground water flows, or use the waters to the extent of endangering the supply of potable or technological water or endanger mineral and thermal springs, the stability of soil and facilities;
7) alter the direction and intensity of surface water flow with a natural flow or is runoff water in private property without proper consent;
8) build facilities, plant trees, plow or dig soil and perform other activities which disrupt the function or endanger the stability of amelioration drainage canals and at least 5 m of width from both sides of the canals, required for their regular maintenance;
9) put solid waste and other materials into watercourses, accumulations, retention areas, amelioration and other canals, releasing contaminated waters or other substances and do works, including material excavation, which may lead to disruption of riverbeds and banks of the natural and artificial watercourse, alter its route, water level and the amount water quality, endanger the stability of protective and other facilities or make it difficult to maintain the water system;
10) perform interventions in stream beds without water acts (protecting banks, rearranging, expanding and deepening beds, etc)
11) perform works which may disrupt the stability of the dam or its purpose, as well as changing the natural conditions near accummulation and retention basins in such a way to cause landslide, erosion or occurrence of gullies and torrents;
12) perform other works which may endanger the stability and make difficult the maintenance of regulative, protective and other facilities.

The prohibition of construction works from paragraph 1 of this article can be extended outside of river basin land, if those works disrupt water regime or water facilities.

- The contractor and future road controller are obligated to act in accordance with all the regulatory requirements related to the limited intensity values of specific factors such as noise, air pollution, water pollution, etc. Protection measures should bring specific impacts at the level of allowed intensity in the scope of specific construction action.
- At the construction and exploitation stage of the section discussed, it is necessary to carry out environmental monitoring, and to report the Authorities of Montenegro, public concerned and population living in the zone of possible negative effects,
- The future road controller will draft maintenance plans of the designed elements related to the environmental protection (greenery, water purification system, etc.)

- The future road controller of the subject road will ensure the monitoring during construction works in order to control the implementation of the protection measures prescribed from the experts in the given field.
- Provide instruments, within the contractual documentation formed by the investor and contractor on the necessity of respecting and enforcing the prescribed protection measures.
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Waste waters protection measure

As far as waste waters are concerned, during the road function only stormwater runoff drained through catch pit grates, channels and canals to the oil and oil derivatives separator, after which they are released into the recepient. For the waste water road purification the 31 separator is required. Given that it was not possible to bury the collectors at greater depths due to a shallow recipient, it is necessary to choose the separator type whose by-pass is at the very top of the separator (manufacturer TECHEAU or others that have by-pass at the top)

As the M-18 section (From the Komanski bridgeto the Danilovgrad roundabout)is planned to be reconstructed, the installation of 31 separators is planned, in addition to the regular discharge (cleaning) of the separator, it is also necessary to control the functionality of the separator as well as perform the control of comprehensible hydro-engineering infrastructure such as culverts, collector for stromwater sewage, etc.

Since M-18 main road route to be reconstructed crosses over the bridges mentioned earlier (existing and planned bridges), it is necessary to provide the required number of catch pits which shall be connected to the collectors and separators. This is of great importance, given that the major part of these watercourses will go directly into the protected area of the Zeta river and the pollution is not negligible.

Separators are intended to be buried into the ground. The depth of the installation, measured from the elevation top point of inspection fitting to the bottom point of inlet pipe Tmin = 1180 mm, maximum depth allowed for installation with the use of additional rings for the increase Tmax depends from the model of the chosen

separator (cca 5 cm). All the separator elements are made of reinforced concrete (EN 206-1), concrete strength class MB 45, ambient exposure class: XA3, XF4.

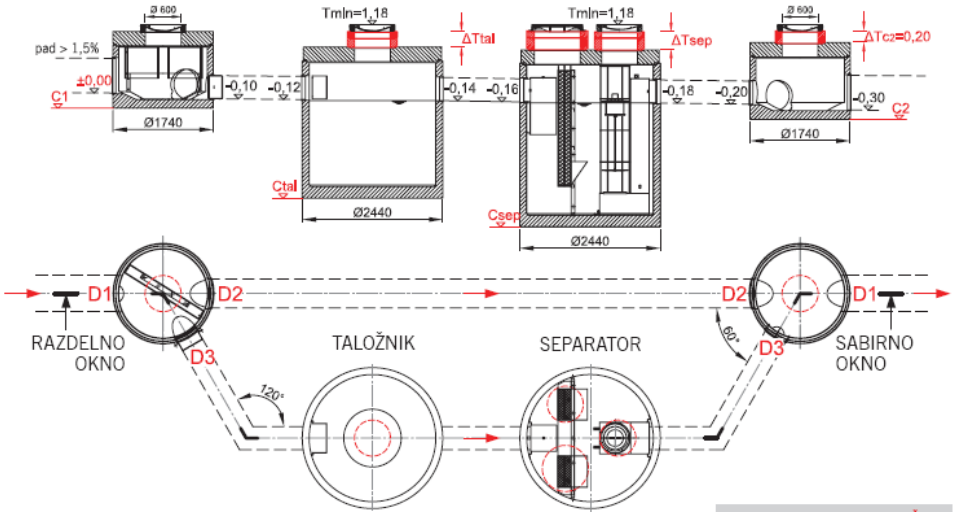

Image 13. *Example of separator installation*

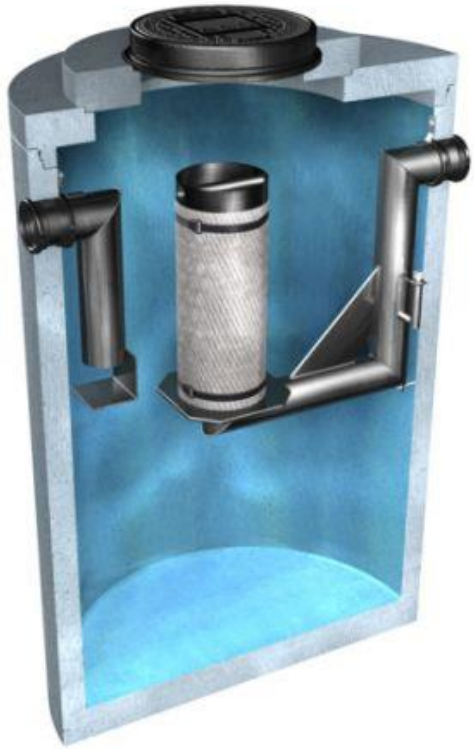

Image 14. *Separator with EXTERNAL BY-PASS*

The purification effect for class I (coalescing separators) – must allow the amount of mineral oil in purified water < 5mg/l.

All elements of the roadway water purification system which are maintained must be accessible at all times.

System maintenance will be conducted at least once in 6 months by experienced personnel. Maintenance is carried out in accordance with manufacturer instructions, it is necessary to include at least the following elements:

- Evaporation pond – determining the volume of the deposit
- Separator
- Measurement of depth layer of light liquid (light oil derivatives),
- Control of devices for automatic outlet closing valve
- Control of coalescing filter permeability, if there is change in water level after coalescing cartridge,
- Control of functionality of alarm device.
- Sampling pit,
- Cleaning of drainage channel.

Waste oil and sludge from the separator should be removed, if necessary, by the specialized company with which the project developer is obligated to sign a contract on enactment of these actions. Discharge from the separator is recommended when half of the total volume of the evaporation pond is reached or 80 % from the maximum capacity of light liquids. Before re-starting the separator, the device is to be filled with clean water.
Waste oil and sludge from the separator will be treated in accordance with Law on Waste Management (Official Gazette of Montenegro 64/11), Rulebook on Waste oil Management (Official Gazette of Montenegro 48/12) and Rulebook on the Manner of Keeping Records of Waste and the Content of a Form on Waste Transport (Official Gazette of Montenegro 50/12).
The cleaning and maintenance report will be available to the inspection services and swill contain notes on specific occurrences (e.g. repairs, incidents, etc.)

Noise protection measures

Given that the noise emission value estimates during the function M-18 have demonstrated that all the facilities found at a distance less than 25 m may be under the effects of certain noise level, it is necessary to obtain an adequate protection. Protection can be carried out only when noise monitoring precisely determines what facilities are affected during the functioning of the project. After noise effects

are determined and the facilities that are in the zone are recorded, it is possible to specify in which way these facilities can be protected from the noise.

There are several options for noise protection so several of them will be provided in this section:

- It is possible to use special materials for the sound isolation of the facade and replacement of windows which may ensure that the noise level inside the facility is within the legally allowed limits.
- It is possible to apply the noise protection structure for the use of absorbent materials, i.e. noise protection structure would be made of natural materials. (e.g. wood-concrete).

During the installation of new windows it has to be taken into account that there are sufficient amounts of fresh air in these facilities while they are closed. In any case, prior to undertaking any actions, it is necessary to carry out noise monitoring which will determine the actual noise level when the road is constructed.
If on the basis of measured noise levels, there are significant noise thresholds exceeded, it is necessary to draft measures for its reduction.

Measures in case of accidents

Preventative safety measures

- Loading and unloading of hazardous substances can be carried out only on sites where the health and lives of people, the environment or material assets are not endangered, in accordance with the regulations on the environmental protection.
- Sites where loading or unloading hazardous substances is performed will be equipped with apparatus or other fire extinguishing devices and must be adequately placed and visibly marked by warning signs.
- Devices for loading or unloading of hazardous substances shall be fully functional, so that during its use any leakage, spillage or droppage of hazardous substances are excluded, or to maximally reduce the possibility of polluting material emission in the air or damaged packaging.
- A consignor or consignee carrying out loading or unloading of hazardous substances is required to control the functionality of devices and electric installations on sites where loading or unloading is carried out, to take care of the functionality of technical devices, equipment and other fire and

explosion protection appliances, as well as environmental protection and to keep a proper record of it.

On sites of loading or unloading of hazardous substances, it is prohibited to:

- Keep substances and devices that may cause fire or cause the spreading of it;
- Keep open flame or working with open flames (welding, etc.);
- Smoke and use of ignition devices (matches, lighters, etc.);
- Use of devices or appliances with furnaces;
- Use of tools or other arcing devices;
- Install of overhead power lines regardless of voltage;
- Put vehicle engines into operation;
- The presence of people who do not directly participate in loading or unloading of these substances.

- As a rule, loading or unloading of hazardous substances is done during the day. If loading or unloading of hazardous substances is done during the night, lighting or loading or unloading must be electric, and all the installations must be electric, devices and lighting designed so as not to cause fire or explosion.

- During the time of loading, transportation and unloading of hazardous substances, the driver is required to act with the safety measures in accordance with the Law on Transport of Dangerous Goods and the ADR Agreement. A vehicle used for transportation of hazardous substances may only move on roads designated for the movement of such vehicles and stop and park only at places designated for such vehicles.

- Preventative safety measures include the application of some technical solutions during design and later on during the reconstruction of the discussed main road, which reduce the possibility of an accident occurrence with unfavourable consequences to the environmental quality:

- With the intended drainage system, i.e. storm water sewage, except for the controlled collection of waste storm water, a regular collection of accidentally released or spilled hazardous substances;

- It is necessary to ensure protection from spillage of light liquids from the separator system;

- Ensure protection from unintended vehicle drift from the road with traffic guard rails (New Jersey bumpers) on embankments, cuts, bridges, and in case of hazardous cargo spillage, ensure that the same channels and other road elements reach a road runoff purification system.

The function of such project carries with itself the risk of incidents that may manifest through a road accident, which carries with itself the possibility of air pollution, with substances due to fire on vehicles participating in an accident that leads not only to the endangering of people's lives but also the emission of hazardous substances into the air.

Protection measures from accidents are adequate control of compliance of traffic regulations on this M-18 section.

An accident occurrence, which is unlikely to happen, is failure of oil separator and oil derivatives that will be installed for the purification of road runoff. In the case of this event, an emergency intervention is necessary to clean and repair the separator.
The maintenance of the separator may be carried out by the separator manufacturer or other licensed company. We recommend regular maintenance of the separator every three months.

In order to prevent he occurrence emergency situations that may lead to fire in the road proximity, it is necessary to place warning signs along the road, concerning the littering of cigarette butts and glass packaging ban. This is imperative because cigarette butts and glass packaging littering is the main cause of fire during summer months.

Active measures in case of accidents include the work of maintenance services and also emergency interventions, traffic vehicle with hazardous cargo limitations measures, notification measures and signalling. These measures are the most important and crucial for the final outcome of any sudden pollution. Passive protection system including buildings and installations is rarely sufficient to neutralize negative consequences. Finally, if the same system accepts the spilled or dropped substance, an emergency drainage intervention, cleaning and sanation will be needed in order to prevent possible leakage into the ground and/or water. At places where the spilled/dropped substance exceeds the limits of controlled collection and purification stormwaters system, human action factor is crucial. The

the whole security protection system is significantly reduced if there is not a well organised and equipped maintenance service and an emergency intervention unit.
Protection measures during accidents due to the hazardous substance transportation, i.e. during traffic accidents and road incidents, even on the designated road are:

- Good organisation an emergency team on the field;
- Good equipment to work in circumstances of accidents;
- Providing the team with special suits and other protective equipment for these types of situations;
- Prompt decision making and emergency intervention at place of collision.

In the event of an accident, the transporter is obligated to provide, collect and remove the hazardous substance or to make it less hazardous in some other way and inform the Ministry, and depending on type and the amount of hazardous substance, inform the state administration body for health affairs, state authority body for environmental protection affairs, state authority for police affairs and state authority for inspection affairs.
If the transporter is not able to collect, remove or place spilled or dropped hazardous substances at a safe place, the Ministry shall invite the company society, legal entity or an entrepreneur who has the technical means to perform this activity at the expense of the transporter.
If due to the failure of transport vehicle or in case of a traffic accident, spilled or dropped substance needs to be reloaded, reload is carried out off the road by the transporter, while being obligated to ensure the security protection measures in the presence of state authority body for police affairs.
The transport of hazardous substances in road traffic may only be entrusted to the driver with a driver qualification certificate.

Protection measures in accidents caused by oil and oil derivatives spillage

In the event of accidents caused by oil and oil derivatives, it is necessary to primarily ensure public safety. Accordingly, the following is to be done:

- First call the emergency phone number listed on the transport documents. If there are no transport documents, or nobody answers the phone, the police should be called.
- The first precaution measure to be done is to isolate the spillage or leakage place at least 50 m in all directions.
- Prohibit access to non-authorized personnel.

- People intervening first should stand downwind and must not bend to the ground.
- It is necessary to wear clothing that includes:
- Equipment for positive pressure breathing (SCBA).
- Protective clothing worn by firefighters provides limited protection.

In the event of oil and oil derivatives leakage or spillage from the tank trunks during transportation, it is necessary to take following safety measures:

- Eliminate all sources of ignition (smoking, welding, fire) nearby;
- All equipment used for moving the product must be on the ground;
- It is prohibited to touch or walk on the spilled substance;
- Stop the spillage if it is not dangerous;
- Prevent the substance from entering the watercourses;
- Pumping remaining substance from the damaged tank trucks (if safe);
- Foam to prevent vaporization can be used for reduction of evaporation;
- Use dry soil, sand or other inflammable substance for absorption and backfilling, and place it in containers;
- Remove surface contaminants, as well as replace soaked soil and dispose it accordance with statutory regulations;
- Use clean tools and non-arcing kit for the collection of absorbed substance;
- Extract polluted ground water from existing wells near the leakage place;
- On endangered agricultural surfaces in the period of 2 to 3 years cultivate crops that have the ability of terrain decontamination (which cannot serve as food in that period).

In the event of spillage of larger amounts of oil and its derivatives and its penetration in the soil and ground waters, it is necessary to take the following safety measures:

- make drainage channels far from the spillage place for later substance drainage;
- cover the endangered areas of soil with sorbent (a substance successfully used for collecting spilled lubricants and oils by the absorption process), which is collected after the spilled oil and taken to decontamination;
- remove contaminated soil layers and backfill with non-contaminated;
- Water spray can reduce evaporation, it cannot prevent indoor ignition.

In the event of fire caused by oils and its derivatives, it should be noted that these products have very low ignition point: use of water spray for extinguishing can be inefficient.

Small fire:

- Dry chemical, CO2, water spray or regular foam.

Big fire:

- Water spray, fog or regular foam.
- Use water spray or fog; do not use direct spurt.
- Remove containers from the areas with fire, unless it is dangerous.

Fire on tank trucks or trailers

- Extinguish fire at the maximum distance or use static fire-extinguishing installations or nozzle monitor.
- Cool containers with large amounts of water until fire is completely extinguished.
- Immediately move away if sound from the safety ventilation holes is heard or the colour of tank is changed.
- Always move away from the burning tank.
- In case of big fire, use static fire-extinguisher or monitor nozzle; in not possible move away from the fire and let it burn.

It should be noted once again that the water must not be used for extinguishing such fires, only for cooling off other non-burning tanks that are in the vicinity.

If evacuation of people is necessary:

- In case of bigger spillage: an initial evacuation is recommended in the direction of the blowing wind at least 300 m.
- In case of fire: if the reservoir or tank is on fire, the area of 800 m should be isolated in all directions; also, the distance for the initial evacuation of 800 m is recommended in all directions.

First aid to the injured person in oil and its derivatives accidents is the following:

- Take the person to fresh air.
- Call the emergency phone number.
- Do CPR if person is not breathing.
- Give oxygen person has difficulty breathing.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with the substance, wash off skin or eyes with running water for at least 20 minutes.
- Rinse skin with soap and water.

- If the person has burns, cool with cold water immediately as long as it takes.
- Do not take off clothes if clinging to the skin.
- Keep the person warm and let the person rest.
- Medical staff must be notified about the type of substance and adequate measures need to be taken for protection.

The project developer is obligated to keep the characteristics proposed at the stage of planning, in the scope of parameters relevant for the analyses stated in this Study.

Plans and technical solutions for the environmental protection

Plans and technical environmental protection measures include all the measures necessary to be provided or are provided by the project in order to reduce and, where possible, to prevent negative effects i.e. bring them into legally permissible limits. Within this viewpoint, all the protection measures from air pollution, land protection measures, surface and ground water measures, noise protection measures; population protection measures, flora and fauna and landscape protection measures are considered.

Air pollution protection measures

Emission and imission vehicle contaminating substance estimates, during exploitation, within the planned scope of traffic, have demonstrated that air pollution is limited to the buffer road strips, except for nitrogen-dioxide, which at certain locations exceeds the buffer road strip, based on the direction, intensity and frequency of the dominant wind. Reduced emission of exhaust products „sus“ engines can be achieved by reducing fuel consumption and using ecologically acceptable fuels.

Land protection measures and surface and ground waters protection measures

Given the proposed collection and purification of M-18 runoff waste stormwater, Podgorica (the Komanski bridge) – Danilovgrad (roundabout) section, it is necessary to implement the following technical land protection surface and ground water measures in separators before its release into the recipient:

- Controlled collection of runoff waste stormwaters drainage must be purified to the required quality to be released into the recipient. (temporary or permanent watercourse, surrounding terrain). Road runoff waste waters

should be directed through the gutter to collectors and separator, where once purified, it will be drawn into the recipient.

- The investor or the future road controller is obligated to draw up a Rulebook on device functioning for purification of waste stormwaters and organise a course for the personnel on work monitoring, surveillance and maintenance water purification.
- All the road runoff water purification system elements maintenance must be accessible at all times.
- System maintenance must be carried out at least once in every 6 months by the competent personnel. Maintenance is carried out in compliance with the manufacturer guidelines, but must include at least the following elements:
- Evaporation pond - determining separator accumulated sediment volume
- Measuring light liquid layer width (light oil derivatives),
- Device control for automatic outlet - valve,
- Inspection of coalescing filter permeability, it there is a change in water level after the coalescing filter
- Inspection of the alarm system function
- Sampling pit
- Cleaning of drainage channel

- Waste oils and sediment from the separator should be removed when necessary by the specialised company with which the project developer is obliged to conclude a contract on performing these actions.
- The separator drainage is recommended when half of the total amount of volume of the evaporation pond is reached or 80 % from the maximum capacity of light liquids. Before its re-starting, it is necessary to fill the device with clean water.
- With waste oil and separator sediment shall be treated in compliance with the Law on Waste Management (Official Gazette of Montenegro 64/11, 39/16), Rulebook on Waste Oil Treatment (Official Gazette of Montenegro 48/12) and Rulebook on the Manner of Keeping Record of Waste and the Contents of the Waste Transport Form (Official Gazette of Montenegro 50/12).
- In intervals of up to 5 years, the separator must be emptied and subjected to general inspection and control of the following:
- System tightness,
- Structural stability,
- Internal protection, if it exists,
- The state of internal elements,

- The state of electric devices and installations,
- Inspection of the device adjustment for automatic closing, valve

The report on cleaning and maintenance must be available to the inspection services and must contain notes on specific occurrences (e.g. repairs, incidents, etc.)

Population protection measures

Population protection measures whose housing units are located in the M-18 route zone include primarily air pollution protection measures, noise, water and land pollution, which is stated in the previous part of the Study. Some of the protection measures are technical measures, functioning as population protection and increase general safety in traffic, i.e. intersection of the mentioned road with other roads.
Given the M-18 reconstruction project, Komanski bridge to Danilovgrad roundabout section, includes the demolition, i.e. the removal of some housing and business facilities, the regular mitigation measure is securing an alternative nearby location for activities in question, as well as compensation, i.e. „social and commercial rehabilitation“. Within the scope of this project, it is necessary to take into consideration the relocation and compensation for people whose facilities or way of life are directly affected by the project. Compensation will also be ensured through property restructuring and pathway adjuctement affected by the road reconstruction.
Negative effects on local community and social environment during road maintenance may be mitigated by well-designed traffic management plans, use of low noise equipment, doing the loudest activities during the day and focussing on improving the quality of signalling, bumpers and other equipment contributing to safety and local accessibility.

Flora and fauna protection measures

The existing road section from the Komanski bridge to the roundabout in Danilovgrad, as a linear construction, intersects the existing area and has a certain effect on the existing habitats of flora and fauna, i.e. it leads to fragmentation of habitats and populations inhabiting it.

Flora protection measures

- It is necessary to maximize the protection of the existing flora.

- Adequate and continuous application of the protection of the existing flora in the wider influential zone through fight against phytopathological and entomological diseases, as well as through the application of care measures and regular maintenance of all vegetative levels in all developmental phenophases;
- State monitoring in the wider influential zone over a period of 3 years after the reconstructed road is put into operation.
- From the herbivore species intended for horticultural decoration of different surfaces along the road, autochthonous spices that form populations in the wider area of the routes should be used.

Fauna protection measures

Protective fence installation along the road at places where applicable will prevent wild and domestic animals from escaping and prevent their death, as well as endangering traffic safety. Animals are directed by the protective fence which should be accompanied by landscaping.
However, it is necessary to leave space for daily and seasonal migrations of the animals from one side of the road to the other. For the space in question, there are no data on regular animal migratory patterns that could represent the basis for the formation of special structures and their movement in the form of landscape bridges and crossings. However, on the road in question, there are a certain number of objects (culverts, bridges), which, in addition to their basic function, may also have the function of passings or crossings, if they are adequately designed and arranged so that it is not necessary to design special structures for animal passing / crossing.
The road controller is obligated to monitor fauna in the first 3 years of exploitation in order to track:

- Animal death,
- Endangerment of endemic, strictly protected spices of animals,
- Difficult migration of some animal groups (gene exchange, food and water search, etc.).
- Reduction of biodiversity.

Light installations on the collector distributor will be placed so that they emit light where it is foreseen, and less horizontally or to the sky. The light intensity should not be higher than the minimum light needed and the light should be directed only to those parts that are required to be lit.

In order to prevent the collision of insects with the lamps, it is recommended to use sodium and low-pressure metal halide lamps that produce almost monohromatic light wherever possible and direct light (shaded lamps). These lamps emit light only in the narrow part of the spectrum, yellow in colour and are relatively insects repellent.

The investor proposed lighting the main road with LED lamps (metal-halide „white lamps“, CFL compact fluorescent lamps, LED- warm white, Lemnis prototype LED light on the road).
The use of mercury and halogen lamps is not recommended. The reason for this is the high emission in the violet part of the spectrum, partly even outside of the designated area, where the light causes a major disruption for insects and birds. Additionally, mercury lamps emit light on numerous wave lengths so it is impossible to filtrate it- also, unfavourable is the fact that the mentioned lamps are short-lived and their characteristics change over time.

Landscape protection measures

- Within the project documentation, it is necessary to carry out the road design within the limits defined by the exploitation project. The adjustment of green areas should include the dividing strip, guard rails from each side of the road; slopes and channels from the outer border of the shoulder to the protective fence; lateral road surfaces limits by the protective fence on one side and expropriation border on the other and the surface within the delevelled intersections.
- Applied solutions to be complied with the surrounding area in order to blend the road to the existing area.
- The existing flora abound the bridges should be maximally protected to make the environment more natural for the animal migration. Planting vegetative materials should be far from the bushes and herbaceous plants or grass that would be planted in such a way to stimulate the natural process of new vegetative community creation. The emphasis is put on the targeted refinement of the under and ground layers with perennials and grass to support the natural seasonal vegetative changes and emphasise visual and utilitarian attraction of vegetative composition, as an instrument of directing animals to use the passage.
- Planting vegetative material should be chosen according to the criterion of autochthonous and nutritional value, but also as a minimum requirement for planting and maintenance.

- It is recommended that greening be carried by the local authorities of Podgorica and Danilovgrad, at parts of their territorial sections.

8.ENVIRONMENTAL IMPACT MONITORING PROGRAMME

1) In compliance with the existing legal regulations of Montenegro, a monitoring environmental programme is also necessary. As mentioned in the previous chapters during the project functioning „Reconstruction of the existing M-18 main road Podgorica-Danilovgrad“, the project developer „Traffic Directorate“ of Podgorica, there will be noise occurrences and air pollution due to the motor vehicle circulation on this road section, as well as road runoff waste stormwaters.

Design and monitoring implementation of the environmental quality in the M-18 main corridor route, with reconstruction section planned from the Komanski bridge to the roundabout in Danilovgrad, will obtain information that will ensure: the efficacy of planned protection measures, defining and taking additional protection measures to prevent or reduce further degradation of environmental quality and establishing the early warning system and introduce the necessary improvement.

Global monitoring objectives are data obtained:

- For defining the environmental quality management policy in the influential main road zone and
- Maintaining and improving environmental quality parameters.

Quality maintenance objectives are promoted according to the needs in the given time period for the specific environmental parameter.

The monitoring data may be used for different purposes but, its main objective is the comparison of measured values with the limit values of imission/emission but, it can also be a great help for tracking the effects during the main road exploitation, as well as for decision making on improvements related to traffic safety or pollution reduction.

The environmental quality monitoring programme given within this Study includes:

- Environmental quality monitoring programme at the stage of construction works on the M-18 section reconstruction,
- Environmental quality monitoring at the exploitation stage.

8.1. An overview of the environment before launching the project or commencement of activities where the environmental impact is anticipated

Environmental state prior to the start of the project functioning is described in chapters 2 and 5 of this Study. Majority of the existing data has been collected and analysed in a consistent manner.
The observed exploration area, when traffic noise sources are concerned, is characterised by traffic flow on the existing M-18 main road, Podgorica-Danilovgrad.

Bearing in mind the above mentioned, there was no need to demand the obligation to carry out long-term zero measurement baseline route. The positive aspect is very important when it comes to data accessibility, which describes zero measurement baseline before the start of the construction which, in case the negative effects happen, could be strictly attributed to the impact of the main road subject section.

The project developer, in compliance with the Regulation on the content of environmental impact assessment report, and for the purpose of the realisation of measures for preventing, reducing or removing of any possible harmful environmental effects by the competent institution, will carry out environmental quality testing at the individual locations of the subject section, which are expected to have an impact on the environment in order to obtain adequate state of the environment at this locality.

8.2. Environmental Impact Monitoring Programme at the stage of construction works on the reconstruction of the M-18 main road section from the Komanski i Bridge to the Danilovgrad roundabout

Monitoring measures related to the environmental protection during the existing M-18 reconstruction are mainly related to the mitigation and minimization of the impact of construction activities that are to be implemented by the contractor. In order to meet all the environmental requirements during construction works, it is necessary for the contractor to employ an environmental engineer and give daily

instructions and suggestions for the improvements. Parameters that are monitored during construction works include implementation of the adopted protection measures and all the parameters that are under continuous control of the Supervisory Authority and the investor, i.e. supervisory inspection services of the republic of Montenegro.

8.2.1. Monitoring parameters on which negative environmental effects can be identified

The obligation of the contractor is to permanently implement environmental quality monitoring during the construction works, by employing accredited laboratories and supervisory institutions according to the legal regulation of Montenegro. Parameters based on negative environmental effects can be identified are:

- Noise level,
- Ambiental air quality,
- Soil quality (content of hazardous and harmful substances in the soil),
- Hazardous and harmful waste water emission at the place of exit from the purification device, i.e. separator,
- Surface water quality,
- Ground water quality,

Along with the quality parameters, environmental testing, it is necessary to permanently monitor the impact on population, vegetative habitats and animal species, impact on landscape, keep record on the type and the amount of generated waste, especially hazardous and monitor seismic mining effects.

8.2.2. Waters

The most prominent impact can potentially be seen in water pollution, especially ground water pollution. The reason for this is in hydrogeologic land properties where the main road is passing.
For this reason, it is necessary to implement proper monitoring and protection measures reflected in the construction of the closed surface runoff water drainage system.

Given the extreme sensitivity and the surface water significance found in the main road zone, the visual monitoring of surface waters at the stage of construction must be carried out on a daily basis.

Surface water pollution during the construction should be monitored by taking a water sample from the rivers Sušica, Matica i Mareza, upstream and downstream from the construction works site.

Samples should be taken a month prior to the start of the construction works on the bridges up until the technical road section admission section. The sampling must be done quarterly. The dynamics of carrying out the ground water monitoring depends strictly on the construction works dynamics. The monitoring programme during the reconstruction of the road section includes the time of construction and the warranty period.

In accordance with the above stated, it is necessary to carry out groundwater quality monitoring at every potential location. The groundwater sampling is taken from the existing wells if they exist near the main road section.

8.2.3. Monitoring the state of the ecosystem (biological monitoring – zero measurement baseline)

The presence of the ecosystem experts is necessary in order to monitor the construction process and track any possible negative effects on the state of ecosystem near the construction site.

8.2.4. Places, manner and the frequency of measurement of established parameters

In order to do environmental quality monitoring and ensure the quality of environmental protection measure implementation of the stated in this Study, it is necessary for the contractor to organise daily presence of the environmental expert and do targeted measurements during the road reconstruction.

- Carry out daily visual monitoring of the dust levels at the construction site during construction;
- Once a month carry out measurement in the zone of housing facilities in accordance with the Law on Environmental Noise Protection (Official Gazette of Montenegro 28/11 and 28/12) and Rulebook on Environmental Noise Limit Values, the Manner of Determining Noise Levels and Acoustic Zones and the Methods of Assessment of harmful Noise Effects (Official Gazette 60/11);
- Provide air quality testing twice a year during construction works in accordance with the Decree on Determination of Pollutants, Limit Values and Other Air Quality Standards (official gazette 25712);
- Visual gas exhaust monitoring on the construction site (by examining certificate on exhaust gasses);
- Daily visual control of terrain cleaning and land occupation;
- Once a month or after heavy precipitation carry out visual control of the erosion at the places of construction;
- Quarterly ensure the surface water quality control, upstream and downstream from the construction sites (bridges);
- Tracking the state of land and inspection of hazardous and harmful substances contents in the ground is realised in accordance with the Environmental Law (Officiate Gazette 52/16), Law on Agricultural Land (Official Gazette 015/92, 059/92, 059/92, 027/94, Official Gazette 073/10, 032/11), and the Rulebook on Permissible Concentrations of Hazardous and Hazardous Substances in Soil and Methods for their Testing (Official

Gazette 18/97). Land testing is done quarterly, only during construction works nearby.

- According to the positive practice during construction, it is essential to monitor the reconstruction impact on the local population. During the construction, these impacts are mainly extremely negative and for that reason, it is necessary to establish a good cooperation with the local people at the very beginning of the project or at the stage of preparatory works and terrain cleaning. The obligation of the contractor is to appoint the person responsible for the communication with the locals and that the data obtained be publicly available at each construction location. Also, it is of extreme importance to keep a precise record of all the complaints from the local people and that the contractor submits it in the form of a table through regular monthly reports to the investor and the supervisory authority.
-

8.2.5. Contents and dynamics of delivery reports measures to be carried out

The contractor is bound to take regular monthly reports to the Supervisor and the investor or the supervisory inspection authorities of Montenegro, at their request.

8.2.6. The obligation to notify the public about the results of the measurements

All the reports on environmental quality inspection and the results of the monitoring will be submitted to the Nature and Environmental Protection Agencies and to the body responsible for the environmental protection of Podgorica and Danilovgrad Municipalities. The public will be informed about the measurement results.

8.3. The monitoring impact programme at the exploration stage of the main road section

The control programme determines all the possible negative impacts of the M-18 road exploitation, from the Komanski i bridge to the Danilovgrad roundabout, on the population and environment, as well as the efficacy of envisaged and implemented protection measures. The project developer is obligated to carry out air quality control, noise level, waste water quality, soil quality and biodiversity monitoring impact.

8.3.1. Air monitoring

Air quality monitoring of the M-18 main road zone during its exploitation shall be carried out in accordance with the Environmental Law (Official Gazette 52/16), Law on Air Protection (Official Gazette 25/10, 43/15), Rulebook on Air Quality Monitoring Mode and Conditions (Official Gazette 21/11) and the Regulation on Determination of Pollutants, Limit Values and Other Standards air quality (Official Gazette 25/12).
The main objective of the monitoring air quality is determining long-term air pollution trends, in order to determine the level of improvement or worsening of air quality in the populated areas, along the subject main road section. Based on the air quality monitoring results, it is possible to assess the dangers to human health, the dangers for all the other environmental elements, the development of mathematical model depending on the imission of traffic load and weather conditions.

The selection of pollutants to be monitored

The development of air quality monitoring should be gradual. At the stage one of all the target measurements, carry out concentration measurements for sulfur dioxide, nitrogen dioxide and oxide nitrogen, particulate matter (PM10, PM2.5), lead, benzene, carbon monoxide, ground ozone, cadmium, mercury, nickel, benzo (a) pyrene (as a marker of polycyclic aromatic hydrocarbons) and fluorides. If the obtained results do not point to the exceeding of limited values prescribed by the Decree on Determining of Pollutants, Limit Values and Other Air Quality Standards (Official Gazette 25/12), the list of pollutants should be narrowed to the concentration measurement of nitrogen oxides (NO2) and particulate matter (PM10, PM2.5).
Provide a periodical air quality testing in accordance with the "Decree on Determination of Pollutants, Limit Values and Other Air Quality Standards" ("Official Gazette 25/12). The air quality monitoring network should include all the settlements in the main road impact zone.

Measurements of air quality to be done four time a year.

The number and arrangement of sites to be measured

When choosing locations for the placement of measuring stations for the air quality it is necessary to meet the following requirements:

- Measured place must be representative of the area selected by the main design,
- Measuring station should be placed in such a way to provide data that can be compared to the data from the other measuring stations within the monitoring network,
- Certain physical requirements should be met. The final location choice of the stations is a compromise of these conditions.

8.3.2. Noise level monitoring

The purpose of the monitoring is to keep track of the noise impact on population and facilities found in the impact main road zone, according to the obtained data and timely reaction, i.e. undertaking adequate protection measures.
The parameter relevant for determining the environmental vulnerability caused by noise is noise level degree indicator measured, then the relevant noise levels are calculated and assessed in accordance with the decrees mentioned in the Environmental Protection Law (Official Gazette 28/11) and the Rulebook on noise Limit Values in the Environment, the Method of Determining Noise and Acoustic Zones and Noise Abatement Methods (Official Gazette 60/11).

Determining relevant noise level

The relevant noise level is determined based on equivalent noise level measurement or only the A-weighted noise level to which corrections are added for different noise types. Noise level measurement and the correction of the measured level depending on the noise type is carried out through the methods described in the MEST 1996-1 and MEST 1996-2 standards.

Provide noise level measurements during the exploitational cycle at the location, in accordance with the Law on Noise Protection (Official Gazette 28/11) and the Rulebook on Noise Limit Values in the Environment, the Means of Determination of Noise Indicators and Acoustic Zones and the Noise Assessment Methods (Official Gazette 60/11).
Noise level measurement shall be carried out four times a year.

Selection of measuring sites

The noise in facilities is measured at a distance of at least 1,0 m from the walls and 1,5 m from the windows at the height of 1,2 m to 1,4 m to the floor when windows and doors are closed. The noise outside of the facilities (in communal environment) is measured at the height of 1,2 m to 1,5 m from the surface of the ground, at a distance of at least 3,5 m from the facility walls (if the conditions permit) and other reflecting surfaces or from the alignment line with no facilities.
If the noise to which the building is exposed is measured, then the noise level is measured at 1 to 2 m in front of the facade, i.e. at 0,5 m in front of the opened window.
During the noise measurement weather conditions are recorded and monitored. If the wind blows from the source to the receiver, it can have the speed not higher than 5m/s. It is necessary to keep a record for each measurement on the volume and traffic structure.

8.3.3. Waste waters quality monitoring

Provide waste water quality measurement for each drainage prior the mixing of waste waters with the recipient water in accordance with the Rulebook on Quality and Sanitary Technical Conditions for Wastewater Discharge into the Recipient and Public Sewage, the Method and Procedure for Testing the Quality of Wastewater, Minimum Number of Tests and the Content of the Report on the Quality of Waste Water (Official Gazette 45/08, 09/10, 26/12, 52/12 and 59/13):

- Carry out the runoff waste water quality analysis on section route after passing through the separators and before its release into the surrounding space.

Wastewater quality measuring shall be done once a month.

The assessment of wastewater quality shall be done through the analysis of the samples from the parameters from article 5 of the above-mentioned rulebook. Wastewater samples are analysed according to the standard methods prescribed by the republic of Montenegro and the European Union.

8.3.4. Land monitoring

The monitoring objective is the improvement of the land use conditions and entails sampling, measuring and processing data on soil fertility factors and toxicity, soil factors, especially heavy metals. The soil contamination can result in reduction or complete loss of many land functions, and indirectly affect the surface and ground water pollution. Soil contamination over permitted level can have numerous consequences of pollutants entering the food chain, which leaves consequences on human health, but also on the ecosystem as a whole. Local pollution is the result of local activities such as industrial plants and depositing solid waste on the ground. Diffuse sources of pollution include sedimented contaminants in the air (PAH, PCB, SO2, NOx and heavy metals). Land pollution can also happen with waste water or contaminated drainage. Negative soil contamination consequences in the loss of organic matter, production of different pathogenic organisms, increased erosion, sanitation and soil acidity are present.

Selection of parameters to be monitored

In addition to the basic parameters and indicators of soil quality to be monitored (Ph value, organic carbon content, Ion exchange capacity, conductivity, dry matter content, particle size distribution and density), it is necessary to monitor specific pollutants, i.e. concentrations of cadmium (Cd) Copper (Cu), Zinc (Zn), Boron (B), Cobalt (Co), Lead (Pb), Mercury (Hg), Arsenic (As), Chromium) and molybdenum (Mo), mineral oils and polycyclic aromatic hydrocarbons (PAHs).

Sites, manner and frequency of measurement of the determined parameters

Exploitation impact monitoring, from the Komanski bridge to the Danilovgrad roundabout road section, should be carried out in the zone of possible impacts, i.e. at the locations of agricultural areas.

Preliminary soil quality monitoring in the subject section zone should last for at least 5 years and sampling should be done once in three months. After the preliminary testing, if necessary, the plan of further research is made. The number of samples depends on the preliminary testing and it is related to the object of the testing.

8.3.5. Biodiversity monitoring

- The environmental monitoring programme (biodiversity) needs to be carried out periodically during the whole time of the construction works and road

reconstruction. It is necessary to monitor the amount and manner of vegetation clearing, especially for the Sušica, Sitnica and Mareza rivers. The monitoring will prevent or report any eventual incidents that can endanger plants and animal world in the rivers.

- It is important to monitor the frequency of animal death and wildlife from the circulation and, if necessary, take additional protection measures (at places where the route intersects long-standing migratory amphibian patterns during the spawning period (springtime) and place devices which would prevent the death at the spawning places. The planned bridge reconstruction will directly influence the morphology of the riverbeds on the very construction site. Given the materials in riverbeds constantly change, i.e. are renewed (it is a reversible process), it is necessary to keep track of river bed morphology, as well as the other habitats on the construction sites, as after a certain period, they should be regenerated to its original state.
- The special emphasis during monitoring is to be put on wetland, coastal and water vegetation known as the Natura habitats 2000 (Mareza) and the potential Natura habitats 2000 at the unexplored parts of the subject area, as well as the most vulnerable groups of fauna, characteristic for this type of infrastructural works, which are birds, fish and amphibians.
- Monitor (four times a month) the amount and manner of vegetation clearing, especially for the Sušica, Sitnica and Mareza rivers.
- Prevent or report eventual incidents which can endanger plants and animal world in the rivers and wetland.
- Special attention to be payed to the wetland habitats and watercourses.
- The monitoring of presence and the number of invasive species in the area of intervention and the immediate surrounding areas.
- At least two times a year by the local laboratory carry out control of the surface waters of Sušica, Sitnica and Mareza by sampling of the samples found during and after the rain.
- The biodiversity fish monitoring programme should be carried out after the reconstruction, for a period of one season. Special emphasis is put on eel and trout species. The monitoring will be done at the already designated locations (Sušica at the Yugoslavia restaurant, the bridge Matica, the Komanski bridge).
- A year after the completion of works the monitoring of frequency of species death should be done *(Pelophylax shqipericus, Emys orbicularis, Testudo hermanni, Bufo bufo)* and, if necessary, define the additional protection measures.

- Carry out a regular monitoring (determine the black points at which the collision of vehicles and bats occurs), especially at the mating stage and migration period.

For each recommended control, it is necessary to do a Control Programme, which will include a wide range of environmental effects that can be measured and compared. The obtained data is to be recorded and used to inform, intervene or point to an incident for a certain segment at the location.

All the results of the measurements should be made transparent to the public.

According to the article 35 of the Environmental Law, the legal entity and the entrepreneur who is the beneficiary of a facility polluting the environment is obligated to submit the result obtained during the monitoring to the competent authority of the local self-government unit on whose territory it is located and to the Nature and Environmental Protection Agency.

9. INFORMATION SUMMARY

Based on the list of projects for which the environmental impact assessment is required, the subject project is listed in the List I, under point 10. Infrastructural projects, under (d) the reconstruction of the new road with four or more lanes, or the reconstruction and/or the expansion of the existing road with two lanes or less, in order to have the road with four lanes or more, in case that such new road or reconstructed and/or expanded section have an uninterrupted length of more than 10 kilometres.

The length of the Danilovgrad-Podgorica section is 15.132 km. The start of the section is at the Roundabout exit in Danilovgrad (the boulevard Danilovgrad) and the end at the entrance of Podgorica after passing the Komanski bridge in the city community of Gornja Gorica.

The reconstruction of the boulevard in planned on the whole section. The planned road reconstruction is in accordance with the Spatial plan of Montenegro by 2020 and the guidelines of the Urban Planning Plan of Podgorica by 2025.
The Spatial Plan of Montenegro by 2020 of the subject section should be turned into a main road for high-speed motor traffic. Taking into account the configuration of the terrain as well as the spatial constraints of the traffic-technical

conditions for the design, it is defined that a design speed of 80 km / h should be provided.

The explored terrain belongs to the geotectonic unit of overlapping old-Montenegrin fault. The stratigraphic series of formations begin with the late Triassic period, ending with the sediments of the Eocene.

In the proximity of the explored terrain, the oldest sediments are up-cretaceous, with the direction of NW-SE, and are evolved in the limestone dolomite facies.

Sediments of the Turonian Age (K22) are represented by yellow-banked and massive, often saharoidal dolomites, dolomite limestones and banked rarely layered and massive limestone. Within this section, the prevalence of dolomites and dolomitic limestones, over limestone, is characteristic.

These sediments form a part of the hill Zelenika. Xenon Age Sediments (K23) form a field in the Komanski area,and appear as greyish-white to greyish-yellow limestones, as well as dolomite limestones and dolomites. They are most commonly banked and layered, rarely massive.

Quaternary aging sediments are represented by quaternary clay (Q) and fluoroagglobal sediments (fgl).

Quaternary clay (Q), occupy most of the Zeta river valley in Bjelopavlići. These are green, yellow or flint-clay, whose thickness reaches up to 80 m of depth. Their brown humus soil is 1-2 m thick.

Fluvioglacial sediments (fgl), are presented by gravelly-sandy sediments. In the exploration areas, there are terraced sediments (t2 and t3), created during the interglacial rib-marks.

By the engineering-geological composition and geotechnical characteristics of the terrain, as a terrain and facility interaction, the following geotechnical environments are listed:

1. Embankment;
2. Clay, glacio-limnic origin, ochre-gray (Cgl);
3. Clay, diluvian origin, dark brown-black colour (Cdl);
4. Sand gravel (SG);

5. Clay gravel (CG):
6. Limestones, dolomitic limestones and dolomites (L,DL,D).

On the explored terrain there are several geotechnical areas, which by their hydrogeologic characteristics, are water-permeable to watertight.

Water-permeable areas are: a part of the area 1, embankment, i.e. area 1a, area 4,5 and 6.
Watertight areas are areas 1b, 2 and 3.

Water-permeable areas, according to the porosity type, are intergranular and fractural-cavernous porosity.

Good water-permeable intergranular porosity areas are 1a and 4. In the planned road and facilities reconstruction, there are no major layers of conglomerate, which could have an impact on the water-permeable characteristics of the area. The laboratory testing has determined that the coefficient of water-permeability is (USBR) from 4x10-1 to 1x10-2.

The M-18 main road route, Podgorica-Danilovgrad section, mostly stretches through the plain terrain, with the emergence of a small part of the uneven terrain.

In the part of the route M-18 Podgorica-Danilovgrad main road zone, there are no protected objects nor cultural-historic heritage goods.

The project is realised in the intercity zone with a determined construction and population density. In the proximity of the M-18 main road, Podgorica-Danilovgrad section, there are a larger number of housing units, whose construction density is the largest on the section which leads from the business centre Iveco to the Danilovgrad roundabout, in relation to the other sections illustrated in the above images, with fewer constructed housing units. Also, along the route of the mentioned section, there is a significant number of business facilities, i.e. of service and production type.

The planned facility will not impact the demographic characteristics.

It should be emphasised that during the construction works during the reconstruction there will inevitably be: dust increase, higher concentration of exhaust gases from the construction machinery, noise, etc.

Nevertheless, these works are of limited duration as it will be demonstrated by the assessment and measures will be implemented to reduce these effects to their permitted concentration levels.

The existing M-18 road route, Podgorica-Danilovgrad section, whose planned reconstruction passess through the zone with a determined population density, has a number of business facilities. The housing and business facilities are located on both the left and right sides on the main road, as it is stated at the beginning of this project.

The project is realised in the zone defined by the provisions of the Spatial Plan of Montenegro by 2020 and the guidelines from the Podgorica Regional Spatial Planning Plan by 2025. The existing M-18 Podgorica-Danilovgrad reconstruction is approved by the issued urban-technical conditions number 0503-1660 / 11 on 11/08/2014 issued by the Ministry of Sustainable Development and Tourism, the Directorate for Civil Engineering.

The project proposes the M-18 main road reconstruction, Podgorica-Danilovgrad, from 114+500 km to 129+632 km. The total length of the section is 15,132 km.
The M-18 main road route to be reconstructed is laid on the corridor of the existing road. The existing road with two lanes is of the approximate width of 7,0 m. The reconstruction of the boulevard planned along the whole section has two traffic lanes in each direction, the median strip and pavements and green areas in Danilovgrad and Podgorica.

The concept of road expansion to the left or right in relation to the existing one is suggested and, if necessary (due to the demolition of facilities or bigger earthworks), the expansion from both sides is proposed.

By expanding of the road to the left or right in relation to the existing one, the construction is made much easier because, when making new lanes, the traffic can be carried out unobtrusively along the existing road. In case of bilateral expansion, the demolition of the facilities to the left or right from the road is reduced, but the construction works are much more difficult due to the ongoing traffic and, in that case, the whole roadway construction must be demolished in order to build a green area on it. The bilateral expansion is specifically unfavourable (impossible) at the place of bridges and is therefore avoided.

Within the Preliminary design, the roundabout – the roundabout with the intersection of the traffic flow have been analysed. The roundabout solution will be

adopted if the other type of the roundabout has not been planned by some of the existing, already adopted, projects of plan documentation.

The horizontal road elements meet the requirements of the traffic-technical conditions for a design speed of 80 km / h. Due to the greater number of the facilities that are connected to the road, it will be necessary to introduce the speed limit.
The reconstruction of exiting facilities has been planned as well as the construction of new ones, if necessary. The larger facilities are the bridges Sušica, Matica, the Komanski bridge as well as a larger number of retaining walls.

From the existing roundabout in Danilovgrad to 114+600 km the road has already been expanded to the right.
The newly planned road connects itself to the constructed road from the right side up to the roundabout at 116+260 km (crossroads Ćurilac). The demolition of the facility in the zone of Europetrol petrol station as well as the petrol station itself is necessary, i.e. its relocation is necessary, due to the already built road expansion from that side.

At 115+270 km by the plan documentation of the Danilovgrad municipality, the four-lane road is planned which, at the request of Danilovgrad municipality, is turned into a roundabout.
At 115+520 km is the limit of the "General Urban Planning of the Danilovgrad Municipality".
At 116+700 (turning for Ćurilac) there are Montenomax, hotel Pejović facilities. Due to the closeness of the facilities with the road, the expansion is on the right side and the demolition of the hotel Pejović is planned.
At 118+345 km the roundabout as a turning for city communities Jastreb and Strahinjići is planned. At that place it is necessary to demolish a small facility.
At 120+000 km the crossroads turning for villages Plana and Bileća is planned.
From 120+080 km to 123 +700 km the bilateral expansion is planned to avoid the demolition of the facilities to the left or the right side of the road at several places along this section, and especially at 122+750 km where, except for Montecco and the other facilities, several retaining walls are built. Apart from that, there is a big cutting on this strip from the both sides of the road on this section.
At 121+280 km the roundabout (Novo Selo) is planned.
At 122+890 km the roundabout (crossroads Bandići is planned. On this roundabout the turning is for Bandići, Spuž as well as for the temporary facilities near the road.
From 123+700 km to 126+500 the expansion from the right side of the road is planned.

Form 123+740 km to 125+240 km there is a service and access road planned by the main design of the construction of the service road in Podgorica.
The centre line, access roads and other elements of the route are taken from this project, and the route fits in the project in front of and behind this strip.
At 124+900 km temporary access to the existing road for Mareza is planned until the service roads are built.
At 125+230 km an access road to the existing one for Komanski i is planned.
At 126 +384 km the roundabout with turning for Cafa and Baloče is planned.
From 126+500 km to 128+700 km a bilateral expansion is planned. The reasons for this are: the restaurant Ognjište, DAK Petrol and the other facilities near the road, the proximity of the river (retaining walls), transmission line posts to the right and high cuts to the right.
From 128+700 km the expansion of the road form the left side is planned (The Komanski bridge).
From 129+340 km to 190+642 km the expansion from the left is planned and integration to the project of the reconstruction road to Podgorica with the bilateral expansion is planned.

As far as the elevation points are concerned, from the start of the route in Danilovgrad to 120+500 km the road is located in a plateau (cca 50 m asl). For the next 1,2 km (121+700 km) the road elevation point is at 84 m asl. From that point to the next 2,0 km the road elevation point is 34 m asl. From that point, up to the end of the route, the road is moving between 33 m asl. and 38 m asl elevation points. The entrance to Podgorica is found at the 34 m asl. elevation point.
The drainage gradient for the most part goes along the existing asphalt because it is necessary to keep the elevation points to the facility pathways which are connected to the main road. Longitudinal inclination is larger than 0.5 % (0.30 %).
At 125+700 km frequent flooding of the terrain occurs, and sometimes of the road, so in that part, the drainage gradient elevation is planned in relation to the existing road.
The following elements of the drainage gradient are applied: Rvmin, ∩=5000m, Rvmin, U=5000m, iPod, max=3.8 with a note that significant favourable elements from the above mentioned are mostly used.

From 114+500 km to 115 +270 km (In Danilovgrad) the cross-section road width is planned as well as the rest of the route on the built part of the boulevard to Danilovgrad and:

Lanes .....2x 3,25 =6,50 m
Marginal strips.....2x0,25 =0,50 m

Divisional island.....4,50 m
Both-sides pavements.....2x1,50 m = 3,00 m
Marginal strips between roadway and pavement.....2x2,00 m=4,00m

From 129+167km to 129+632 km (In Podgorica) the following width of the cross-section road are planned:

Lanes.....2x3.25 =6,50 m
Marginal strips.....2x0.25 =0,50 m
Divisional island.....4,50 m
Both side pavements.....2x2,00 m =4,00 m
Guard rails .....2x0,50 m = 1,00 m

The following road cross section is planned on the rest of the road:

- Lanes.....2x3,25 =6,50 m
- Marginal strips.....2x0,25 =0,50 m
- Divisional island.....4,50 m
- Guard rails on banks.....1,50 m
- Channels in cuts.....0.75 m
- Banquette in cuts.....1,25 m

On the newly designed bridges, the following cross section in planned:

Lanes.....2x3.25=6.50m
Marginal strips.....2x0.25 =0,50m
Protective strip that stretches to the elastic crash barrier.....2x0.50=1,00 m
Elastic crash barrier.....2x0.18=0.36m
Service lane on divisional strip.....0.75 m
Footpath.....1.20m

According to the traffic-technical requirements the following phase realisation is planned:

1. Phase I – Danilovgrad boulevard-intersection Ćurilac (km 114+500 - km 116+260, L=1.76 km),
2. Phase II intersection Ćurilac – intersection Novo Selo (km 116+260 - km 121+280, L=5.02 km),

3. Phase III intersection Novo Selo-Intersection Bandići (km 121+280 - km 122+890, L=1.71 km),
4. Phase IV intersection Bandići – intersection Mareza (km 122+890 - km 125+230, L=2.34 km),
5. Phase V intersection Mareza-intersection Komanski bridge (km 125+230 - km 129+632, L=4.40 km)

On less loaded access roads, the following roadway construction is planned:

AB 11 ..... d=4 cm
- BNS 22A ..... d=7 cm
- crushed stone aggregate 0/31.5 ..... d=15 cm
- crushed stone aggregate 0/63 ..... d=20 cm

At places of deviations and fitting of asphalt connectors, the following roadway construction is planned:

- Bitumen felt BNHS 16 A ..... d=6cm
- crushed stone 0/31.5mm ..... d=12cm
- crushed stone 0/63mm ..... d=20cm

On pavements, the following roadway in planned:

Concrete MB 30 ..... d = 12 cm
Sub-base – blanket course ..... d = 15 cm

The traffic design for the road reconstruction includes the existing roads, planned curbs, which requires the building of stormwater sewage collector for stormwaters, its directing and drainage.
According to the traffic design, at places of the existing culverts, new culverts of Ø1500 mm in diameter have been planned, regardless of the road level. At places where this is not possible due to the low bank level, the culverts of Ø1000 mm in diameter have been planned with inspection fitting on the division island. The regulation on roadway design for culverts with width more than 20m, the minimum culvert diameter is Ø1500 mm, due to maintenance, by adding these inspection fittings the length of culverts has been reduced. Also, on sections where the longitudinal canals along the road existed, the design includes the construction of new earthen hydraulic characteristics.

As the crown section road is concerned, the runoff water drainage from the both sides of the road is planned, with longitudinal collectors that allow the traffic circulation during the construction of each road lane, as there are no lateral canals.
As the designed road with changing crossfall is planned, the stormwater drainage project design, on sections with bilateral curbs, plans to place stormwater sewage collectors along the roadway edges with catch pits placed in „niches“ on divisional islands (which avoids the passing of vehicles across the catch pit grate). On sections where the pavements are planned along the road, in the roundabout zones and on sections where the divisional islands are smaller in length, catch pit grates are placed on the road.
In cuts and cuts and fills, where the channels are planned, on different sections (from 120-200 m), depending on the longitudinal fall, the catch pits with double grates are planned, from which the waters will be directed into the collector through the pipes. In these sections, all the riparian waters which are not oiled will through the berm, whose cross fall turned from the road to the cut, be directed to the culverts at distances of 250 m. This concept has been given up only on sections in cuts (where culverts are not possible to build) where the berm fall is turned to the roadway, so the riparian waters are directed into the separators, as these are relatively small amounts of waters compared to runoff water (section P469-P566 The amount of water from the nearby terrain is about 30.64 l/s, and the amounts getting into the separator is 608.22 l/s). The same has been applied to the section from P801 to P821 at the Ognjište restaurant, where the culvert was not possible to be placed due to the restaurant.

As based on the UTU, the terms of reference and water conditions, the stormwater purification is necessary, the installation of the separators of the oil derivatives with by-pass, evaporation ponds, and coalescing filters, which enable water purification according to the SIST-EN 858-1 standards have been planned by the main design. The separators are placed in the divisional island (except for the first 3, which are in the green area between the roadway and pavement). Given it is not possible to bury the collectors at bigger depths due to shallow recipients, it is necessary to select a type of separator whose by-pass is at the very top of the separator (TECHEAU manufacturer or other with by-pass at the top of the separator).
The project includes 31 separators. The relatively great number of separators are necessary due to the greater number of sections with low longitudinal fall, and relatively shallow culverts in which the water drains after purification.
The purified waters are released from the separator into the designated canals or culverts. In front of each separator, the catch pit basins are planned with AB pipes Ø1000 mm in diameter, and for the large amounts of water, rectangular shape

pipes. On the separators, the inspection chambers are planned, and for its maintenance, AB rings of Ø1000 mm in diameter with lower slabs, which directs the load on the surrounding terrain, and not on the separator itself.

At places where the collectors intersect with the designed culverts, the syphons are planned (9 syphons). During the hydraulic syphon dimensioning, the criterium is taken, according to the literature, that the speed of syphons is 2.0-3.0 m/s. In front of the syphon, the catch pit basins are planned with syphon inspection fittings on of rectangular dimensions 1.00 x 1.50 m. Also, on the profiles P422, P453 and P777 the syphons which direct the water through the upstream berms into the downstream through the access roads are planned, as there are no possibilities to build a culvert for the berm water drainage.

On sections where there is no longitudinal slope, or is at its minimum, the flush curbs are planned into the rectangular catch pit basins. On several sections (e.g. Section P704-P760) the collector diameters whose capacity is larger than the amounts of water that get onto the road due to the bigger depth of burrowing are proposed, as the reduction of the catch pit is conditioned by the bigger permitted minimum slopes.
The drainage from the bridges is given in the route facility design, and this design includes catch pits in which the road runoff water will be collected.

On the planned collector, there are catch pits with one catch pit grate 600x600 mm in dimensions D400 class at a distance of about 25m (grate permeability is about 20 l/s), except on the drainage channel inspection fittings, where double grates are planned.
The catch pit basin is adapted to the traffic solution respectful of the longitudinal and cross falls and other conditions from the design. The body of the catch pit is made of AB pipes Ø1000 in diameter for the collectors of Ø300, Ø400 and Ø500 in diameter. On the Ø600 collector, there are AB square catch pit basins, with a clear opening of 1.00 x 1.00 m in dimensions.
For all the stormwater sewage collectors, there are corrected propylene pipes PPR with the rigidity factor of Sn8.

Construction works on the route

- Within the scope of preliminary works, it is necessary perform the cutting down of trees, the removal of shrub, logs, roots, perform a demolition and the removal of walls and facilities, concrete and stone fences, dismantling of

the existing wire fence with posts and elastic guard rails, to remove the existing signs, cutting of asphalt carpet, hacking off and the demolition of the existing roadways, as well as the demolition of the existing culverts will be done according to the dynamics of the construction works along the route.

- The excavation should be carried out by the use of machinery and others means, so that the manual works are limited to the necessary minimum. The excavation of hard stone material should be performed by machine drilling, deep mining and regular mining and the re-mining of the larger rocks, if this would require the purposeful use of excavated material. Mechanical pushing, i.e. the loading of material and transportation to the site of use, i.e. the landfill with unloaded material should also be taken into consideration. All the excavation should be performed according to the sections, designed elevation points and prescribed inclination. At this stage of works, the necessary road drainage must be enabled. During the works, the necessary care must be taken, if undermining occurs, any imbalance or damage of the excavation slopes designed by the project. When using explosives, it should be acted according to the regulations for such works, and should be careful when handling explosives, so the protection of the surroundings, facilities, roads and people must be provided. When mining, as well as the works on the excavation sites, all the effects which could cause the obstruction of traffic, people and the environment, should be reduced to minimum and all the necessary traffic and warning signalling should be placed.
- Temporary landfill material from the excavations, which will be used for the embankment construction, should be made at appropriate locations along the route.
- The replacement of weak material from the foundation is performed in such a way that after the excavated hummus, the earthen material is excavated, which due to its poor geomechanical characteristics must be deposited and replaced with a better material (gravel or sand), with necessary compaction.
- The embankment works include filling, spreading, rough and fine grading, drying, wetting and compaction of the embankment material according to he dimensions prescribed by the project. The material which would over time change its physical-mechanical properties due to biochemical activity, cannot be placed into the embankment. The construction material for the embankment can be obtained from the cuts on the route or from the borrowing pit, given it is not sensitive to water presence. The stone material can be obtained from he mining or screening gravel or sand obtained from dredging. If the embankment is constructed from the non-cohesive material, grain size must not be bigger than 30 cm, and maximum 10% to 40cm. The materials with road base stability can be used for the embankments. Every

single layer must the spread longitudinally at maximum inclination equal to the designed longitudinal inclination. In cross section every single layer must have double-sided or one-sided inclination of 2-5 % for stormwater drainage. When landfilling, the transportation passages must be evenly distributed along the whole surface of the substructure. The height of each spread layer must be according to the compaction effect for the depth of the agent used for compaction, the type of the spread material and the segregational occurrences, but not larger than 30 cm in loose condition. The stone material embankments are made of layers of usual thickness of 30-50 cm, but the actual thickness of loose embankment layer is demonstrated on the pilot section. The mentioned materials are compacted by vibrating rollers (self-propelled or towed roller), vibratory rammer and compactors. Each embankment layer must be compacted in full width with the proper mechanical apparatus, during which the compaction must be done from the edge to the centre.

- All inaccessible machinery sites or sites where the use of compaction devices would for other reasons be inadequate, (the filling behind facilities, retaining walls, etc.) should be compacted with other purposeful machinery or methods. Prior to the compaction, every material from each layer must be pulverised, mixed, wetted or dried to proper humidity so that the used material can be compacted to the proper density. If after the compaction and quality control, compaction is not performed immediately but after some time, before continuing the compaction process, it is necessary to re-check the density quality of the mentioned layer. In case where the primarily cohesive material would be necessary for the embankment, and weather conditions would prevent its use, it is permitted to use other means for the embankment construction, e.g. use stabilisation, treatment or use of other material. The embankment works will be stopped any time when the intended results are not possible to be achieved, especially due to rain, high groundwater levels or some other weather conditions. The embankment material cannot be incorporated in frozen surfaces, snow or ice. When the inclination of the terrain is from 20% to 30%, the benched terrain dapping must be done during the construction at width of 1-1,5m. The dapped benched-sides should be inclined 2:1. When the terrain inclination is more than 30%, dapping is to be done continually, and when the terrain inclination is between 20 and 30%, 1 m of in-between space must be provided. Cross inclination of the dapped sides should be 3% down the slope. The finishing layer of earthen embankment at width of 30-50 cm, if possible, and should be made of stone or gravel material from the borrow pit.

- The design of the formation soil includes the preparation of the foundation for the embankment construction, after the excavation and transport of the poor or fertile soil and hummus are done, and includes rough grading and the formation soil compaction at a depth of 30-50 m. Local soil that functions as a formation soil should have technical-mechanical properties as the materials from which the embankment is made. The formation soil surface, after open cut is done, should be roughly graded, that in specific terrain conditions, an adequate cross surface inclination and ground water drainage is provided. The natural foundation soil, after grading is finished, should be compacted in full width by adequate compaction devices. The foundation material, at the start of works, must have appropriate wetness, so that the compaction can successfully be carried out. Poor bearing foundation material (inadequate material), is replaced with other material, which have more favourable geomechanical properties.
- The bedding placement includes the preparation road bed in cuts and cut and fills and embankments by rough and fine grading and bedding material compaction, with eventual wetting. The bedding placement includes layer construction of average width of w=30cm from cohesive materials. The construction should not be done during the period of frost, and also in case that on the road bed (embankment bedding), a layer of ice and snow is present, i.e. or the road bed is frozen. Spreading, grading and compaction is done by machinery. Compaction is to be done by adequate means for cohesive material compaction. The bedding must have longitudinal and cross inclination prescribed by the main construction design, i.e. the levelled elevation points on each cross section cannot deviate more than ±20 mm. The flatness of foundation soil, measured on each cross-section (left edge, centre line, right edge) measured with a levelling staff at length of 4 m and wedge, cannot have depression greater than 20mm. The sub-base is made of crushed stone material with granulation of 0-63mm in layer of thickness t=20-26 cm and granulation of 0-31.5 mm of layer thickness of t=15cm. This includes procurement, supply, placing, rough and fine grading, possible wetting, and the compaction of the sub-base. The material must be inclined longitudinally, the same as the designed drainage gradient inclination, and in cross section inclination must be according to the project, necessary for stormwater drainage. Compaction is done by adequate rollers in full width, from the lower to the upper edge. The stone aggregate must meet the requirements of the physical-mechanical and mineralogical-petrographic properties of the same stone and aggregates, the same bearing capacity, the content of organic matter and the light particles, must be stable in weather conditions, not prone to degradation due to the circulation of construction

traffic at different meteorological conditions. Vehicles with muddy wheels should not be driven on spread or compacted material.

- Asphalt construction works are carried out using bituminous paver and adequate roller equipment. The production of asphalt mixture is carried out using machinery in asphalt mixing plant. Prior to the beginning of works, the contractor is obligated to draw up a project of the previous asphalt mixture in the authorized laboratory in all accordance with the requirements of the technical conditions. The construction of bituminous sub-base BSB-22sA includes the procurement of materials, hot-mixing process, spreading, placing and compaction of mineral and bituminous asphalt mixture in one layer of designed thickness, i.e. according to the elevation points and dimensions stated in the main project. Composite materials for the construction of the bituminous sub-base are rock flour of carbonate composition, crushed rock material of carbonate or silicate composition from 0 to 4 mm, crushed sedimentary stone aggregate of 4/8, 8/16 and 16/22 mm and binder Bit 45 or Bit 60. In the asphalt mixture, the ratio of bitumen is approximately 3.5-4%. Bituminous sub-base is done in two layers (2x6cm) of total thickness of t=12cm and t=6cm, depending on the position of the route. Prior to laying the BSB, the bedding must be well-washed, cleaned with steel brushes and compressed by a compressor, dried and cannot be frozen. On parts where the bedding surface layer is different form the prescribed height for more than 20mm, it is necessary for the contractor to perform a correction of the bedding by enhancing the asphalt mixture layer or in adequately remove the excess of bedding. The temperature of the asphalt mixture at the place of placement cannot be lower than 130°C and higher than 175°C. The wearing course is made of asphalt-concrete AC-11s in thickness of t=4.0 cm. The composite materials for the construction of wearing course are rock flour of carbonate composition, crushed rock material of carbonate or silicate composition 0 - 4 mm, crushed eruptive stone aggregate 4/8, 8/11 mm and as binder bitumen BIT 60. Optimum bitumen content in asphalt mix should be less than 5.0%, to prevent the high fatigue performance of asphalt concrete. The temperature of asphalt mixture at the place of placement cannot be lower than 140°C and higher than 175°C.

The placing of asphalt mixture can be started when binding and non-binding materials are cleaned from the bedding, dry and sprayed with bitumen emulsion in the amount of 150 g of bitumen binder per m^2. For binding the between the layers, the cationic semi-stable emulsion or anion emulsion must be used. The type of emulsion depends on the type of bedding. Spraying must start at least 2-3 hours before the asphalt placing, so that the water could evaporate, and the bitumen part

could bind to the bedding. The asphalt layer can be placed strictly when the air temperatures are higher than 5oC, without wind and minimum 10oC during winds. The asphalt mixture placing should not be done in times of fog or rain. The bedding temperatures cannot be lower than +5oC. With continuation of works, after longer periods of work stalling or work stoppage, the binding part should be cut along the whole thickness and coated with bitumen emulsion. The asphalt mixture can be transported only in vehicles whose cargo bed is cleaned and coated with silicon emulsion solution. The use of oil and oil derivatives is forbidden. During transportation, the asphalt mixture must be covered. The asphalt layer is flattened until the required compaction is achieved, which is controlled with an isotopic probe.

- The concrete channels should be resistant to the effects of ice and salt. The channel should be on the bedding of mechanically compacted stone material, flat with permitted differences of not more than +2cm. The concrete channels must be placed on-site in full section, prefabricated elements on the concrete bedding or with concrete curbs and concrete plate on-site. They should be placed in rings according to the project, especially at lengths of 3 to 5 m. Rings are separated with joints. At lengths of 3 m, joints are made of roofing paper which stays there permanently, and for lengths greater than 3m, 10mm long joints are made and removed after concrete hardening. Joint sealing is performed with sealing mass. If channels are placed in previously constructed shuttering, it must be hardened and resistant to twisting. Concrete is placed into the shuttering by vibrating. The concrete surface must be flat.
- The curb placing from concrete type MB 40 is carried out on the prepared concrete bedding MB 25 quality, which is placed over the previously compacted and tested road base. The curb placing is performed by joints in width of 1cm filled with cement mortar R=1:3, with treated fugue sunk 1 cm. All the protection measures from wind, sun and effects of ice should be taken. For porous flush curbs, different material curbs with integrated linear draining channels can be used. The material must be resistant to corrosion, freezing, the effects of salt and chemicals. The lateral element stabilization is carried out with concrete of minimum C20/25.
- The construction of pavements is carried out with MB30 concrete, d=12 cm on the previously prepared and technically polished bedding, the gravel-sand material bedding 15 cm in thickness is made. Over the previously placed base, the concrete is placed with vibrating plate, with slope staking and use of level. The concrete bedding is carried out with cross contraction joints at every 5 m. After finishing the concrete placing, the protection and tending of the finished construction should be ensured during the first 7 days.

Construction works on bridges

- **The construction of piles Ø150 made of concrete MB 30** – the construction of boring piles includes the access for the earth borer and the necessary work area. The boring machine is placed into adequate position at the marked site and the earth borer is positioned vertically.
- Boring can be done even if groundwater is present, but it is necessary for the borehole to be protected during the boring process, concrete and reinforcing placing with steel casing pipes. The groundwater is not drawn from the borehole so that ground breach does not occur. During the boring process, erratic boulders can be found, which must be crushed, and the drilling must be continued until the designed bottom of the pile is reached. Drilling machinery must be properly equipped for the injection of casings, ground excavation and casing extraction. Casings must be made of steel, composed from segments which can be joined together (welded) when thrusting downwards, and separated (cutting) into parts when each segment is drawn. Casing is thrusted to the bottom of the pile level with simultaneous ground excavation. These two operations are practically simultaneous: the machine is thrusting the casing to a certain depth, and then the excavation is done and material excavate, so the casing is thrusted again. The casing, when reaching the bottom of the pile is drawn up, depending on the concrete injection speed. Concrete injection is done after the reinforcement cage is injected. The concrete is injected into the casing of D=200mm in diameter, dipped along the cage axis, whereas the casing is fixated at about 10 to 15 cm above the bottom of borehole before the start of the concrete injection. After, the concrete is injected at the height of about 2,0 m in the dipped casing when the casing extraction begins, which then continues during the concrete injection. The casing dipping into the concrete is necessary to avoid the mixing of fresh and already injected concrete, elevating it to the surface and the top of the borehole, where the casing will be cut off and removed. The depth of casing dipped into the mix is constantly monitored so that the submersion is always at about 2m. If the concrete level in the casing is dipped too quickly, the depth of dipping is controlled with the drilling machine. If the concrete level is still too low, the water-cement ratio should be lowered. The concrete injection with mobile concrete pump is permitted, if this is to ensure better quality and faster works, which will be determined by the supervisory body. The funnel at the entrance of the casing should be in the shape of a truncated cone, with sides at angle of 45° horizontally. The funnel size should be of the same the volume as the total casing volume to ensure the continuity of the moving concrete in a casing. For the casing of

D=200 mm in diameter and concrete dipping at depths of 20 m, the funnel volume should be about 0.65 m3. The proper start of concrete placing is of great importance for the pile quality as a whole, so this stage must be done carefully. The first amount to be injected must be enough for the first two metres of the borehole. After the first injection, concrete injection is continued together with the simultaneous casing extraction from 5 to 10 cm, paying special attention to avoid the cavity at the bottom of the casing. If the casing is emptied during concrete placing, is should be slowly thrusted downwards into the mix until the funnel level is equal to the level funnel and casing contact. The concrete placing stops at the level of 30 cm minimum above the top of the pile, therewith the altitude on the first constructed pile should be 60 cm minimum. This is the way to check the required length of cropping. After the concrete placing, but not before 72 hours, the excess concrete is removed up to the bottom of the beam top, i.e. the designed top of the pile and removed (cropped), with careful tending of the placed reinforcement.

- **The construction of prefabricated girder made of MB 45 concrete –** The concrete placing is done on the previously prepared deck. The cross girders formwork must be flat and smooth, as the coating of the asphaltic concrete will enable it to detach itself easily from the concrete. In the bottom part of formwork, the triangular wooden staves 3x3 cm are placed and reinforced, to prevent the spilling of cement paste along the bottom surface of the finished deck through construction joints between the elements when placing the upper deck. If the steel formwork is used, instead of solid wood for the formwork, the triangular steel element is welded 20x20mm. The formwork can be used as many times as it is permitted by the authority body, whereas each time it must be cleaned and coated. The surface parts of the prefabricated girders what come into touch with the concrete placed on-site, must be done with fine hammering or provide textured finish in some other way. This also applies to the bond concrete girder deck and cross girders.
- **Post-tension –** For the post-tension of structure and construction elements, the certified systems of domestic manufacturing IMS and SPB are planned, the subsequent post-tension systems, i.e. used only after concrete reaches required solidity. Only steel that meets certain requirements stated by the Rulebook on Technical Norms for Steel Wires, Beams and Ropes for Post-Tension Constructions“ can be used. The post tension steel is transported in solid, dry and closed transport means. The steel must be stored in completely dry rooms, with wooden floors, and no possibility of condensation. After the reception of wires and ropes, as well as prior to its installation, the wire cannot be oxidized nor have indentations, bumps or cuts or any other type of

damage. For cable conduction, the flexible tinplate ribbed pipes are used. The pipes must be solid enough to retain its shape under the cable pressure and concrete weight during the concrete placement, at the same time being elastic enough to follow the cable lines. The pipes cannot be permeable to leak the concrete paste and must be made of material that does not cause tensile steel corrosion, either directly or electro-chemically. Suspension-cable anchor must be stored on the construction site and protected from stormwater effects and mechanical damages. It is necessary to inspect the suspension-cable anchor and clean the dirty areas to ensure the adhesion of the protective concrete layer prior to the post-tension concrete.

Cable tension can be carried out only after the concrete has reached its minimal solidity. When post-tension is done before 28 days, the concrete solidity must be inspected by control sampling with the same conditions as the concrete construction. Prior to the post-tension works, the post-tension programme must be done. The post-tension programme is carried out by the contractor based on the project details and it is authorised by the Supervisory body and must entail, apart from the post-tension time, the data on post-tension strength, cable tension order and elongation with adequate display of concrete reduction under the pressure and must entail the size of friction and flow. The order of the tension must be done properly so as not to lead to non-permissible tensions. After the programme acceptance and approval for the start of the post-tension by the Supervisory body, the necessary preparations must be done: check the cable mobility, inspect suspension cable anchor, set the necessary scaffolding, set electrical ports and shorten the cables to a minimal length required for the press procedure. After the cable splittering, the anchor with wedges must be placed and the press must be set. The diagrams of hydraulic set calibration cannot be older than 6 months. The maximum temporary force of the cable, at the place of anchorage cannot exceed the prescribed 75% of characteristic breaking force (exceptionally 80%). The amount of force will be determined with a pump nanometre. The cable elongation measurement and comparison to the operating force is to determine whether the losses due to friction are calculated properly. If the significant differences are present, the force calculation must be re-evaluated. During the works, the cable elongation record is kept. If the sum of deviations from the prescribed operation force is determined, measured with nanometre, in percentage, for each cable, greater than the permitted, the Supervisory body will be notified in writing. Also, if the deviation from the total post-tension force prescribed or the total elongation prescribed greater than 5 %, the Supervisory body must be notified in writing. This must be carried out regardless of whether the Supervisor is present during the elongation works. In special instances, the Supervisor must demand that the force measurement in critical cross sections along the cables with special devices is

placed beforehand. These places, after the completion of works, must be protected properly. In order to protect the installed cables from corrosion and be able to tie them to the surrounding concrete, the protective post-tension casing must be carefully injected with a proper injection mixture. The protective casing must be cleaned from the penetrated water after the concrete placing. This must be done thoroughly by pneumatic air exhaust. Then, until the injection is started, the protective casing must prevent water from re-entering. Accordingly, the air circulation must be prevented in the protective casing. The injection mixture consists of cement, water and chemical and mineral additions. The injection is done at the temperature greater than +5 ^{o}C.

The rehabilitation of damaged concrete parts with restoration mortar – These works include the injection of restoration concrete or mortars at places where the concrete structure is damaged and entails the rehabilitation of the protective layers reinforced of previously tensioned elements and the repair of large concrete surfaces. The smaller areas and shallow damages (1-2 cm in depth) include the use of mortar, and deeper damages, especially on larger surfaces, require restoration concrete. After all the unstable parts are cleaned with one of the abrasive methods (recommended sand blasting) and the contact surface prepared by cleaning and autoclaving, the contact surface should be wetted directly before the injection, and then the restoration mortar or fine-grained mortar is injected. The reinforcement is re-tapped and welded, if necessary, and the smaller profile reinforcement is added if needed, and properly connect it with a wire. When the reinforcement is protected, the restoration material is injected.

Injection of cracks/fissures - The works include the rehabilitation of cracks or porous parts of concrete injection - filling the damaged concrete parts with binder made of synthetic resin under higher pressure. The furrows of cracks and cavities should be cleaned completely from unstable concrete parts by wire brushes and a chisel. After the completion of chiselling and drilling, the remaining dust from the cracks and fissures should be removed by pneumatic air exhaust whcich cannot be contaminated with oil. The injection casing should strengthen on the marked parts with the same synthetic resin for injection. The distance between the injection pipes depends on the depth of the crack, material injection viscosity, temperature, the necessary strengthening and proper placement of the injection apparatus. The distance should not be less than 10 cm and greater than 50 cm. The injection must start in the injection casing, placed on the lowest part of the crack and cannot be stopped until the mixture of the synthetic resin appears at the end of higher placed injection casing, or the first adjoining casing. The injection should be stopped immediately when the pressure intensity is high (no other crack exists) or when no more pressure in the system injection is present. The ends of the injection casing

should be closed immediately after the mixture extraction at the ends, to avoid the resin withdrawal back into the casing. For this reason, the most practical solution is for the casing to be fitted with valves at the ends. The injection procedure is carried out continually up until the moment of the appearance of synthetic resin on the last injection casing. The casings must be removed after the strengthening of the mixture is completed.

Placement of carbon tapes - These works include the reinforcement of concrete elements by using carbon tapes, which are glued onto the concrete surface and have the role of an external reinforcement. The surface which should be strengthened must be flattened, with variations and bumps not bigger than 0,5 mm. The evenness and levelling of the surface should be checked with a levelling staff. The length tolerance at 2 m can be 10mm maximum and for 0.3 m is 4 mm. The tapes are cut to the required length. Immediately prior to the gluing, the tape surface should be cleaned with a solvent to remove the dirt. The surface temperature should be from +8°C to +30°C, the humidity max 4% pdv and the special attention should be payed to condensation. The ambient temperature must at least be 3°C above the point of wearing. The inspection of placed tapes is done by a „pull off „ test. The breakage of concrete must occur during the testing, not tape detachment.

All the road runoff must be directed to the separators, and then released outside. The amounts of excess excavated materials are deposited on landfill next to the road defined by the project design. If this manner of landfilling is not permitted, the total amount of excess material will be transported to the construction material landfill in Podgorica or Danilovgrad, in accordance with the approval by the local authority body. For the emission estimates and concentration of harmful components which occur when mining, the following data is used: the length of mining field, mining field width, the size of mining field, the number of borehole rows in mining field, the distance between boreholes in rows, the distance between the rows, the total number of boreholes in the field, the total length of boring for one mining, the line of least resistance, the length of borehole, the amount of explosive per borehole and the required explosives.

Dust emission during the mine borehole drilling depends on the manner and speed of boring, the diameter of borehole and mechanical characteristics of the rocks.

Given the activity of machinery and its simultaneous works, the distance estimate has been done at which the noise level is within the permitted limit values, i.e.

the distance at which the noise from the construction site does not exceed the limits regulated by the law. Based on the given estimates, it can be stated that within the given distances there are housing units, so the construction machinery noise during the works can, to a certain extent, affect the mentioned populated areas.

The air pollution estimate is carried out based on the number and vehicle structure, the speed of passenger and heavy-duty vehicles 80 km/h, with adequate corrections, due to road functional dependence on weather conditions, especially wind speed and duration of winds. As it can be seen from the estimated values, gas exhaust concentrations from the traffic flow are significantly lower than the prescribed limited values.

The main road exploitation does not create solid waste of any type.

During the project function, in order to ensure the optimum works, population health and the environmental protection from the eventual harmful effects of this process, it is necessary to implement measures to ensure prevention or elimination of any possible pollution.

In addition to the measures proposed by the Study, which must be regularly implemented during construction works, the measures which can be implemented in case of incidents are proposed.

The function of such project carries with itself the risk of incidents that can be manifested through traffic accidents, which again is a possibility of air pollution with substances due to fires on vehicles, and the endangering of human lives and emission harmful substances into the air can occur. The traffic accident protection measure represents an adequate control of respecting the traffic regulation on this road section.

THE DATA ON POSSIBLE DIFFICULTIES

During the development of the Environmental Impact Assessment Study, the author had some difficulties in obtaining the necessary basics for the analysis. The members of the multidisciplinary team have been visiting the road section in question and based on that the necessary data for the Environmental Impact Assessment has been collected. One part of the data is taken from the available project documentation for specific project environmental segments. Bearing in mind all that the author has had during the development of this study, we considered that no special on-site research was necessary and that is why the descriptions of environmental segments are taken from the existing documentation.

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