LABORATORYTESTING for CONSTRUCTION MATERIALS
& GEOTECHNICAL STUDY

LABORATORYfor CONDUCTING CONSTRUCTION MATERIAL TESTS &
GEOTECHNICAL STUDIES

REPORT

ON THE GEOLOGICAL-ENGINEERING CONDITIONS OF THE CONSTRUCTION SITE FOR THE PROJECT "WATER SUPPLY PROJECT FOR THE COASTAL AREAS OF THE DIVJAKA MUNICIPALITY AND THE REMAS ADMINISTRATIVE UNIT", DIVJAKA

LabP-12 QM 7,2,1

Lab D -12.3

Vore Contact:, Tel: +355 4 4500 884; +355 4 4500 885

Address: Tirane-Durres Highway km 12, Picar

(080) ebruary 2020

Tirana,F

Mob: ++ 355 682074332, Mob: ++ 355 68 2031 906; Mob: ++ 355 684071577

Email:
skendr.allkja@alteageostudio.comWebsite:
www.alteageostudio.com

EN ISO 9001:2015 No. 010140786
SCC**:2011No. 20 106 122007136
EN ISO 14001:2015 No. 04 016008
OHSAS 18001:2007 No. 03012019
Pass99:2012No.02613005

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Author: Eng. Geologist Skender THE KEY

Geologist Besian XHAGOLLI Geotechnical

Engineer Ardita MALAJ

Order: "DIPER" Ltd.

Address: Tirana-Durres highway km 12, Picar Vore
Contact:, Tel: +355 4 4500 884; +355 4 4500 885
Mob: ++ 355 682074332, Mob: ++ 355 68 2031 906; Mob: ++ 355 684071577
Email:
skendr.allkja@alteageostudio.comWebsite:
www.alteageostudio.com

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1.0 FoRewoRd

On January 21, 2020, based on the contract concluded between the companies « Diper » sh.pk represented by Ms. Stela Guxo and the company "ALTEA & Geostudio 2000 " for the drafting of the geological study of the project "Water supply design study for the coastal areas of the Divjaka municipality & the Remas administrative unit", a geological study was conducted on the ground by the company "ALTEA & Geostudio 2000 ". This geological study was carried out in the areas around the Karavasta lagoon from the village of Hasuturkas in the south to the vicinity of the village of Terbuf in the north, as well as in the area where the city of Divjaka is built. During this geological study on the ground by the geologists of the company "ALTEA & Geostudio 2000 ", special attention was paid to the hilly areas where the water supply line will pass and especially to the hill where the main water tanks will be built.

-The most important part of this project is the geological-engineering conditions, including the physical-mechanical properties and negative geodynamic phenomena of the foundation where the water supply reservoir for this area under study will be built.

-In the final construction of this geological-engineering report, we will provide the geological-engineering conditions of the area where the water supply line for the city of Divjaka and the surrounding areas will be built, along with the relevant recommendations.

- To construct this geological-engineering report, we relied on data collected in the field and on the experience of the authors of this study.

1.1 Purpose of the study

The purpose of this study consists of:

1. Identification and determination of the soils and rocks involved in the area where this project will be built.
2. Identification and description of negative geological-engineering phenomena present in this area.
3. Preparation of the final geological-engineering report for this area along with relevant recommendations.

1.2 Objective of the Works

For the construction of this geological-engineering report and the successful realization of the above-mentioned goals, we relied on:

1. Inspection and field assessment of the geological and geo-engineering conditions of the area under study.

2. Study of geological and geomorphological maps of the area.
3. All previous geological works carried out by the authors and by other local authors which were carried out for other purposes but have cognitive value have been reviewed. All published and unpublished studies for the area in question will be reviewed.

This area is included in the Karavasta valley, which is built from deposits with weak physical-mechanical properties, just like other lagoons located in the coastal part of our country.
To carry out this study, previous geological and geo-engineering works carried out for areas with the same geological structure were used.

1. Geological-engineering and geotechnical study conducted by "ALTEA & GEOSTUDIO 2000" for the "VLORA AIRPORT" project in the Narta lagoon, May 2018
2. Geological-engineering and geotechnical study conducted by "ALTEA & GEOSTUDIO 2000" for the "Shengjin-Velipoje" road project in the Viluni lagoon, June-July 2018
3. Geological-engineering studies for various projects carried out by "ALTEA & GEOSTUDIO 2000" in the city of Divjaka, 1996-2020

The studies were conducted in accordance with the standards included in the agreement between the parties, such as: ASTM, AASHTO, BSI, UNI.

2.0 GEOMORPHOLOGY

In this chapter we will elaborate on the description of the area where the water supply project for the city of Divjaka will be built, the forms of the current relief, the geological conditions of the formation of this relief. The geological and geodynamic phenomena of the area will be described.

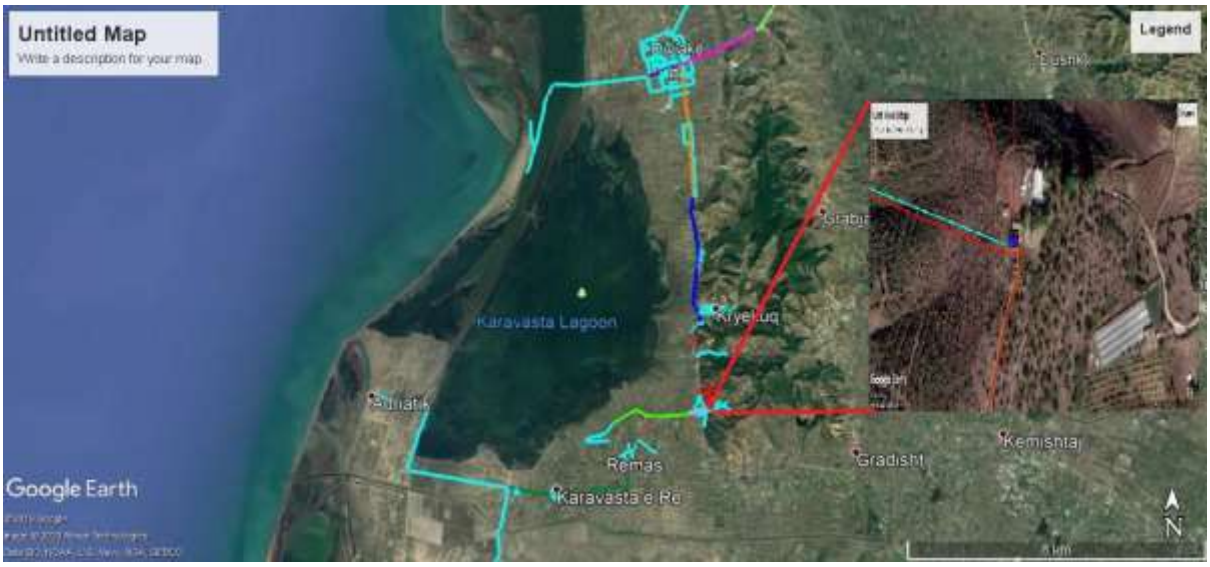

Figure 1- Satellite view of the area under study.

2.1 Location and relief

The area under study is part of the westernmost part of the Republic of Albania. Administratively, it is part of the municipality of Divjaka. The area under study, in the south and west, lies very close to the Karvasta lagoon, passes in the north towards the city of Divjaka and then heads north-east near the village of Terbuf. The area under study has a small difference in elevation and the maximum height goes up to 5m above sea level, excluding the hilly part of the area.The climate is Mediterranean and there are many contrasts between the seasons. Precipitation falls mainly in the spring season. Snowfall is rare in this country. Hail falls more in the spring season. There are up to 3 days of hail per year. Frosts are rare. There are up to 10 days of frost per year. The first frosts appear in January and the last in March. The drought period lasts about 90 days per year. There have also been cases of prolonged droughts and there have been about 3 cases in 10 years. The wind is frequent. The dominant winds of the warm half of the year come from the south while the cold half from the north. In Divjaka there is also the case of storms. They occur most often in March and there are an average of 2 days of storms per year. The damage caused by the storms was: the fall of crops, the fall of old trees, which often caused the downing of power lines.

This area is located in the center of the Pre-Adriatic Uplift. The Pre-Adriatic Uplift includes the hilly and plain terrains of the Pre-Adriatic molasse basin, which was founded in the Middle Miocene (Serravalian), first after the main folding of the outer Ionian zone and then filled with Miocene and Pliocene molasse. To the west of the Pre-Adriatic Uplift lies the Pliocene-Quaternary platform with basinal facies, discovered in the Adriatic Sea in recent years from the results of seismic surveys. The Pre-Adriatic Uplift is considered a lateral Uplift since it is located mainly on the outer side of the orogen with a different structural plan and partly also on the offshore platform, in a concordant manner. The folded structure of the Pre-Adriatic Uplift is due to two compressional phases: one, the weaker one, at the Miocene-Pliocene boundary and the other, the stronger one, in the Lower Pleistocene. The area under study during the Middle and Upper Pleistocene as well as the Holocene has had a tendency to subside.

2.2 Geological and Geodynamic Processes

In studying the geological phenomena of this area, we have based ourselves on existing studies and on the new information we have obtained from the current study. Based on these data, we are describing the geological phenomena that are present in the geological formations found in this area.

The most notable geological and geodynamic phenomena observed in this area are:

1. **The Phenomenon of Alienation**
2. **The Phenomenon of Erosion**
3. **The Landslide Phenomenon**
4. **The phenomenon of consolidation of deposits with weak physical-mechanical properties**

Below we are addressing in more detail one by one these phenomena that negatively affect the stability of the water delivery channel.

1. **The process of alienation**is the phenomenon which is caused as a result of climate changes causing physical and chemical changes in the structure and texture of rocks. During the process of weathering the rock undergoes significant structural and textural changes, significantly reducing its physical and mechanical properties. This phenomenon is present in the area under study. During this geodynamic process the mass of the parent rock behaves like a mass of soil. This phenomenon is observed in the hilly part of the area under study.

2. **The phenomenon of erosion**just as the phenomenon of alteration develops more in the rocks that build the hills of this area. These rocks are of very young geological age. The age of these rocks is of the Pliocene period with an age of (1.8-5.3) million years. These rocks belong to 4 different lithologies. The rocks of the Lower Pliocene (N21) are composed of Claystone, Siltstone and Fine Sandstone and the rocks of the Upper Pliocene are composed of Conglomerates (N22). These rocks are of weak cementation and weak strength and due to this geological nature they are very sensitive to exogenous erosional conditions. During times of heavy rainfall, the altered part of the parent rock is washed away and transported towards the lower elevations of the relief. In the plain part of the area, which is built up by small differences in elevation, eolithic phenomena occur, such as the case of sand dunes. Dunes are temporary deposits that change their location from time to time.

3. **The phenomenon of landslides**occurs on slopes with a slope of more than 15°, in the area taken into study, no moving masses have been observed. These moving masses are mainly provoked by the saturation of the material with water. The hills that are covered by the rocks of the lower Pliocene appear problematic for the possibility of landslides because they are built of layers of clay, silt and fine sandstone. Layers of clay serve as sliding planes especially in the case of the presence of groundwater. On the hill where the main storage for the water supply for the city of Divjaka will be built, this phenomenon is not present because this hill is built of conglomerate rocks. During the time of the field survey, no active landslides or old landslides have been observed. The possibility of landslide activation in this area is very small.

4. **The phenomenon of consolidation of deposits with weak physical-mechanical properties**This phenomenon is observed in the plain part of the study area, mainly in the old deposits of the Karavasta lagoon. The lagoon deposits are of Holocene age, not exceeding 10,000 years. Lithologically, they are made up of Clay, Silt and Fine Sand with a high content of organic matter. These deposits have not had the conditions and time to consolidate because they are very young and the content of organic matter significantly hinders the consolidation process of these soils.

3.0 GEOLOGICAL STRUCTURE AND HYDROGEOLOGICAL CONDITIONS

In this chapter we will address the geological composition of the area by utilizing existing works and previous works by other geologists who have contributed to the construction of geological maps of various scales for this area. Based on the collected material we are elaborating the geological structure of the area.

3.1 Quaternary (Q) deposits

In the Pre-Adriatic Lowland, Quaternary deposits are widely distributed in terrains with a tendency to subsidence during the Quaternary, mainly in the western coastal part and along the Mio-Pliocene synclines. In the coastal part of this lowland, marine-lagoon deposits develop, which further east, towards the interior, pass into alluvial deposits. The Quaternary marine-lagoon deposits are characterized by sand, clay, silt and silty clay and sometimes with peat fragments. The Quaternary deposits here reach a thickness of over 150m and lie horizontally and with a pronounced angular unconformity on the folded Mio-Pliocene deposits. In the studied area, the following Quaternary deposits are found:

-Holocene deposits represented by marine deposits (Qh).

These deposits consist of fine marine sands. They are beige in color, moist, contain little dust, and are very slightly compacted.

-Holocene deposits represented by lagoonal deposits (Qh).

These deposits consist of clay, silt, and powdered silt, are beige and gray in color, saturated with water and in a plastic to flowable state, contain organic matter, and are very slightly compacted.

-Holocene deposits represented by alluvial-marsh deposits (Qh)

These deposits consist of fine sand and gravel, are beige and gray in color, very moist, contain silt, organic matter and clay bands. The gravel is of the fine and medium fraction and rarely of the coarse fraction. They are slightly compacted to moderately compacted.

-Pleistocene-Holocene deposits represented by mixed alluvial deposits-proluvial (Qp-h)

These deposits are represented by Dust, Sand and Gravel, are beige and beige-gray in color, with moisture, show a light cementation and are compacted, these deposits serve as foundations with good properties.

3.2 Neogene (N) deposits

The Neogene deposits belong to the Lower Pliocene and Upper Pliocene epochs. These deposits are molasse deposits. The Pliocene molasse cycle is deposited transgressively and with angular unconformity on the edges of the Pre-Adriatic Uplift, both on the formations of the Ionian and Kruja zones.

-Lower Pliocene deposits (N21)These deposits are found in the hilly part ofzone and consist of fine claystones, siltstones and sandstones, they are beige and beige-brown rocks, with weak clay-sandstone cementation and weak strength. These deposits in geology are known as the "Helemesi Suite". This suite is placed everywhere transgressively on the underlying deposits of the Upper Pre-Adriatic, mainly on the Miocene molasse. In these deposits, Divjake-Kryevidh and in Durres, the presence of deposits of the Grobolotalia margaritae zone, and of that Grobolotalia puncticulata, successively placed on the deposits of the Sphaerodinellopsis zone, has been evidenced. The increasingly younger deposits of the Lower Pliocene are followed towards the central part-

western part of the Pre-Adriatic Ultersira. In Divjaka-Kryevidh, deposits of the Middle Pliocene (Globorotalia crassaformis zone) have also been encountered, which are normally covered by the sandy-conglomerate facies of the "Rrogozhina" suite.

-Upper Pliocene deposits (N22)These deposits are found in the hilly part ofthe study area and build the upper part of the hill where the water reservoir will be built. These deposits consist of fine Sandstones and Conglomerates. The sandstones of this suite are beige in color and the conglomerate rocks are multi-colored and beige to brown in color in the matrix. The rocks of this age are of weak clay-sandstone cementation and weak strength.
These deposits are known in geology as the "Rrogozhina Suite". This suite is successively placed on the clay facies of the "Helmesi" suite, and has a more typical and complete representation. The Rrogozhina Formation belongs to the regressive cycle of the Pliocene molasse and is represented by sandy-conglomerate deposits with rare intercalations of clays. From a lithofacies point of view, they are represented by conglomerates, gravels, sands, gravelly sands with intercalations of silty-sandy clays. These deposits do not contain planktonic foraminifera, but rather redeposited ones. The "Rrogozhina" suite is distributed throughout the Ultersira and is placed on the levels of the "Helmesi" suite. Thus, in Divjaka and Kryevidh, this suite is placed on the deposits of the Globorotalia crassaformis zone of the Middle Pliocene. The deposits of the "Rrogozhina" suite contain benthic foraminifera, mainly Ammonina beccarii pinuseptata.
, by which they are distinguished from those of the Tortonian-Messinian molasse. The stratigraphic position of the "Rrogozhina" suites is determined in each place, starting from the fact that on the deposits of which the planktonic zones of the "Helmesi" suites lie in succession. Based on these considerations, the "Rrogozhina" suite is dated from the Lower Pliocene, younger than the Sphaerodinellopsis zone, up to and including the Upper Pliocene. Since in Divjaka the deposits of the "Helmesi" suites rise to the Middle Pliocene and are successively followed by a considerable thickness of deposits, of the "Rrogozhina" suite. The total thickness of both Pliocene suites reaches an average of 1600m and a maximum of 2500m in the Rrogozhina section. As a rule, the thickness of the Pliocene deposits increases from south to north and from east to west of the Pre-Adriatic Upland. (Sh.Aliaj)

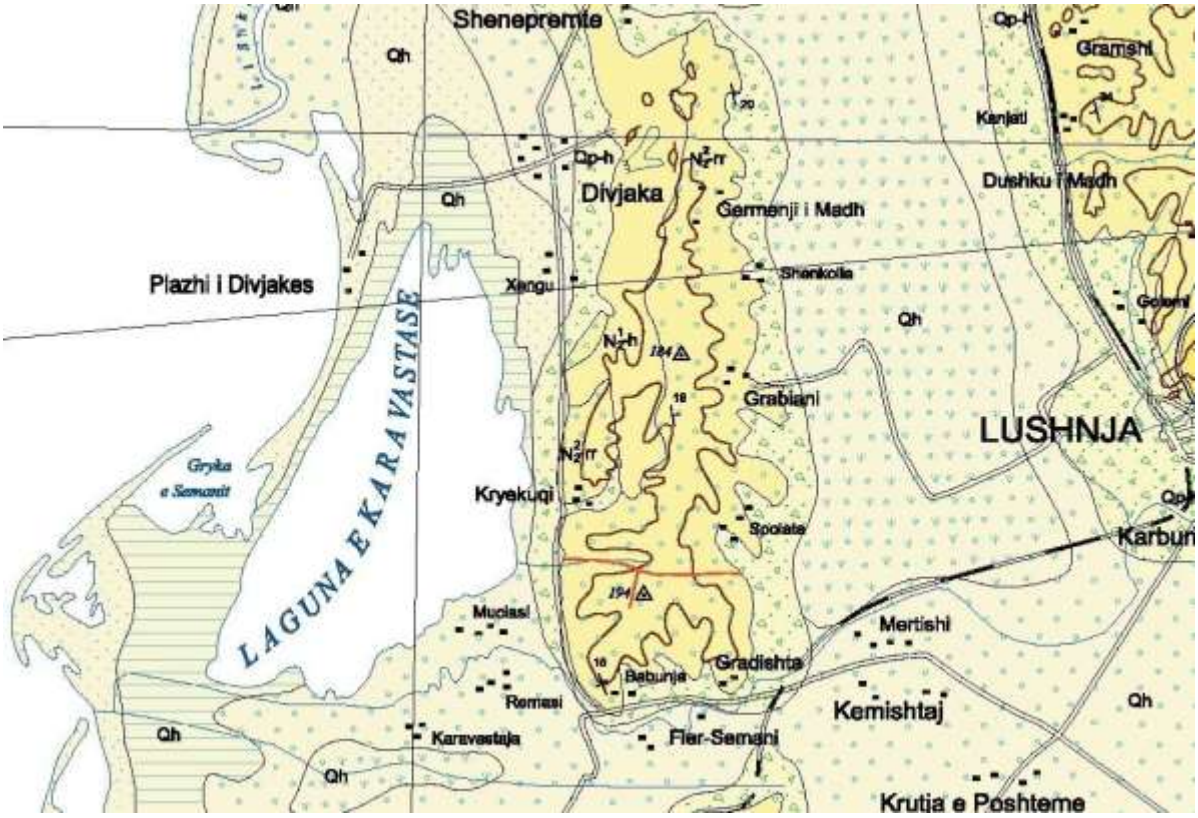

Figure 2.Geological map of Albania at a scale of 1:200,000, showing the area along the Karavasta lagoon and the city of Divjaka

Figure 3.DepositionQuaternary

Figure 4.The de-situations of the “Rrogozhina” suite

3.3 Hydrogeological conditions

In the studied area, we have distinguished two groundwater complexes. The Pliocene rock aquifer complex and the Quaternary soil aquifer complex. These complexes differ in their hydrogeological laws and nature.

- ***Pliocene sedimentary complex (N2)***

This aquifer complex is not rich in groundwater. The groundwater in this aquifer complex is phreatic and in the dry seasons of the year the groundwater level is deep from the surface of the earth. The source of nutrition for this aquifer complex is atmospheric precipitation. Contact springs emerge from this aquifer complex. This complex is built of clay, siltstone, sandstone and conglomerate rocks. Sandstone and conglomerate rocks have good water-bearing properties, while clay and siltstone rocks are insulating rocks. At the contact of these lithologies we have the emergence of groundwater springs.

- ***Quaternary sedimentary complex (Qh)***

This water reservoir complex is rich in groundwater. As we mentioned above, this complex is built from soils with good filtering properties, except for clays and silts. The water level in this water reservoir complex is close to the surface of the earth. This is one of the areas with the lowest elevations and serves as a drainage area for freshwater. The waters in this water reservoir complex are aggressive to iron and concrete because we have seawater penetration. In these cases, the concrete must be of strong brands and the iron must be coated with an insulating material such as bitumen. The water supply pipeline will pass through this water reservoir complex and during the opening of the pits, we do not exclude the possibility of water entering the pits.

4.0 STUDY RESULTS

This chapter discusses the results of the geological study based on field observations and existing study data for this area.

The geological-engineering conditions of the area under study will be given for the hilly area where the water reservoir will be built and for the plain area where the water distribution pipeline will be laid.

4.1 Geological and engineering conditions of the hilly area where the water reservoir will be built During the field inspection and assessment of the geological-engineering conditions of the foundation where the water storage facility will be built, it was concluded that this area is in good geological-engineering conditions. No active landslides or old landslides have been found in this area. The groundwater level in this area is much deeper than the surface.

Below we provide the characteristics of the layers found in this study area.

Layer 1

-The topsoil consists of medium-grained clay with a beige to brown color, moist, plastic, contains plant roots and fine to medium gravel, slightly compacted. It is found at depths of (0.00-0.80)m.

Layer 2

-It is represented by eluvial deposits of Conglomerate rocks. This layer consists of clayey gravel. The gravel is of all fractions, many colors, with little moisture, with poplar content. The gravel has a rounded shape and is of calcareous, sandy and less ultrabasic origin. It is found at depths of (0.80-1.80)m.

The physical-mechanical characteristics for this layer are:

Granulometric composition

factionclay< 0.005 mm12.60 %
factionpowdery0.005-0.075 mm12.10 % Fraction sand>
0.075 mm31.50 %
factiongravelly> 4.75mm43.80 %

Plasticity

The upper limit ofplasticityW r = 24.37 %
The lower limit ofplasticityW p = 16.2 %
Number ofplasticityF = 8.35
HumiditynaturalW n = 10.37 %
Weightspecificδ = 2.7 T/m^3
Volumetric weight in conditionnaturalγ = 1.98 T/m^3
Module ofdeformationE =13.5 mPa.s.
The angle of friction ofINTERNAL φ = 31.22o
CohesionC = 11.24 CAP
Permitted load incompressionσ = 2.0 kg/cm2
The indicator ofCBRCBR = 20-25%

Layer 3

-It is represented by the Upper Pliocene Conglomerate rocks. The conglomerates are multi-colored and beige in matrix, are weakly cemented and moderately weak in strength. The gravel grains are small, medium and large to large. They are rounded in shape and of calcareous, sandy and less ultrabasic origin. They are very compact. Found at depths of (1.80-10.0)m.

The physical-mechanical characteristics for this layer are:

HumiditynaturalWn = 7.20 %
Weightspecificδ = 2.68T/m3
Volumetric weight in conditionnaturalΔ = 2.34 T/m3
The coefficient ofporosityε = 0.40
Module ofdeformationE = 784.5 kg/cm^2
The angle of friction ofINTERNAL φ = 380
CohesionC = 0.60 kg/cm^2
Compression resistanceuniaxialRsh = 5-7 kg/cm2
Permitted load incompressionσ = 3.60 kg/cm2

4.2 Geological and engineering conditions of the area The pipeline line for the distribution of water will be built in the field. water

The geological engineering conditions in the area where the water supply pipeline for the city of Divjaka will pass are presented with weak physical-mechanical properties. The deposits that make up this area are slightly compacted and the groundwater level is close to the surface. These waters are aggressive towards iron and concrete.

Below we provide the characteristics of the layers found in this study area.

Layer 1
-The vegetable soil consists of light, dusty clays with a beige to dark brown color, moist, plastic, contains plant roots, slightly compacted.
Found at depths of (0.0-0.6)m

Layer 2
-It is represented by marine and lagoonal deposits. This layer consists of medium dusty clays with a gradual transition to heavy silts, they are beige and beige-gray in color, they are more humid and in a plastic state. They contain little gravel, they are slightly compacted. They are found at depths of (0.6-10.0) m.

The physical-mechanical characteristics for this layer are:
Granulometric composition

factionclay<	0.005 mm	12.60 %
factionpowdery	0.005-0.075 mm	36.20 %
Fraction sand>	0.075 mm	43.00 %
factiongravelly>	4.75mm	8.20 %

Plasticity

The upper limit ofplasticityW	r = 28.60 %
The lower limit ofplasticityW	p = 21.4 %
Number ofplasticityF =	7.2
HumiditynaturalW	n = 24.65 %
Weightspecificδ	=2.61T/m^3
Volumetric weight in conditionnaturalγ = 1.90 T/m^3	
The coefficient ofporosity	ε = 0.70
Module ofdeformationE =68	kg/cm2
The angle of friction ofINTERNAL	φ = 16o
CohesionC = 0.16kg/	cm2
Permitted load incompressionσ = 1.40	kg/cm2
The indicator ofCBRCBR =	5-6%

5.0 CONCLUSIONS AND RECOMMENDATIONS

1. The area under study is located in the Pre-Adriatic Lowlands, which is the westernmost part of our country and the relief has a small difference in elevation.

2. During the field visit, in the partsNo active landslides or landslides have been identified in Kodrinoren. old.

3. The groundwater level in the plain part of the study area is close to the ground surface.

4. Groundwater is aggressive towards iron and concrete.

5. We recommend that the water tank be supported on layer 2 or layer 3 as these layers have good physical-mechanical properties.

6. If during the project, in the field part of the study area, deep holes are dug, then there will be water inflow which can be removed through pumps.

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Adresa: Autostrada Tirane-Durres km 12, Picar Vore
Kontaktt:, Tel: +355 4 4500 884; +355 4 4500 885
Mob: ++ 355 682074332, Mob: ++ 355 68 2031 906; Mob: ++ 355 684071577
E-mail: skender.allkja@alteageostudio.com
Website: www.alteageostudio.com

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Date: 2026.06.26
12:23:16 +02'00'

Adresa: Autostrada Tirane-Durres km 12, Picar Vore
Kontaktë:, Tel: +355 4 4500 884; +355 4 4500 885
Mob: ++ 355 682074332, Mob: ++ 355 68 2031 906; Mob: ++ 355 684071577
E-mail: skender.allkja@alteageostudio.com
Website: www.alteageostudio.com