Project: “Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation” Interreg CBC Italy-Croatia 2014.-2020.

Priority Axis: Safety and resilience

Specific objective: Improve the climate change monitoring and planning of adaptation measures tackling specific effects, in the cooperation area

(D_3.2.5) Report on the soil physics on samples collected in the Croatian site

Work Package 3: Studying

Activity 2: Laboratory investigations

Partner in charge: PP4 (UNIST-FGAG)

Partners involved: PP4 (UNIST-FGAG), PP5 (CROATIAN WATERS), PP6 (DUNEA)

Final version

Public report

September, 2022

Contents

Laboratory tests

In accordance with the program of laboratory tests for the subject: Field and laboratory research service in the Lower Neretva area for the needs of the Project "Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation", tests were performed by the Laboratory of Geokon Zagreb d.d. The geomechanical laboratory of the company Geokon Zagreb d.d. is accredited for laboratory tests according to the standard HRN EN ISO / IEC 17025: 2008.

The following tests were performed on representative disturbed and undisturbed soil samples.

STANDARD DESCTRIPTION	SYMBOL	UNIT	STANDARD ID
Classification tests, soil identification and description			
Water content determination	w_o	%	ASTM D 2216-10
Bulk density determination	ρ & ρ_d	g/cm^3	HRN U. B1. 016
Specific density	ρ_s	g/cm^3	ASTM D 854-14
Consistency limits determination (Atterberg limits)	w_L & w_P	%	ASTM D 4318-17
Particle size analysis of soils	--	%	ASTM D-422-63
Chemical testing of soil			
Determination of combustible and organic matter content	--	%	HRN U.B1. 024
Soil permeability testing			
Determination of permeability coefficient using a Flexible Wall Permeameter	k	(cm/s)	ASTM D 5084-97

The tests were carried out in accordance with valid regulations and standards.

The laboratory report on the performed laboratory tests is presented in Appendix 5.

The results of laboratory tests are shown in the borehole logs in Appendix 2 and in the summary tables in Appendix 6.

Description of laboratory tests

A brief overview of the standards according to which the soil is tested:

ASTM D 2216-10

Standard test methods for laboratory determination of water (moisture) content of soil and rock by mass. These test methods cover the laboratory determination of the water (moisture) content by mass of soil, rock, and similar materials where the reduction in mass by drying is due to loss of water.

HRN U. B1. 016

Standard test methods for of density and unit weight of soil specimens. These test methods describe ways of determining the total/moist/bulk density, dry density, and dry unit weight of intact, disturbed, remoulded, and rec.

ASTM D 854-14

Standard test methods for specific gravity of soil solids by water pycnometer. These test methods cover the determination of the specific gravity of soil solids that pass the 4.75-mm (No. 4) sieve, by means of a water pycnometer.

ASTM D 4318-17

Standard test methods for liquid limit, plastic limit, and plasticity index of soils. These test methods cover the determination of the liquid limit, plastic limit, and the plasticity index of soils.

ASTM D-422-63

Standard test methods for particle-size analysis of soils. This test method covers the quantitative determination of the distribution of particle sizes in soils. The distribution of particle sizes larger than 75 µm (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 µm is determined by a sedimentation process, using a hydrometer to secure the necessary data.

HRN U. B1. 024

Determining the water (Moisture) content, ash content, and organic Material of organic soils. This test method covers the measurement of water (moisture) content, ash content, and organic material in peats and other organic soils, such as organic clays, silts, and mucks.

ASTM D 5084-97

Standard test methods for measurement of hydraulic conductivity of saturated porous materials using a flexible wall permeameter. This test method covers the laboratory measurement of the hydraulic

conductivity (also referred to as coefficient of permeability) of water-saturated porous materials with a flexible wall permeameter at temperatures between about 15 and 30.

Preformed laboratory tests

The following tables show the laboratory program with data on the performed tests of samples submitted to the laboratory.

Test ID	Depth (m)		Water content		Specific gravity		Bulk density	Particle size analysis of soils		Atterberg limits		Direct Shear Test		Unconfined Compressive Strength		One-Dimensional Consolidation Properties		Determination of permeability	Standard Effort		Organic matter	CBR	Proctor	Modified Effort	Note
	FROM	TO	HRN U.B1.012 (1979)	ASTM D 2216-10	HRN U.B1.014 (1968)	ASTM D 854 - 14	HRN U.B1.016 (1968)	HRN U.B1.018 (1980)	ASTM D 422-63	HRN U.B1.020 (1968)	ASTM D 4318-10	HRN U.B1.028 (1969)	ASTM D 3080-11	HRN U.B1.030 (1968)	ASTM D 2166M – 13	HRN U.B1.032 (1969)	ASTM D 2435M – 11	HRN U.B1.034 (1969)	ASTM D 5084-03	HRN U.B1.038 (1968)	ASTM D 698-12e2	HRN U.B1.024 (1968)	ASTM D 1883-14	ASTM D4947/D4947M-13	ASTM D 1557-12	
S-104-21-01-01	1,0	1,1		1		1			1		1															
S-104-21-01-02	2,0	2,3		1		1	1		1		1								1							
S-104-21-01-03	3,4	3,5		1		1			1		1															
S-104-21-01-04	4,5	4,6		1		1			1																	
S-104-21-01-05	6,8	6,9		1		1			1																	
S-104-21-01-06	8,9	9,0							1																	
S-104-21-01-07	10,5	10,6		1		1			1		1															
S-104-21-01-08	13,3	13,5		1		1	1		1		1								1							
S-104-21-01-09	15,5	15,8		1		1	1		1		1															
S-104-21-01-10	17,5	17,6		1		1			1		1															
S-104-21-01-11	18,5	18,8		1		1	1		1		1								1							

Test ID	Depth (m)		Water content		Specific gravity		Bulk density	Particle size analysis of soils		Atterberg limits		Direct Shear Test		Unconfined Compressive Strength		One-Dimensional Consolidation Properties		Determination of permeability	Standard Effort		Organic matter	CBR	Proctor	Modified Effort	Note
	FROM	TO	HRN U.B1.012 (1979)	ASTM D 2216-10	HRN U.B1.014 (1968)	ASTM D 854 - 14	HRN U.B1.016 (1968)	HRN U.B1.018 (1960)	ASTM D 422-63	HRN U.B1.020 (1968)	ASTM D 4318-10	HRN U.B1.026 (1959)	ASTM D 3080-11	HRN U.B1.030 (1968)	ASTM D 2166M – 13	HRN U.B1.032 (1969)	ASTM D 2435M – 11	HRN U.B1.034 (1969)	ASTM D 5084-03	HRN U.B1.038 (1968)	ASTM D 698-12e2	HRN U.B1.024 (1968)	ASTM D1883-14	ASTM D4647/D4647M-13	ASTM D1557-12	
S-104-21-01-12	20,6	20,8		1		1	1		1		1															
S-104-21-01-13	22,6	22,8		1		1			1		1															
S-104-21-01-14	24,7	25,0		1		1	1		1		1								1							
S-104-21-01-15	25,5	25,6		1		1			1		1															
S-104-21-01-16	26,1	26,2		1		1			1																	
S-104-21-01-17	26,9	27,0		1		1			1		1															
S-104-21-01-18	27,8	27,9		1		1			1		1															
S-104-21-01-19	29,4	29,5		1		1			1		1															
S-104-21-01-20	31,2	31,3		1		1			1		1															
S-104-21-01-21	32,5	32,6		1		1			1																	
S-104-21-01-22	33,5	33,6		1		1			1		1															

Test ID	Depth (m)		Water content		Specific gravity		Bulk density	Particle size analysis of soils		Atterberg limits		Direct Shear Test		Unconfined Compressive Strength		One-Dimensional Consolidation Properties		Determination of permeability	Standard Effort		Organic matter	CBR	Proctor	Modified Effort	Note
	FROM	TO	HRN U.B1.012 (1979)	ASTM D 2216-10	HRN U.B1.014 (1968)	ASTM D 854 - 14	HRN U.B1.016 (1968)	HRN U.B1.018 (1960)	ASTM D 422-63	HRN U.B1.020 (1968)	ASTM D 4318-10	HRN U.B1.026 (1959)	ASTM D 3080-11	HRN U.B1.030 (1968)	ASTM D 2166M – 13	HRN U.B1.032 (1969)	ASTM D 2435M – 11	HRN U.B1.034 (1969)	ASTM D 5084-03	HRN U.B1.038 (1968)	ASTM D 698-12e2	HRN U.B1.024 (1968)	ASTM D1883-14	ASTM D4647/D4647M-13	ASTM D1557-12	
S-104-21-02-01	1,0	1,1							1																	
S-104-21-02-02	4,2	4,3				1			1																	
S-104-21-02-03	6,7	6,8		1		1			1		1															
S-104-21-02-04	8,5	8,6				1			1																	
S-104-21-02-05	11,5	11,6				1			1																	
S-104-21-02-06	13,5	13,6		1		1			1		1											1				
S-104-21-02-07	15,5	15,6		1		1			1		1											1				
S-104-21-02-08	17,8	17,9		1		1	1		1		1								1			1				
S-104-21-02-09	18,5	18,6		1		1			1		1															
S-104-21-02-10	20,4	20,8		1		1	1		1		1								1			1				
S-104-21-02-11	22,0	22,1		1		1			1		1															
S-104-21-02-12	23,5	23,9		1		1	1		1		1								1							
S-104-21-02-13	24,5	24,6		1		1			1		1															
S-104-21-02-14	27,5	27,6				1			1																	
S-104-21-02-15	29,5	29,6				1			1																	

Test ID	Depth (m)		Water content		Specific gravity		Bulk density	Particle size analysis of soils		Atterberg limits		Direct Shear Test		Unconfined Compressive Strength		One-Dimensional Consolidation Properties		Determination of permeability	Standard Effort		Organic matter	CBR	Pinhole	Modified Effort	Note
	FROM	TO	HRN U.B1.012 (1979)	ASTM D 2216-10	HRN U.B1.014 (1998)	ASTM D 854-14	HRN U.B1.016 (1998)	HRN U.B1.018 (1980)	ASTM D 422-63	HRN U.B1.020 (1998)	ASTM D 4318-10	HRN U.B1.028 (1999)	ASTM D 3080-11	HRN U.B1.030 (1998)	ASTM D 2166M – 13	HRN U.B1.032 (1999)	ASTM D 2435M – 11	HRN U.B1.034 (1999)	ASTM D 5084-03	HRN U.B1.038 (1998)	ASTM D 698-12e2	HRN U.B1.024 (1998)	ASTM D1883-14	ASTM D4647/D4647M-13	ASTM D1557-12	
S-104-21-02-16	30,7	30,8		1		1			1		1											1				
S-104-21-02-17	31,2	31,3		1		1			1		1															
S-104-21-02-18	31,9	32,0		1		1			1																	
S-104-21-02-19	33,0	33,1							1																	
S-104-21-02-20	36,0	36,1							1																	
S-104-21-02-21	39,0	39,1							1																	
S-104-21-02-22	42,0	42,1							1																	
S-104-21-02-23	43,9	44,0							1																	
S-104-21-02-24	46,9	47,0							1																	
S-104-21-02-25	49,9	50,0							1																	
S-104-21-02-26	52,9	53,0							1																	
S-104-21-02-27	54,7	55,0		1		1	1		1		1															
S-104-21-02-28	57,0	57,1							1																	
S-104-21-02-29	60,0	60,1							1																	
S-104-21-02-30	63,0	63,1							1																	

Test ID	Depth (m)		Water content		Specific gravity		Bulk density	Particle size analysis of soils		Atterberg limits		Direct Shear Test		Unconfined Compressive Strength		One-Dimensional Consolidation Properties		Determination of permeability	Standard Effort		Organic matter	CBR	Pinhole	Modified Effort	Note
	FROM	TO	HRN U.B1.012 (1979)	ASTM D 2216-10	HRN U.B1.014 (1998)	ASTM D 854-14	HRN U.B1.016 (1998)	HRN U.B1.018 (1980)	ASTM D 422-63	HRN U.B1.020 (1998)	ASTM D 4318-10	HRN U.B1.028 (1999)	ASTM D 3080-11	HRN U.B1.030 (1998)	ASTM D 2166M – 13	HRN U.B1.032 (1999)	ASTM D 2435M – 11	HRN U.B1.034 (1999)	ASTM D 5084-03	HRN U.B1.038 (1998)	ASTM D 698-12e2	HRN U.B1.024 (1998)	ASTM D1883-14	ASTM D4647/D4647M-13	ASTM D1557-12	
S-104-21-02-31	66,0	66,1							1																	
S-104-21-02-32	34,9	35,0							1																	
S-104-21-02-33	37,9	38,0							1																	
S-104-21-02-34	40,0	40,1							1																	
S-104-21-02-35	41,5	41,6							1																	
S-104-21-02-36	43,0	43,1							1																	
S-104-21-02-37	45,0	45,1							1																	
S-104-21-02-38	47,9	48,0							1																	
S-104-21-02-39	48,9	49,0							1																	
S-104-21-02-40	50,9	50,1							1																	
S-104-21-02-41	51,9	52,0							1																	
S-104-21-02-42	52,0	53,0							1																	
S-104-21-02-43	53,9	54,0							1																	
S-104-21-02-44	56,0	56,1							1																	
S-104-21-02-45	59,0	59,1							1																	

Test ID	Depth (m)		Water content		Specific gravity		Bulk density	Particle size analysis of soils		Atterberg limits		Direct Shear Test		Unconfined Compressive Strength		One-Dimensional Consolidation Properties		Determination of permeability		Standard Effort		Organic matter	CBR	Pinhole	Modified Effort	Note
	FROM	TO	HRN U.B1.012 (1979)	ASTM D 2216-10	HRN U.B1.014 (1968)	ASTM D 854-14	HRN U.B1.016 (1968)	HRN U.B1.018 (1980)	ASTM D 422-63	HRN U.B1.020 (1968)	ASTM D 4318-10	HRN U.B1.026 (1969)	ASTM D 3080-11	HRN U.B1.030 (1968)	ASTM D 2166M – 13	HRN U.B1.032 (1969)	ASTM D 2435M – 11	HRN U.B1.034 (1969)	ASTM D 5084-03	HRN U.B1.036 (1968)	ASTM D 698-12e2	HRN U.B1.024 (1968)	ASTM D1883-14	ASTM D4647/D4647M-13	ASTM D1557-12	
S-104-21-02-46	59,0	59,1							1																	
S-104-21-02-47	61,0	61,1							1																	
S-104-21-02-48	62,0	62,1							1																	
S-104-21-02-49	63,9	64,0							1																	
S-104-21-02-50	64,5	64,6							1																	
S-104-21-02-51	65,5	65,6							1																	
S-104-21-02-52	67,5	67,6							1																	
S-104-21-02-53	68,5	68,6							1																	
S-104-21-02-54	69,5	69,6							1																	
S-104-21-02-55	70,5	70,6							1																	
S-104-21-02-56	71,5	71,6							1																	
S-104-21-02-57	72,5	72,6							1																	
S-104-21-02-58	73,5	73,6							1																	
S-104-21-02-59	74,9	75,0							1																	
S-104-21-02-60	75,9	76,0							1																	

Test ID	Depth (m)		Water content		Specific gravity		Bulk density	Particle size analysis of soils		Atterberg limits		Direct Shear Test		Unconfined Compressive Strength		One-Dimensional Consolidation Properties		Determination of permeability		Standard Effort		Organic matter	CBR	Pinhole	Modified Effort	Note
	FROM	TO	HRN U.B1.012 (1979)	ASTM D 2216-10	HRN U.B1.014 (1968)	ASTM D 854-14	HRN U.B1.016 (1968)	HRN U.B1.018 (1980)	ASTM D 422-63	HRN U.B1.020 (1968)	ASTM D 4318-10	HRN U.B1.026 (1969)	ASTM D 3080-11	HRN U.B1.030 (1968)	ASTM D 2166M – 13	HRN U.B1.032 (1969)	ASTM D 2435M – 11	HRN U.B1.034 (1969)	ASTM D 5084-03	HRN U.B1.036 (1968)	ASTM D 698-12e2	HRN U.B1.024 (1968)	ASTM D1883-14	ASTM D4647/D4647M-13	ASTM D1557-12	
S-104-21-02-61	76,9	77,0							1																	
S-104-21-02-62	77,9	78,0							1																	
S-104-21-02-63	78,9	79,0							1																	
S-104-21-02-64	79,9	80,0							1																	
S-104-21-02-65	81,0	81,1							1																	
S-104-21-02-66	82,0	82,1							1																	
S-104-21-02-67	83,0	83,1							1																	
S-104-21-02-68	84,0	84,1							1																	
S-104-21-02-69	85,0	85,1							1																	
S-104-21-02-70	86,5	86,6							1																	
S-104-21-02-71	88,0	88,1							1																	
S-104-21-02-72	89,9	90,0							1																	

Test ID	Depth (m)		Water content		Specific gravity		Bulk density	Particle size analysis of soils		Atterberg limits		Direct Shear Test		Unconfined Compressive Strength		One-Dimensional Consolidation Properties		Determination of permeability	Standard Effort		Organic matter	CBR	Proctor	Modified Effort	Note
	FROM	TO	HRN U.B1.012 (1979)	ASTM D 2216-10	HRN U.B1.014 (1968)	ASTM D 854-14	HRN U.B1.016 (1968)	HRN U.B1.018 (1960)	ASTM D 422-63	HRN U.B1.020 (1968)	ASTM D 4318-10	HRN U.B1.028 (1999)	ASTM D 3080-11	HRN U.B1.030 (1968)	ASTM D 2166M – 13	HRN U.B1.032 (1969)	ASTM D 2435M – 11	HRN U.B1.034 (1969)	ASTM D 5084-03	HRN U.B1.035 (1968)	ASTM D 698-12e2	HRN U.B1.024 (1968)	ASTM D1883-14	ASTM D4647/D4647M-13	ASTM D1557-12	
S-104-21-03-01	0,5	0,6				1			1																	
S-104-21-03-02	1,5	1,6				1			1																	
S-104-21-03-03	4,5	4,6				1			1																	
S-104-21-03-04	7,5	7,6				1			1																	
S-104-21-03-05	10,0	10,1				1			1																	
S-104-21-03-06	12,5	12,6				1			1																	
S-104-21-03-07	13,5	13,6		1		1			1		1											1				
S-104-21-03-08	15,0	15,3		1		1	1		1		1								1							
S-104-21-03-09	17,0	17,3		1		1	1		1		1								1							
S-104-21-03-10	19,7	20,0		1		1	1		1		1								1							
			0	38	0	49	13	0	104	0	33	0	0	0	0	0	0	0	10	0	0	6	0	0	0	

Determination of hydraulic conductivity coefficient K and effective porosity n_e

After receiving the results of geomechanical laboratory analyses of samples from exploratory boreholes B-1 (S-104-21-01), B-2 (S-104-21-02) and B-3 (S-104-21-03) from the Neretva river valley, the obtained data were processed in order to conduct hydrogeological interpretation of the obtained results. In terms of hydrogeological interpretation, it is necessary here to briefly describe the relationships between geomechanical, geological and geochemical features on the one hand and hydrogeological features on the other.

The original hydrogeological properties on a local and laboratory scale are primarily related to the pore space in which the fluid can accumulate and through which it can move. This very diverse space and its actual shape is not feasible to describe mathematically. It can be discussed extensively, but the state and phenomena of water movement in it can only be accurately represented by parameters that numerically express the mediocre effects of actual or possible accumulation and movement of fluid through these pores. Accordingly, there are three basic parameters. These are porosity or porosity which expresses the volume of cavities in the rock volume, specific surface area which expresses the size of the irregular contact surface between these cavities and solids and permeability which expresses the ease of liquids flow through the sediment, which strongly depends on the specific surface. All these parameters are

related to the size, shape and stacking of particles, grains and pebbles in the deposits. The effect of granulometric composition on the permeability of incoherent sediments takes place following the simple effect of porosity as a carrier of the action of driving force and specific surface area as a resistance factor. These ratios for uniform fine and medium-grained sands are very successfully expressed by unique coefficients and Hazen effective grain. In contrast, the relation of universal validity must follow a theoretically exactly related phenomenon of fluid motion with measurable characteristics of the cavities through which it moves. This is exactly what was achieved by the Kozeny-Carman equation, which derives from the model of Hagen-Poiseuille's law adapted for flow through a porous media.

For the purposes of this project, values of hydraulic conductivity of the samples were calculated and presented in tables and graphs. The values of hydraulic conductivity were calculated using several methods, which resulted in the verification of the results. These values will serve as input data for the development of groundwater flow models.

The Kozeny-Carman method

The functional relationship between the specific surface area and the permeability of a porous media can be explained under certain assumptions by applying the Hagen-Poiseuille law to the occurrence of fluid flow through the pores of a porous medium. The hydraulic radius and the specific surface area are the parametric link of the flow through the tube bundle and the porous media.

There is a great and indisputable advantage of the Kozeny-Carman equation which theoretically correctly expresses the relations of permeability and geometrical characteristics of the porous media as a conduit.

The basic characteristics of the Kozeny-Carman equation is the introduction of a specific surface area as a function of permeability. Elements of such an approach have been noted in Blake (1922) and Fair et Hatch (1933), but authorship is rightly attributed to Josef Kozeny (1927) who has theoretically exact, following Hagen-Poiseuill's law, by solving Navier-Stokes flow equations through the cross section of a bundle of tubes of equal length and different but invariant cross section came to the equation:

$$q = -I\frac{\rho g}{\mu}c_0\frac{n^3}{a_p^2} \tag{1}$$

which is described by the designations used herein. Kozeny (1927) gave values for the factor c_0 depending on the shape of the tubes: 0.5 (circular), 0.562 (square), 0.597 (triangular and 0.66 (thin slit).

Philip C. Carman (1937, 1939, 1956), verifying Kozeny's (eq. 1) equation, introduced the concept of hydraulic radius of the porous medium RH, and expressed the specific surface area per unit mass of solid that does not change with changing porosity, so the permeability equation takes the form:

$$k = C\frac{n^3}{\rho_k^2 a_m^2 (1-n)^2} \tag{2}$$

Carman (1939) also considers the flow of water through a porous medium around solid particles of irregular shape by introducing an angular deviation of 45% of the ground direction including thus the curvature effect. He achieved the best experimental results with a factor of C = 0.2, so in the literature Kozeny-Carman equation is most often expressed in the form:

$$k = \frac{n^3}{5a_k^2 (1-n)^2} \tag{3}$$

Expressing the specific surface area related to volume of the solid.

If the specific surface is expressed by granulometric parameters, the permeability is expressed as the ratio:

$$k = \frac{D_m^2}{180}\frac{n^3}{(1-n)^2} \tag{4}$$

where D_m represents some reference mean grain. It is a term most commonly cited in the literature as the Kozeny-Carman equation.

When applying the Kozeny-Carman equation, there are two main questions:

(1) selection of the reference mean grain and

(2) adequate effective porosity of the porous medium.

The application of two basic approaches appears in the literature. One is more theoretically correct, and relates to the use of D_m medium grain (Bear, 1972; Dagan, 1989; Carier, 2003) as recommended for calculating the specific surface area based on overall granulometric composition data. Others (Boreli, 1984; Vuković & Soro, 1992; Carlson 2007) refer to the literature on experiments and recommend the use

of effective grain D_{10} to D_{17} from the particle size distribution curve, which is not consistent with any analysis of specific surface area and therefore hydraulic diameter.

When investigating hydraulic conductivity K, Kozeny-Carman equation expands as follows:

$$K = \frac{\rho g}{\mu} \frac{D_m^2}{180} \frac{n^3}{(1-n)^2} \tag{5}$$

If the grain size D_m is included in mm and the hydraulic conductivity is expressed in m/s and refers to an aquifer where the water temperature is T = 10 ° C at which the kinematic viscosity

$$v = \frac{\mu}{\rho} = 1{,}307 * 10^{-6}$$

is

$$K = 0{,}042 \frac{n^3}{(1-n)^2} D_m^2 \tau \tag{6}$$

Starting from the conceptual settings of the Kozeny-Carman method, its application should not depend on the size, shape and uniformity of the solid grain practically until the molecular forces of small, especially clay particles disrupt the dominant influence of gravitational forces. For successful application, it is essential to know the actual granulometric composition to the extent necessary to determine the real mean grain size and porosity. In practice, difficulties may arise in the sampling technique either related to nucleation or the selection and size of the sample subjected to particle size analysis. The difficulty of another nature may be related to the heterogeneity of aquifers on a laboratory scale as is the case with thin stratification which makes it difficult to collect samples.

The application of the Kozeny-Carman equation in the study of the permeability of semipermeable coherent formations in the literature is associated with several questions. First of all, the issue of determining the specific surface area of particles is emphasized if it cannot be expressed by a reference size of contained particles in a way suitable for incoherent formations (sand and gravel), then the issue of effective porosity and the coefficient of shape coefficient. These are probably the reasons why this method is very rarely used in hydrogeological practice.

Defining the reference grain size on a sample scale

A special question arises in connection with the method of calculating the mean grain. The methods of determining the mean grain in sieving were applied: arithmetic, geometric and harmonic applied by Kozeny. It is characteristic that $D_a > D_g > D_h$, however, these differences do not give a large difference in the amount of middle grain, if the influence of individual sieves is added arithmetically as recommended in the literature.

Here, the application of a complete geometric mean is tried, in which the mean value is equal to the antilogarithm of the sum of the effect of the logarithms of the mean diameters of the individual sieves. This procedure better mimics the natural size distribution of the grains contained because it equalizes the effect of individual sieves and therefore the effect of grains of extreme sizes. Thus, a wide range of medium grains was achieved, and a procedure that was not previously used in the hydrogeological literature was included. However, it can be compared to the method of determining the geometric mean of Shirazi-Boersme (1984) which take the geometric mean of three aggregates (sand, silt and clay) represented by the arithmetic mean of their particle size range, while all sieves whose mean is included grain size also determined by geometric procedure.

The central question is the reference size of the contained particles, which in the Kozeny-Carman equation represents the effect of the specific surface area of the particle surface and is the dominant factor of the permeability value. In the current literature, attention is focused on the calculation of the mean grain size, ie, the content between two sieves and applies the arithmetic, geometric and harmonic mean, while the sum of their shares in the formation of the average grain in the sample is arithmetic, although Arkin et al. (1956) note that the arithmetic mean can be strongly distorted by extreme values. However, grain size distribution has the characteristics of a logarithmic sequence that is represented by a semi-logarithmic diagram. Following that, we used the application of the logarithmic sum in calculating the geometric mean of grain size. The procedure is equivalent to that used by Shirazi and Boersma (1984) in creating an orthogonal three-component diagram (Fig. 2), except that the mean grain size does not refer to the total aggregate of clay, silt and sand, but to individual sieves. geometric grain sizes of the whole aggregate of the sample, D_{lng}:

$$D_{\ln g} = EXP[0{,}01\Sigma P_i lnD_i] \quad (7)$$

where P_i is the percentage of individual sieves or segments on the granulometric curve, and D_i is the geometric mean grain size in the sieve or segment.

When interpreting granulometric analyses of silt-clay formations, an additional problem is the evaluation of the effect of the smallest particles. Namely, in numerical analyses of granulometric curves and sieve weight data, there is no real data on the size of the smallest particle. The actual sample always has a minimum measured grain size that may be different in each analysis, so the question arises of determining the value of the equivalent size D_{eq} for particles smaller than the minimum measured particle size for the sample.

For such cases, two similar procedures have been used here. One procedure that Chapuis & Légaré (1992) propose to calculate the equivalent particle size, D_{eq}, of residual content by the ratio:

$$D_{eq}^2 = \frac{1}{D_{min}} \int_0^{min} y^2 dy = \frac{D_{min}^2}{3} \tag{8}$$

where D_{min} is the smallest registered grain.

In the second case, the value of the end of the curve D_0 is determined, based on the slope of the curve between the last three sieves, so that:

$$D_0 = EXP\left[-\frac{P_n}{P_{n-2} - P_n} ln\left(\frac{D_{n-2}}{D_n}\right) - \ln(D_n)\right] \tag{9}$$

and the equivalent mean particle size in the rest of the sample is

$$D_{eq} = EXP\left\{\left[-\frac{P_n}{P_{n-2} - P_n} ln\left(\frac{D_{n-2}}{D_n}\right) - \ln(\frac{D_n}{D_{n-2}})\right]/2\right\} \tag{10}$$

where P_n is the percentage of the weight of the last, and P_{n-2} sieves before the penultimate sieve, D_n the size of the opening of the last, and D_{n-2} sieves before the penultimate.

The effective porosity

The effective porosity is considered here as the part of the porosity through which the flow takes place, so its value for a given effective mean grain diameter results in the highest accuracy of the calculated hydraulic conductivity using the Kozeny-Carman method.

The notion of effective porosity has different interpretations. Here, the effective porosity includes only those pores that participate in the flow of groundwater, excluding the so-called. blind pores, ie pores that have only one connection with the total porn space, although their influence is important in some problem areas of flow (water leakage, diffusion and dispersion phenomena, etc.). A similar case is with fine-grained medium with very narrow pores of capillary dimensions, which behave differently in saturated water than in unsaturated medium, so consideration of emerging phenomena may lead to a different definition of effective porosity.

Unlike total and yield porosity that can be measured exactly in the laboratory, the effective porosity is not suitable for laboratory measurements, but can be identified from water flow data through porous media when other flow parameters identification procedure. Therefore, a diagram showing the relationship between the reference mean grain and the effective porosity is used to determine the effective porosity.

Figure 1 Diagram of the ratio of effective porosity and referential mean grain size (Urumović, 2016)

Fine-grained sediments such as silt and clay are called semipermeable in hydrogeological classifications because the specific flow through them is very low and therefore not suitable for concentrated extraction and drainage of groundwater. However, this is only the first approximation used in general qualifications. Their properties are much more intrinsic, which is primarily caused by the very small dimensions of the cavities between the solid particles, the influence of their mineral composition and possible discontinuities. In such circumstances, it is difficult to identify numerical values of hydrogeological parameters of these formations.

The basic property of semipermeable formations is a very small diameter of solid particles and thus the size of pores is very small and the phenomenon of cohesion is pronounced. Their limiting size according to the grains of fine sand is not unambiguously classified. According to generally accepted classifications, the boundary between fine sand and coarse silt ranges from 0.02 mm (ISSS) to 0.063 mm according to the Wentworth scale, and in all other classifications it is 0.05 mm. In such small cavities, the appearance of air bubbles is expressed, which generates the formation of capillary forces, and they can strongly control the movement, especially with small hydraulic gradients. By further reducing the volume, the influence of molecular forces also becomes relatively significant.

The size of the particles is also related to their shape, which is very close to spherical in the case of coarser silt and fine sand, but in the case of clay particles elongated and flattened shapes are widespread, in which their thickness is more important than size. This is especially important for the amount of the specific surface area and permeability.

There is a consensus in the literature that achievable precision depends primarily on the procedures for sampling, testing and internal variability of materials. An extensive and well-argumented discussion of the accuracy of permeability determination and specific surface area was presented by Robert P. Chapuis and Michel Aubertin (2003) based on a research program to improve the reliability of permeability determination. The project was funded by the Natural Sciences and Engineering Council of Canada and implemented at the École Polytechnique de Montréal, Département des génies civil, géologique et mines. Special attention was paid to the assessment of hydraulic conductivity using the Kozeny-Carman equation. As part of the study, they used about 300 laboratory results, partly from literature and partly from their own research. The reality of the estimates is controlled by laboratory tests and on this track they define the concept of excellent precision of the laboratory test depending on the type of analysed sample. The highest accuracy of excellent precision is achievable for sand and gravel when the experiments are carried out under ideal conditions if the K-value is within ± 20%, for 3 specimens from the same sample.

The sensitivity of the amount of specific surface area and permeability is high, even with a small variation in the size of particles and cavities of the micron scale. In the case of silty non-plastic materials, three

correct tests on three specimens of the same sample may give a value of hydraulic conductivity between ½ and twice the mean value. In the case of highly homogenized clays of uniform porosity and Atteberg limits, relatively high uniformity of test results can be achieved, however when clay properties are more variable then the measured K values achieved by a properly conducted experiment can be between 1/3 and 3 times different from their mean value (Chapuis et Aubertin, 2003).

The stated limitations of the real accuracy of laboratory tests of permeability 1/3 to 3 K (measured in the laboratory) for clays, ½ up to 2 K for silt and ± 20% K tested for sand and gravel can be, from a scientific as well as engineering point of view, correctly observed and as a very rigorous evaluation of hydraulic conductivity prediction methods based on granulometric composition and Atteberg limits.

Hydraulic conductivity and silt and clay content relations

Correlation relations of permeability and content of basic soil aggregates are a very widespread topic in soil science research. These relationships are generally focused on studies of the hydraulic conductivity of "nearly saturated" soil, ie soil at a vacuum of 10 cm, due to its suitability for assessing unsaturated conductivity (Jarvis et al. 2002). Such statistical analyses and the resulting pedotransfer functions are mainly related to loose soils with a standard density of 1300 kg / m3.

From the hydrogeological point of view, the results of the correlation of saturated hydraulic conductivity presented by Campbel & Campbel (1982) according to the total content of clay and silt in fineclastic formations, and especially according to their individual content (Campell, 1985) are:

$$K = Cexp\left[-3{,}7m_p - 6{,}9m_g\right] \tag{11}$$

The content of silt m_p and clay m_g is expressed in parts of the total mass of the sample, and the best correlation of all soil samples with density ρ = 1300 kg/m3, which is taken as a standard in soil science research, was achieved with a constant C = 3.92 * 10-5 (m/s).

The effect of the density of consolidated deposits is included by introducing the suction properties of coherent formations using the circumstance that the saturated hydraulic conductivity K is approximately inversely proportional to the square of the inlet air pressure ψ_e. This can be expressed by the relationship:

$$K\psi_e^2 = const. \tag{12}$$

which is taken as the basic parameter of the measure of variability in the study of variations in soil hydraulic properties (Warrick et al., 1977; Russo and Bresler, 1980). The effect of the density (ρ_e) of an

arbitrary formation on the ratio of the inlet air pressure of the observed (ψ_e) and standard ($\psi_{1,3}$) soil can be expressed empirically

$$\frac{\psi_e}{\psi_{1,3}} = \left(\frac{\rho_e}{1,3}\right)^{0,67\beta} \quad (13)$$

as proposed by Campbell (1985) correcting the correlation relationships of data published by Hall et al. (1977), and Russo & Bresler (1980). In this relation, the exponent ß = lnψ / lnSe represents the cotangent of the angle that closes the bilogarithmic outline of the saturation curve Se with the ordinate of the potential ψ, and corresponds to the reciprocal of the Brooks-Corey (1966) saturation curve coefficient.

By equalizing equations 11 and 12, and including equations. 13 for $\psi 1,3 = \psi_e$, equation for soil of any density ρ_e takes the form:

$$K = C\left(\frac{1.3}{\rho_e}\right)^{1,34\beta} exp\left[-3.7m_p - 6.9m_g\right] \quad (14)$$

Expression of the coefficient ß using granulometric parameters Campell (1985) finds by analysing the course of data curves of humidity and air entry potential and analog sequence of statistical parameters of granulometric composition d_g-σ_g of observed materials and proposes expression of suction properties of observed soil relations:

$$\psi_{1,3} = -\frac{0,5}{\sqrt{d_g}} \quad (15)$$

$$\beta = -2\psi_{1,3} + 0,2\sigma_g = \frac{1}{\sqrt{d_g}} + 0,2\sigma_g \quad (16)$$

which are included in a group of pedotransfer functions suitable for modelling water retention and hydraulic conductivity of soil across the USA (Rawls, 2004).

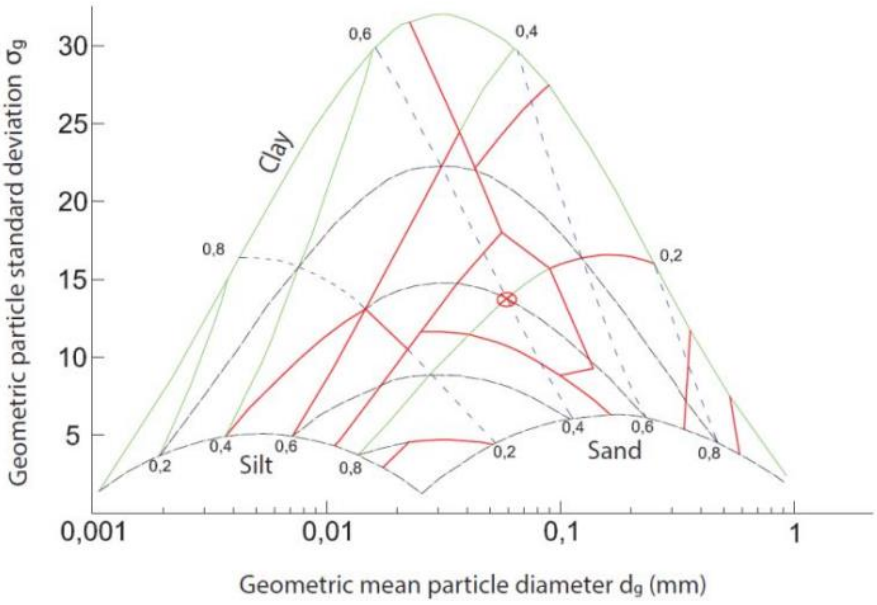


Figure 2 Orthogonal texture diagram of fine-grained formations achieved by rotating the USDA triangular diagram into an orthogonal system of geometric mean diameter dg and standard deviation σg (according to Shirazi & Boersma, 1984)

The calibration resulted with a conclusion that the coefficient C = 1.6 * 10-5 is best suited for the investigated water retention deposits, so equation 14 was used in the form:

$$K_{COR} = 1{,}6 * 10^{-5} \left(\frac{1{,}3}{\rho_e}\right)^{1{,}34\left(\frac{1}{\sqrt{d_g}}+0{,}2\sigma_g\right)} exp\left[-3{,}7m_p - 6{,}9m_g\right] \quad (17)$$

It is well known that the increase in the plasticity of clay formations is accompanied by a decrease in their permeability. The functional correlation between these two traits is unknown. However, there is a clear functional relationship between permeability, ie hydraulic conductivity and specific surface area, and numerous, often quite successful correlations between specific surface area and individual Atteberg limits, especially flow limits. There may be some discrepancy in the relationship between permeability and specific surface area due to its ambiguity in clay soils primarily caused by the inner surface of the clay mineral, because only the outer specific surface participates in the resistance to water flow.

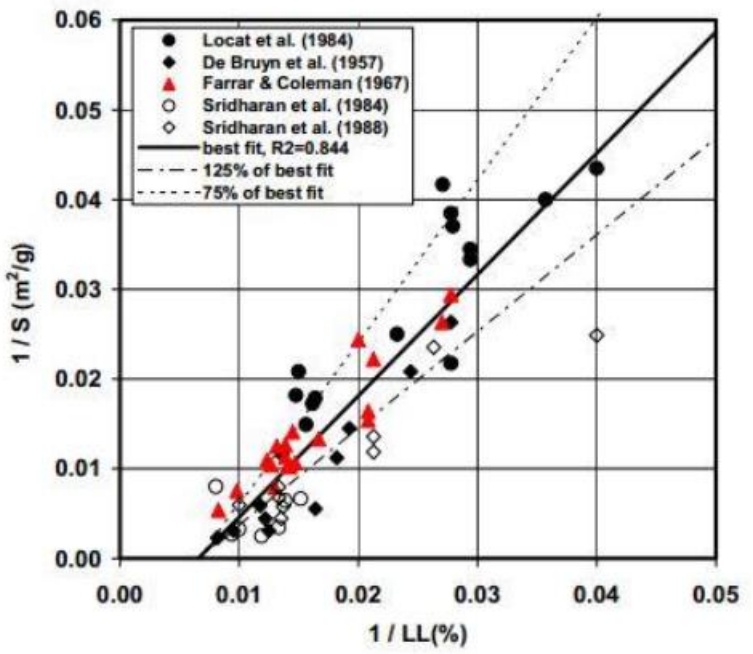


Figure 3 Correlations of reciprocal values of specific surface area and the liquid limit from literature data (according to Chapuis & Aubertin (2003)

The correlations of individual forms of specific surface area and Atteberg boundaries are widely used in the literature. In her master's thesis, Amy B. Cerato (2001) presented, in addition to her own research, 12 correlation functions from the literature, 3 of which relate to the external specific surface. Some of the data in these works were presented by Chapuis & Aubertin (2003) with a diagram (Figure 3) and a straight line correlation (R^2 = 0.84) of reciprocal values of mass specific surface area am (m^2 / g) and liquid limit LL (%).

Here, the liquid limits of samples from exploration wells B-1 (S-104-21-01), B-2 (S-104-21-02) and B-3 (S-104-21-03) in the Neretva delta were used to calculate the mass specific surface area included in the Kozeny-Carman equation of shape:

$$K = \frac{\rho g}{\mu} \frac{n^3}{5\rho_k^2 a_m^2 (1-n)^2} = 0{,}21 \frac{n^3}{a_m^2 (1-n)^2} \tag{18}$$

Data on measured liquid limits were used to calculate the mass specific surface area using the literature recommendation on their relationships achieved by statistical correlations of laboratory data on the size of the liquid limit and mass specific surface area of the same sample.

A number of proposed routes have been tested, and the best results have been achieved through the following 5 relations by various authors for a variety of soils and a diverse range of liquid limits:

$\frac{1}{a_m} = 1{,}3513\frac{1}{LL} - 0{,}0089$	(Chapuis & Aubertin, 2003)	Acciording to the literature data (slika 3)
$a_m = \frac{LL - 19}{0{,}21}$	(Gill & Reavs, 1957)	Soils with a_m from 17% to 78%
$a_m = \frac{LL - 0{,}93}{0{,}67}$	(Ferrar & Coleman, 1967)	British clayey soils
$a_m = \frac{LL - 19{,}805}{0{,}14}$	(Smith et al., 1985)	Izraeli soils
$a_m = \frac{LL - 19}{0{,}21}$	(Zaki, 1971)	Soils with a_m from 50% to 125%

The method of Chaipuis and Aubertin was chosen for the case of typical fine-grained materials that form semipermeable deposits in the Neretva delta.

Results of effective porosity and permeability / hydraulic conductivity analyses – Hydrogeological interpretation of laboratory analysis results

Hydrogeological interpretation of laboratory analysis results was performed using the methods described above. All data received from GEOKON laboratories have been verified and processed in detail by algorithms for calculating hydraulic conductivity and specific surface area (only for low permeability deposits). The data obtained in this way will be the input parameters for hydrogeological analyses and the development of a model of groundwater flow that will follow the monitoring of groundwater and surface water.

The results of the calculations are given in tables and diagrams representing the hydraulic profiles of the underground at the locations of wells B-1 (S-104-21-01), B-2 (S-104-21-02), B-3 (S-104-21-03).

Specific surface area on the sample scale

The specific surface area of a particle is a feature of the material that has a great influence on both the physical permeability of the material and the ability of the material to retain and bind contaminants to the deposits. It thus has a great protective role for the aquifer. The values of the specific surface area of clay-silt and silt-sand samples are presented here.

Table 1 Results of specific surface area (SSA) on the sample size for samples from borehole B-1 (S-104-21-01)

Depth	Sample	SSA (cm2/g)
1,05	S-104-21-01-01-1-04	6.666183274
2,15	S-104-21-01-02-1-04	5.485819975
3,45	S-104-21-01-03-1-04	1.748330372
4,55	S-104-21-01-04-1-04	1.827489904
6,85	S-104-21-01-05-1-04	3.929854375
8,95	S-104-21-01-06-1-04	0.561024243
10,55	S-104-21-01-07-1-04	3.440649275
13,45	S-104-21-01-08-1-04	11.220484860
15,65	S-104-21-01-09-1-04	11.220484860
17,55	S-104-21-01-10-1-04	7.840194558
18,65	S-104-21-01-11-1-04	74.803232420
20,65	S-104-21-01-12-1-04	8.857132925
22,55	S-104-21-01-13-1-04	4.648093452
24,85	S-104-21-01-14-1-04	9.404600233
25,55	S-104-21-01-15-1-04	7.480323242
26,15	S-104-21-01-16-1-04	1.405580784
26,95	S-104-21-01-17-1-04	22.440969730
27,85	S-104-21-01-18-1-04	224.409697300
29,45	S-104-21-01-19-1-04	1.920445725
31,25	S-104-21-01-20-1-04	6.862280029
32,55	S-104-21-01-21-1-04	2.140362666
33,55	S-104-21-01-22-1-04	1.266993467

Table 2 Results of specific surface area (SSA) on the sample size for samples from borehole B-2 (S-104-21-02)

Depth	Sample	SSA (cm2/g)
4,25	S-104-21-02-02-1-04	1.895471090
6,75	S-104-21-02-03-1-04	3.276555784
8,55	S-104-21-02-04-1-04	1.597799235
11,55	S-104-21-02-05-1-04	1.333218274
13,55	S-104-21-02-06-1-04	7.095061185
15,55	S-104-21-02-07-1-04	8.075306339
17,75	S-104-21-02-08-1-04	74.803232420
18,55	S-104-21-02-09-1-04	3.847173325
20,6	S-104-21-02-10-1-04	28.051212160
22,05	S-104-21-02-11-1-04	224.409697300
23,7	S-104-21-02-12-1-04	149.606464800
24,55	S-104-21-02-13-1-04	124.672054000
27,55	S-104-21-02-14-1-04	2.112132375
29,55	S-104-21-02-15-1-04	2.066698738
30,75	S-104-21-02-16-1-04	5.428199546
31,25	S-104-21-02-17-1-04	4.202296747
31,95	S-104-21-02-18-1-04	2.865561852
54,85	S-104-21-02-27-1-04	4.577750976

Table 3 Results of specific surface area (SSA) on the sample size for samples from borehole B-3 (S-104-21-03)

Depth	Sample	SSA (cm2/g)
7,55	S-104-21-03-05-1-04	1.618145703
10,05	S-104-21-03-06-1-04	1.731296638
12,55	S-104-21-03-07-1-04	3.974077883
13,55	S-104-21-03-08-1-04	8.824223122
15,15	S-104-21-03-09-1-04	6.956805438
17,15	S-104-21-03-10-1-04	2.687070064

It can be concluded that these semi-permeable deposits in the event of an accident (fuel spill or other contaminant) would not play a greater protective role due to the small thickness and relatively low specific surface area of the material.

Hydraulic conductivity

The hydraulic conductivity of the deposits was determined by the methods described in the previous chapter, the Kozeny-Carman model, and the correlation method from grain size distribution data in the sample.

The results of calculations using the Kozey-Carman model are shown in the tables.

Table 4 Values of the effective porosity ne, permeability k and hydraulic conductivity K of samples from the borehole B-1 (S-104-21-01)

Depth	Sample	D_g (mm)	n_e	kKC (cm^2)	kKC (m^2)	KKC (cm/s)	KKC (m/s)
1,05	S-104-21-01-01-1-04	0.033664	0.125	1.61E-08	1.61E-12	1.21E-05	1.21E-07
2,15	S-104-21-01-02-1-04	0.040907	0.14	3.45E-08	3.45E-12	2.59E-05	2.59E-07
3,45	S-104-21-01-03-1-04	0.128357	0.25	2.54E-06	2.54E-10	1.91E-03	1.91E-05
4,55	S-104-21-01-04-1-04	0.122797	0.255	2.50E-06	2.50E-10	1.88E-03	1.88E-05
6,85	S-104-21-01-05-1-04	0.057104	0.16	1.05E-07	1.05E-11	7.89E-05	7.89E-07
8,95	S-104-21-01-06-1-04	0.413	0.35	9.03E-05	9.03E-09	6.77E-02	6.77E-04
10,55	S-104-21-01-07-1-04	0.065223	0.19	2.47E-07	2.47E-11	1.85E-04	1.85E-06
13,45	S-104-21-01-08-1-04	0.02	0.08	1.35E-09	1.35E-13	1.01E-06	1.01E-08
15,65	S-104-21-01-09-1-04	0.02	0.085	1.63E-09	1.63E-13	1.22E-06	1.22E-08
17,55	S-104-21-01-10-1-04	0.028623	0.115	8.85E-09	8.85E-13	6.63E-06	6.63E-08
18,65	S-104-21-01-11-1-04	0.003	0.035	2.30E-12	2.30E-16	1.73E-09	1.73E-11
20,65	S-104-21-01-12-1-04	0.025337	0.115	6.93E-09	6.93E-13	5.20E-06	5.20E-08
22,55	S-104-21-01-13-1-04	0.04828	0.16	7.52E-08	7.52E-12	5.64E-05	5.64E-07
24,85	S-104-21-01-14-1-04	0.023862	0.1	3.91E-09	3.91E-13	2.93E-06	2.93E-08
25,55	S-104-21-01-15-1-04	0.03235	0.11	9.78E-09	9.78E-13	7.33E-06	7.33E-08
26,15	S-104-21-01-16-1-04	0.159656	0.27	5.23E-06	5.23E-10	3.93E-03	3.93E-05
26,95	S-104-21-01-17-1-04	0.0176	0.06	4.21E-10	4.21E-14	3.16E-07	3.16E-09
27,85	S-104-21-01-18-1-04	0.0011	0.04	4.67E-13	4.67E-17	3.50E-10	3.50E-12
29,45	S-104-21-01-19-1-04	0.116853	0.25	2.11E-06	2.11E-10	1.58E-03	1.58E-05
31,25	S-104-21-01-20-1-04	0.032702	0.115	1.15E-08	1.15E-12	8.66E-06	8.66E-08
32,55	S-104-21-01-21-1-04	0.104847	0.23	1.25E-06	1.25E-10	9.41E-04	9.41E-06
33,55	S-104-21-01-22-1-04	0.17712	0.25	4.85E-06	4.85E-10	3.63E-03	3.63E-05

Table 5 Values of the effective porosity ne, permeability k and hydraulic conductivity K of samples from the borehole B-2 (S-104-21-02)

Depth	Sample	D_g (mm)	n_e	kKC (cm^2)	kKC (m^2)	KKC (cm/s)	KKC (m/s)
1,05	S-104-21-02-01-1-04	0.3315	0.35	6.20E-05	6.20E-09	4.65E-02	4.65E-04
4,25	S-104-21-02-02-1-04	0.118393	0.25	2.16E-06	2.16E-10	1.62E-03	1.62E-05
6,75	S-104-21-02-03-1-04	0.06849	0.18	2.26E-08	2.26E-11	1.70E-04	1.70E-06
8,55	S-104-21-02-04-1-04	0.140449	0.26	3.52E-06	3.52E-10	2.64E-03	2.64E-05
11,55	S-104-21-02-05-1-04	0.168322	0.3	8.68E-06	8.68E-10	6.51E-03	6.51E-05
13,55	S-104-21-02-06-1-04	0.031629	0.12	1.24E-08	1.24E-12	9.31E-06	9.31E-08
15,55	S-104-21-02-07-1-04	0.02779	0.11	7.22E-09	7.22E-13	5.41E-06	5.41E-08
17,75	S-104-21-02-08-1-04	0.0032	0.035	2.62E-12	2.62E-16	1.97E-09	1.97E-11
18,55	S-104-21-02-09-1-04	0.058331	0.17	1.35E-07	1.35E-11	1.01E-04	1.01E-06
20,6	S-104-21-02-10-1-04	0.00311	0.035	2.48E-12	2.48E-16	1.86E-09	1.86E-11
22,05	S-104-21-02-11-1-04	0.00192	0.035	9.44E-13	9.44E-17	7.08E-10	7.08E-12
23,7	S-104-21-02-12-1-04	0.0015	0.034	5.27E-13	5.27E-17	3.95E-10	3.95E-12
24,55	S-104-21-02-13-1-04	0.0018	0.035	8.29E-13	8.29E-17	6.22E-10	6.22E-12
27,55	S-104-21-02-14-1-04	0.106248	0.23	1.29E-06	1.29E-10	9.66E-04	9.66E-06
29,55	S-104-21-02-15-1-04	0.108584	0.22	1.15E-06	1.15E-10	8.60E-04	8.60E-06
30,75	S-104-21-02-16-1-04	0.041341	0.14	3.53E-08	3.53E-12	2.64E-05	2.64E-07
31,25	S-104-21-02-17-1-04	0.053402	0.16	9.20E-08	9.20E-12	6.90E-05	6.90E-07
31,95	S-104-21-02-18-1-04	0.078313	0.2	4.26E-07	4.26E-11	3.20E-04	3.20E-06
33,05	S-104-21-02-19-1-04	3.378838	0.18	5.51E-04	5.51E-08	4.13E-01	4.13E-03
36,05	S-104-21-02-20-1-04	3.259704	0.185	5.63E-04	5.63E-08	4.22E-01	4.22E-03
39,05	S-104-21-02-21-1-04	4.066656	0.2	1.15E-03	1.15E-07	8.62E-01	8.62E-03
42,05	S-104-21-02-22-1-04	4.554678	0.19	1.21E-03	1.21E-07	9.04E-01	9.04E-03
43,95	S-104-21-02-23-1-04	5.020756	0.22	2.45E-03	2.45E-07	1.84E+00	1.84E-02
46,95	S-104-21-02-24-1-04	5.428245	0.21	2.43E-03	2.43E-07	1.82E+00	1.82E-02
49,95	S-104-21-02-25-1-04	1.948738	0.2	2.64E-04	2.64E-08	1.98E-01	1.98E-03
52,95	S-104-21-02-26-1-04	4.037447	0.14	3.36E-04	3.36E-08	2.52E-01	2.52E-03
54,85	S-104-21-02-27-1-04	0.049022	0.14	4.96E-08	4.96E-12	3.72E-05	3.72E-07
57,05	S-104-21-02-28-1-04	3.433867	0.125	1.67E-04	1.67E-08	1.25E-01	1.25E-03
60,05	S-104-21-02-29-1-04	4.001250	0.15	4.16E-04	4.16E-08	3.12E-01	3.12E-03
63,05	S-104-21-02-30-1-04	3.234677	0.15	2.72E-04	2.72E-08	2.04E-01	2.04E-03
66,05	S-104-21-02-31-1-04	5.983952	0.16	1.16E-03	1.16E-07	8.67E-01	8.67E-03
34,95	S-104-21-02-32-1-04	4.324274	0.15	4.86E-04	4.86E-08	3.64E-01	3.64E-03
37,95	S-104-21-02-33-1-04	3.289626	0.16	3.49E-04	3.49E-08	2.62E-01	2.62E-03
40,05	S-104-21-02-34-1-04	2.368442	0.155	1.63E-04	1.63E-08	1.22E-01	1.22E-03

41,55	S-104-21-02-35-1-04	4.266192	0.16	5.87E-04	5.87E-08	4.41E-01	4.41E-03
43,05	S-104-21-02-36-1-04	5.719224	0.185	1.73E-03	1.73E-07	1.30E+00	1.30E-02
45,05	S-104-21-02-37-1-04	3.320284	0.17	4.37E-04	4.37E-08	3.28E-01	3.28E-03
47,95	S-104-21-02-38-1-04	4.617651	0.16	6.88E-04	6.88E-08	5.16E-01	5.16E-03
48,95	S-104-21-02-39-1-04	2.558673	0.145	1.52E-04	1.52E-08	1.14E-01	1.14E-03
50,95	S-104-21-02-40-1-04	3.959027	0.155	4.54E-04	4.54E-08	3.41E-01	3.41E-03
51,95	S-104-21-02-41-1-04	3.814036	0.15	3.78E-04	3.78E-08	2.83E-01	2.83E-03
51,5	S-104-21-02-43-1-04	5.977468	0.1	2.45E-04	2.45E-08	1.84E-01	1.84E-03
53,95	S-104-21-02-44-1-04	2.878668	0.16	2.67E-04	2.67E-08	2.01E-01	2.01E-03
56,05	S-104-21-02-45-1-04	4.770635	0.15	5.91E-04	5.91E-08	4.43E-01	4.43E-03
58,05	S-104-21-02-46-1-04	5.231415	0.1	1.88E-04	1.88E-08	1.41E-01	1.41E-03
59,05	S-104-21-02-47-1-04	2.419964	0.17	2.32E-04	2.32E-08	1.74E-01	1.74E-03
61,05	S-104-21-02-48-1-04	4.306607	0.095	1.08E-04	1.08E-08	8.10E-02	8.10E-04
62,05	S-104-21-02-49-1-04	6.464566	0.18	2.02E-03	2.02E-07	1.51E+00	1.51E-02
63,95	S-104-21-02-50-1-04	4.850004	0.145	5.45E-04	5.45E-08	4.09E-01	4.09E-03
64,55	S-104-21-02-51-1-04	3.385236	0.15	2.98E-04	2.98E-08	2.23E-01	2.23E-03
65,55	S-104-21-02-52-1-04	4.600310	0.17	8.39E-04	8.39E-08	6.29E-01	6.29E-03
67,55	S-104-21-02-53-1-04	3.371057	0.13	1.83E-04	1.83E-08	1.38E-01	1.38E-03
68,55	S-104-21-02-54-1-04	6.556638	0.16	1.39E-03	1.39E-07	1.04E+00	1.04E-02
69,55	S-104-21-02-55-1-04	6.449435	0.16	1.34E-03	1.34E-07	1.01E+00	1.01E-02
70,55	S-104-21-02-56-1-04	4.027925	0.15	4.21E-04	4.21E-08	3.16E-01	3.16E-03
71,55	S-104-21-02-57-1-04	4.045090	0.14	3.38E-04	3.38E-08	2.53E-01	2.53E-03
72,55	S-104-21-02-58-1-04	3.626650	0.145	3.05E-04	3.05E-08	2.29E-01	2.29E-03
73,55	S-104-21-02-59-1-04	4.801875	0.16	7.44E-04	7.44E-08	5.58E-01	5.58E-03
74,95	S-104-21-02-60-1-04	2.758284	0.13	1.23E-04	1.23E-08	9.21E-02	9.21E-04
75,95	S-104-21-02-61-1-04	4.685564	0.14	4.53E-04	4.53E-08	3.40E-01	3.40E-03
76,95	S-104-21-02-62-1-04	3.377393	0.15	2.96E-04	2.96E-08	2.22E-01	2.22E-03
77,95	S-104-21-02-63-1-04	3.249903	0.15	2.74E-04	2.74E-08	2.06E-01	2.06E-03
78,95	S-104-21-02-64-1-04	2.413657	0.16	1.88E-04	1.88E-08	1.41E-01	1.41E-03
79,95	S-104-21-02-65-1-04	6.155690	0.09	1.85E-04	1.85E-08	1.39E-01	1.39E-03
81,05	S-104-21-02-66-1-04	3.901705	0.145	3.53E-04	3.53E-08	2.65E-01	2.65E-03
82,05	S-104-21-02-67-1-04	3.895629	0.16	4.90E-04	4.90E-08	3.67E-01	3.67E-03
83,05	S-104-21-02-68-1-04	4.797371	0.19	1.34E-03	1.34E-07	1.00E+00	1.00E-02
84,05	S-104-21-02-69-1-04	9.727934	0.23	1.08E-02	1.08E-06	8.10E+00	8.10E-02
85,05	S-104-21-02-70-1-04	7.237409	0.25	8.09E-03	8.09E-07	6.07E+00	6.07E-02
86,55	S-104-21-02-71-1-04	6.421885	0.22	4.01E-03	4.01E-07	3.01E+00	3.01E-02
88,05	S-104-21-02-72-1-04	4.086309	0.18	8.05E-04	8.05E-08	6.04E-01	6.04E-03
89,95	S-104-21-03-01-1-04	0.438863	0.33	8.57E-05	8.57E-09	6.43E-02	6.43E-04

Table 6 Values of the effective porosity ne, permeability k and hydraulic conductivity K of samples from the borehole B-3 (S-104-21-03)

Depth	Sample	D_g (mm)	n_e	kKC (cm^2)	kKC (m^2)	KKC (cm/s)	KKC (m/s)
0.55	S-104-21-03-02-1-04						
1.55	S-104-21-03-03-1-04						
4.55	S-104-21-03-04-1-04						
7.55	S-104-21-03-05-1-04	0.138683	0.275	4.23E-06	4.23E-10	3.17E-03	3.17E-05
10.05	S-104-21-03-06-1-04	0.129619	0.23	1.92E-06	1.92E-10	1.44E-03	1.44E-05
12.55	S-104-21-03-07-1-04	0.056468	0.16	1.03E-07	1.03E-11	7.72E-05	7.72E-07
13.55	S-104-21-03-08-1-04	0.025431	0.09	3.17E-09	3.17E-13	2.37E-06	2.37E-08
15.15	S-104-21-03-09-1-04	0.032258	0.115	1.12E-08	1.12E-12	8.43E-06	8.43E-08
17.15	S-104-21-03-10-1-04	0.083515	0.215	6.25E-07	6.25E-11	4.69E-04	4.69E-06

For the purposes of calculation and as a calibration factor, basic statistical parameters, standard deviation of grain size and geometric mean grain by Chapuis method were determined for each sample of semipermeable material by the Shirazi & Boersma method. The results of the verification procedure are within 84% of the values determined by the Kozeny-Carman method, which indicates the accuracy of the previous calculations.

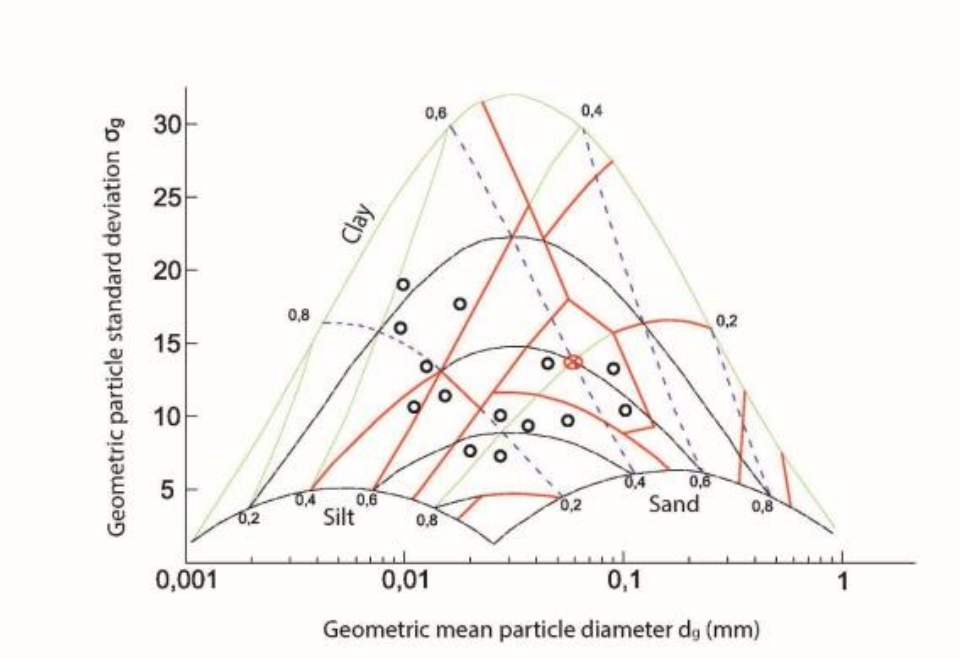


Figure 4 Orthogonal texture diagram of the fine grained samples from the borehole B-1 (S-104-21-01)

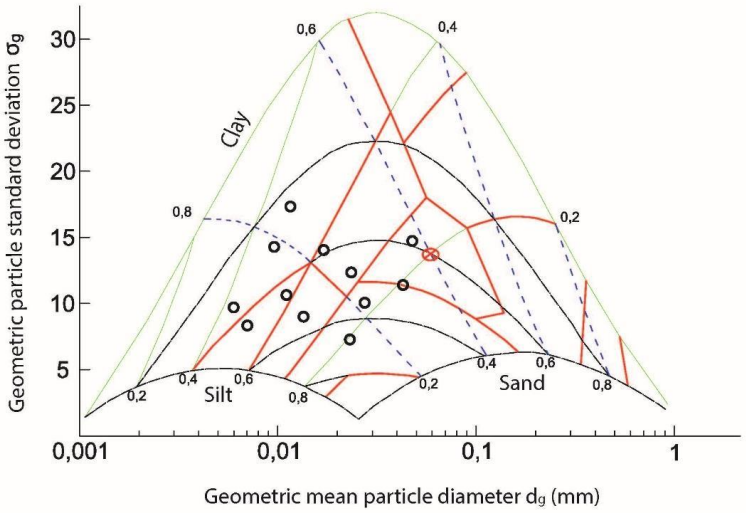


Figure 5 Orthogonal texture diagram of the fine grained samples from the borehole B-2 (S-104-21-02)

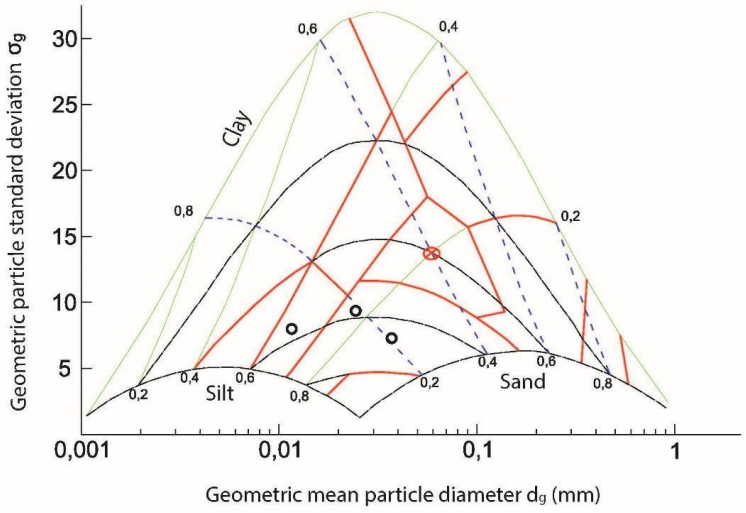


Figure 6 Orthogonal texture diagram of the fine grained samples from the borehole B-3 (S-104-21-03)

The statistical indicators thus defined have confirmed all the calculations presented so far, so it can be concluded that the data presented in this report can be used as input data for the development of groundwater flow models in the Neretva Delta.

Based on the presented results of the analysis, hydraulic profiles of wells were constructed, which will facilitate the creation of a hydrogeological model. In general, hydrogeological environments can be distinguished by wells, but core logging has shown that the composition of deposits in wells is very diverse.

The hydraulic profiles are shown in Figure 7, Figure 8 and Figure 9.

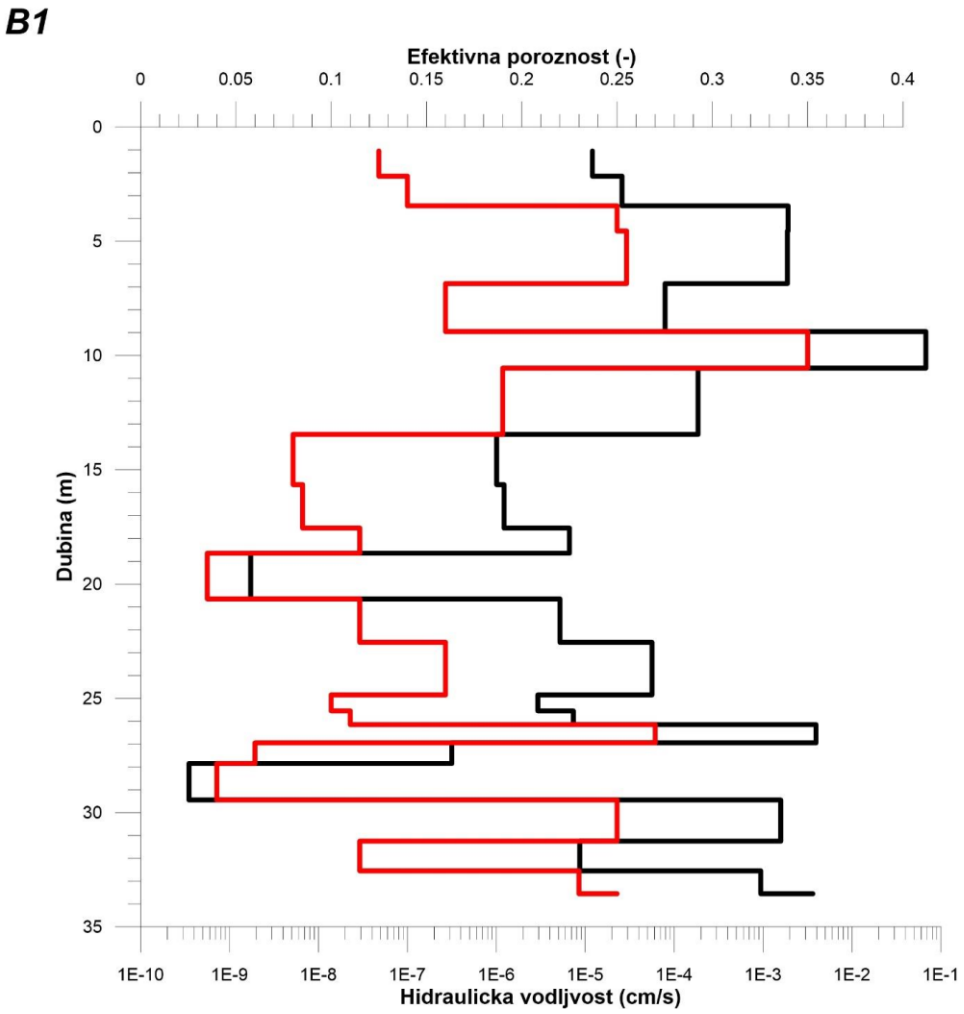


Figure 7 Hydraulic cross section of hydrogeological complex in borehole B-1 (S-104-21-01) based on the calculation of the hydraulic conductivity and the effective porosity

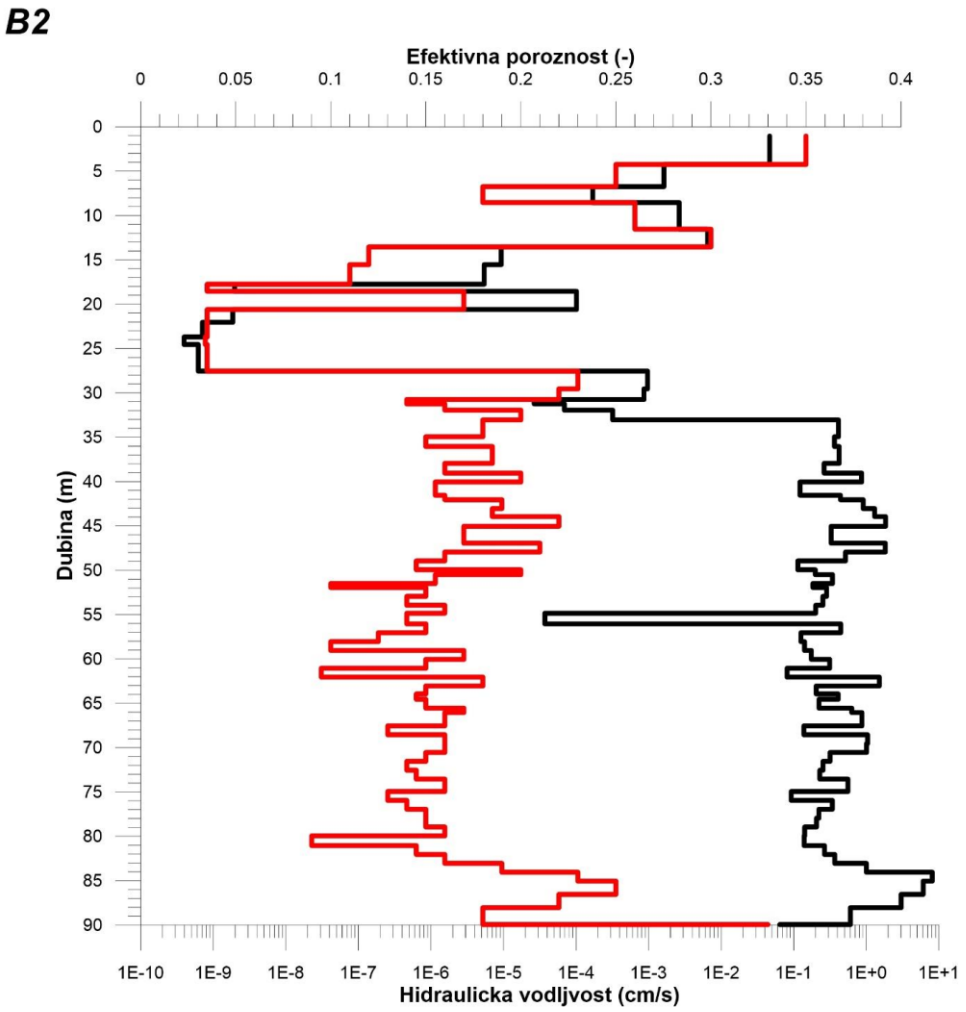


Figure 8 Hydraulic cross section of hydrogeological complex in borehole B-2 (S-104-21-02) based on the calculation of the hydraulic conductivity and the effective porosity

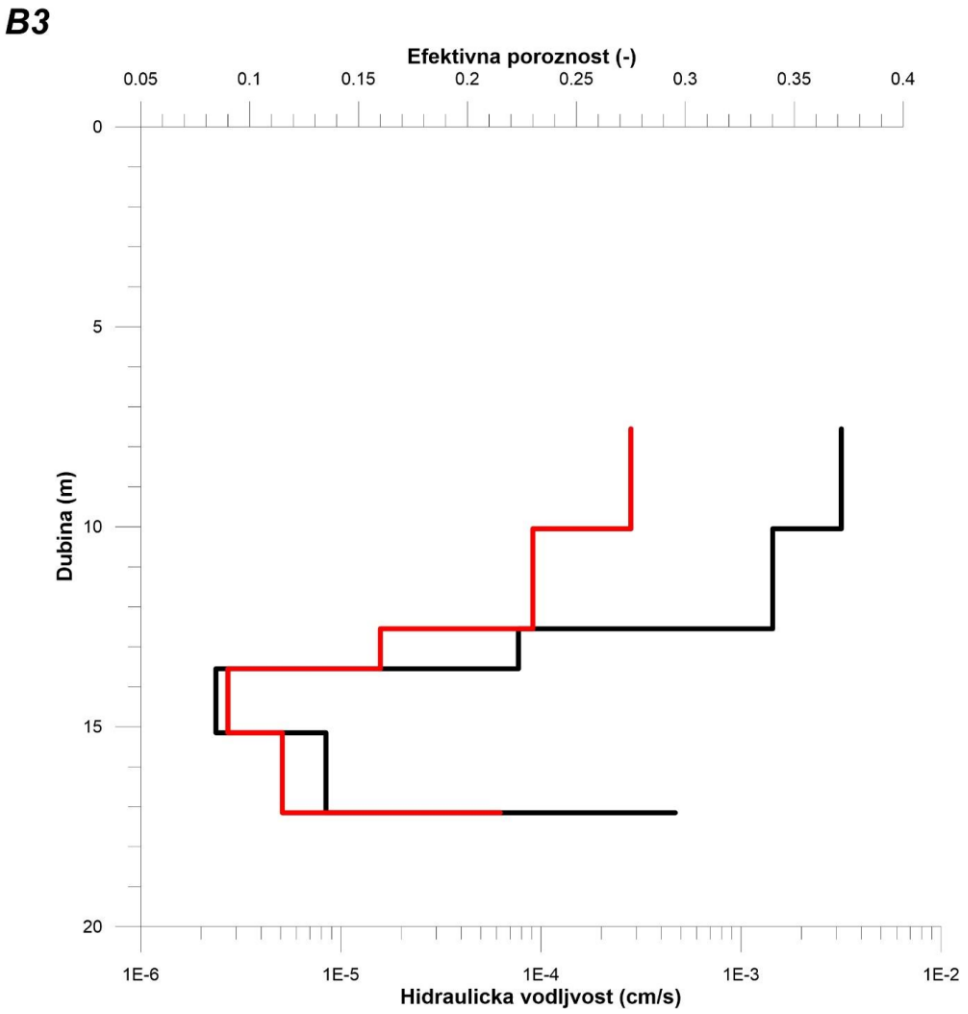


Figure 9 Hydraulic cross section of hydrogeological complex in borehole B-3 (S-104-21-03) based on the calculation of the hydraulic conductivity and the effective porosity

Conclusion

As a conclusion, as based on the analysis of the exploration borehole core, three environments can be distinguished in the investigated area. The first is a permeable unit of sand with pebbles, the second is a very high permeability gravel unit that dominates well B-2 (S-104-21-02), and the third is a sandy-silty and clayey material that intercalates the entire aquifer at an average depth of 15 to 30 meters and definitely represents water bearing unit due to its relatively low permeability. Due to the lateral diversity of hydrogeological environments, making a model at a later stage of the project will be a great challenge. Hydraulic profiles are shown graphically in Figure 7, Figure 8 and Figure 9and the values of hydraulic conductivity and permeability and effective porosity on the sample scale in common units are shown in Table 4, Table 5 and Table 6.

Literature

Arkin, H. and Colton, R.R. (1956): Statistical metods. Barnes&Noble, Inc., 226 p. New York

Aubertin, M., Mbobimpa, M, Bussière, B. and Chapuis, R. P. (2003): Development of the model to predict the water retention curve using basic geotechnical properties. EPM-RT-2003-01. Département of Civil Géological and Mining Engineering, Ėcole Polytechnique de Montréal. 1-55

Bear, J. (1988): Dinamics of Fluids in Porous Media. Dover Pub. P 163, pp 764.

Bouwer, H. (1978): Grounwater Hydrology. McGraw-Hill p.22. pp.479

Campbell, G.S. (1985): Soil physics with basic. Transport model for soil-plant system. Elsevier Sci.Publ., Amsterdam

Campbell, G.S. and Campbell, M.D. (1982): Irrigation scheduling using soil moisture measurement: theory and practice. Qadvances in irrigation 1, 25-42.

Carman, P.C. (1956): Flow of Gases through Porous Media. Butterworths Scientific Publ., London.

Cerato, A.B. (2001): Influence of specific surface area on geotechnical characteristics of ine graded soils. Thesis. Department of Civil and Environmental Engineering University of Massachusetts

Chapuis, R. P. (1992): Full-scale hydraulic performance of soil-bentonite and compacted clay liners. Canadian Geotechnical Journal, 39 (2)

Chapuis, R. P. and Aubertin, M. (2003): Predicting the coefficient of permeability of soils using the Kozeny-Carman equation. Département des génies civil, géologique et des mines. Ėcole Polytechnique de Montréal. 1-31

Chapuis, R.P. and Légaré P.P. (1992): A simple method for determining the surface area of fine aggregates and fillers in bituminous mixtures. In Effects of aggregates and mineral filters onasphalt mixture performance ASTM STP 1147, 177-186.

De Bruyn, C.M.A., Colins, L.F. and Williams, A.A.B. (1957): The specific surface, water affinity and potential expansiveness of clay. Clay Mineralogy Billetin, 3, 120-128.

Farrar, D.M. and Coleman, J.D. (1967): The corelation of surface area with other properties of nenteen British clay soil. Journal of soil Science, 18, 118-124.

Gill, W.R. and Reaves, C.A. (1951): Relationship of Atteberg limits and cation exchange capacity of some physical properties of soil. Soil Science Society of America Proceedings, Vol. 21pp. 109-116.

Kovács, (1981): Seepage hydraulics, Elsevier Science Publishers, Amserdam

Kozeny, J. (1927): Ueber kapillare Leitung das Wassers in Boden, Wien, Akad. Wiss. 136(2a) 271.

Locat, J., Lefebvre, G. And Ballivy, G. (1984): Mineralogy, chemistry and physical properties interrelationships of some sensitive clay from Eastern Canada. Canadian Geotechnical Journal, 21, 530-540.

Mbonimpa, M., Aubertin, M., Chapuis, R.P. and Bussière, B. (2002): Practocal pedotransfer functions for estimating the hydraulic conductivity. Geotechnical and Geological Engineering, 20, 235-259.

Rawls, W.S. (2004): Pedotransfer functions for the United States. Developments in Soil Science, Elsevier B.V., V. 30, 437-447

Shirazi, M. A. and Boersma, L. (1984): A unifying quantitative analysis of soil texture, Soil Sci. Soc. Am.J. Vol. 48, 142-147.

Smith, C.W., Hadas, A., Dan, J. and Koyumdjisky, H. (1985): Shrinkage and Atteberg limits relation to other properties of primciple soil types in Israel. Geoderma, 35, pp. 47-65

Urumović, K., 2013. Parameter quantification of clastic sediments hydrogeologic properties based on test fields in northern Croatia. Dissertation, RGN, Zagreb.

Urumović, K., Urumović Sr., K., 2016. The referential grain size and effective porosity in the Kozeny–Carman model. Hydrology and Earth System Sciences 20, 1669–1680. https://doi.org/10.5194/hes s-20-1669-2016

Zaki, G. (1971): Neobjavljeni sadržaj u McGill Univesity, peuzeto iz Cerato, 2001.

Ziems, J. (1969): Beitrag zur kontakterosion nichtbindiger erdstoffe. Disertation, Institut für Fluß- und Seebau, TU Dresden.

Yong, R.N.and Warkentin, P.B. (1975): Soil properties and behaviour. Elsevier Scientific Publishing Co. New York pp 449

List of figures

List of tables

Appendices

The list of appendices is provided by the following table:

AppendixNo.	Appendix name
1	Map of conducted investigation works
2	Exploratory borehole logs
2.1.	Exploratory borehole log B-1 (S-104-21-01)
2.2.	Exploratory borehole log B-2 (S-104-21-02)
2.3.	Exploratory borehole log B-3 (S-104-21-03)
5	Laboratory report
6	Laboratory test tables
6.1.	Physical properties table
6.2.	Mechanical properties table

MAP OF CONDUCTED INVESTIGATION WORKS

M 1:10 000

E-104-21-01

app. No.: 1

Legend:

Previous exploratory boreholes

Year:
- 2005
- 2008
- 2011
- 2012
- 2013
- 2014
- 2017

Preliminary geophysical works 2019
- Geoelectrical probes
- Geoelectrical profiles

Interpretative geophysical profiles
- 1-1'
- 2-2'

Hydrogeology / Geophysical profiles
- P-1 (Diga)
- GE-3
- P-5 (Opuzen)
- P-2 (Crepina)
- P-3 (Vidrice)
- P-4 (Opuzen magistrala)

Geoelectrical probes
- 100m
- 200m

Hydrogeology profile
- P-6 (Diga-Opuzen)
- Exploratory boreholes 2022

LEGEND
- exploration borehole
- spring
- bedding plane
- joint
- vertical joint
- geological boundery
- fault
- fault zone

LITHOSTRATIGRAPHIC UNITS
- delta sediments, organic-swamp sediments (Q)
- limestones with rudists ($K_2^{2,3}$)
- limestones ($K_2^{1,2}$)
- limestones (K_2 ?)
- limestones with favreina (K_1)
- limestones with Clypeina ($J_3^{2,3}$)

CLIENT:

UNIVERSITY OF SPLIT

Faculty of Civil Engineering, Architecture and Geodesy

Matice hrvatske 15, Split

FIELD CLASSIFICATION: Marijana JELIĆ, dipl.ing.geol.

DRILL OPERATOR: Davor RIBIĆ

DRILLING RIG: Nordmeyer DSB 1/3,5

HEAD OF INVSTIGATIONS: prof.dr.sc. Leo Matešić, dipl.ing.građ.

BOREHOLE COORDINATES:
E: 583304,18
N: 4762640,16

GROUND LEVEL (m.a.s.l.):
H: 0,46

START DATE: 28.01.2022.

END DATE: 01.02.2022.

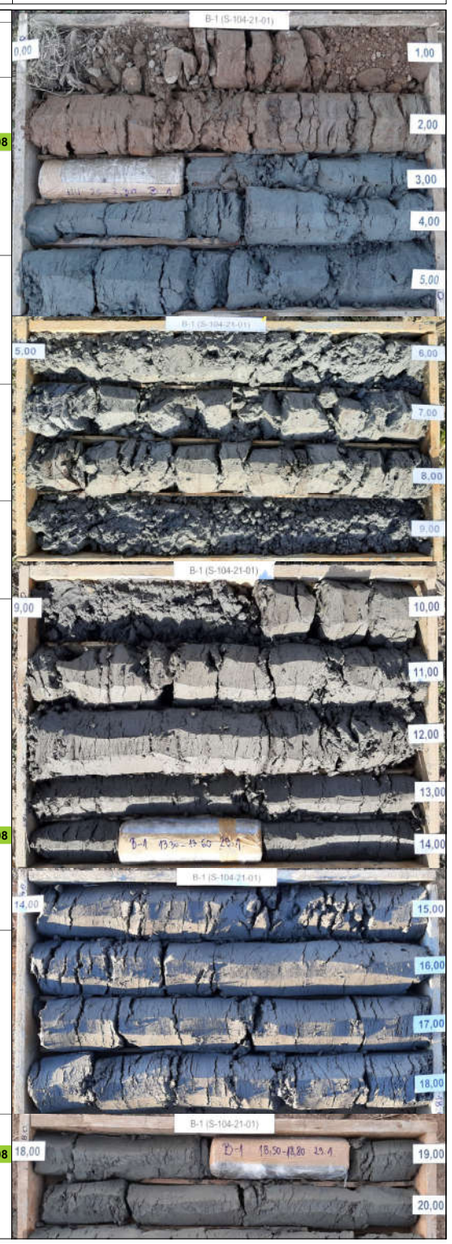
PROJECT: Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation

LOCATION: Lower Neretva

Borehole log: B-1 (S-104-21-01)

Scale: 1:100

DEPTH (m)	GROUND LEVEL (m.a.s.l.)	CORE BARREL DIAMETER (mm)	PROTECTIVE CASING DIAMETER (mm)	GWO (m)	GWL (m)	SYMBOL	INTERVAL (m)	GROUP OF MATERIALS	SOIL DESCRIPTION	STANDARD PENETRATION TEST (Blow count) N_0	N_1	N_2	N	N_{60}	POCKET PENETROMETER q_U (kPa)	FIELD VANE TEST c_U (kPa)	c_r (kPa)	SAMPLE TYPE	SAMPLE ID	INTERVAL (m) FROM	TO	PLASTICITY LIMITS w_L (%)	w_P (%)	PLASTICITY INDEX I_p (%)	CONSISTENCY INDEX I_c	WATER CONTENT w_c (%)	DRY / BULK DENSITY ρ (g/cm³)	ρ_d (g/cm³)	ρ_s (g/cm³)	PARTICLE SIZE ANALYSIS G (%)	S (%)	M (%)	C (%)	Permeability (accord. to USBR) k (cm/s)	SHEAR TESTS c/C_u (kPa)	ϕ (°)	TIP	UNCONFINED COMPRESSION STRENGHT q_u (kPa)	OEDOMETER TEST (MPa) σ_{30}	σ_{50}	σ_{100}	σ_{200}	σ_{400}	σ_{800}	σ_{1600}	σ_{3200}	PERMEABILITY OEDOMETER / TRIAXIAL CELL k (cm/s) $\sigma_{100}/\sigma_{300}$	$\sigma_{200}/\sigma_{400}$	$\sigma_{400}/\sigma_{800}$	σ_{800}	σ_{1600}
0,0	0.26						0,20		Humus																																										
1,0	-0.64					CL	1,10		Lean clay, stiff consistency, brown color, in places contains manganes concretions.									PU	1	1.00	1.10	37.32	21.78	15.54	0.88	23.58			2.72		11.00	64.00	25.00	3.16E-07																		
2,0	-1.84					CH	2,30		Fat clay, soft to medium consistency, brown color, in places contains manganes concretions.									NU	2	2.00	2.30	56.37	24.02	32.34	0.24	48.74	1.80	1.28	2.69		11.50	66.50	22.00	8.86E-07																	6.30E-08	4.60E-08	2.50E-08
3,0						SC/CL			Clayey sand to sandy lean clay, fine sand, gray color, in places contains peat.									PU	3	3.40	3.50	35.06	22.42	12.64	0.19	32.60			2.73		53.40	28.00	18.60	2.57E-06																		
4,0	-3.54				4.2		4,00																																										
5,0						SC			Clayey sand, fine, gray color.									PU	4	4.50	4.60					38.96			2.76		77.70	13.60	8.70	5.43E-04																		
6,0	-5.64	146					6,10																																										
7,0						CL			Sandy lean clay, soft consistency, gray color, in places contains peat.									PU	5	6.80	6.90					41.86			2.68		30.10	49.50	20.40	1.34E-06																		
8,0	-7.54						8,00																																										
9,0						SP			Poorly graded sand, medium to fine, gray color.									PU	6	8.90	9.00									2.20	96.60		1.20	2.09E-02																		
	-9.14						9,60																																										
10,0																																																	
11,0																																																	
12,0						CL			Lean clay with sand, soft consistency, gray color, organic smell, in places contains peat.									PU	7	10.50	10.60	36.64	21.79	14.86		37.92			2.71		27.20	54.10	18.70	2.26E-06																		
13,0		101																																															
14,0																																																	
15,0	-14.54						15,00																																										
16,0		146							Lean clay, soft to medium consistency, gray color, in places contains some sand.									PU	9	15.50	15.80	37.56	21.34	16.22	0.07	36.46	1.89	1.43	2.68		18.80	62.40	18.80	2.73E-06																		
17,0			178			CL																																										
18,0	-17.54						18,00																																										
19,0		101																																															
20,0																																																	



SAMPLE DISTRIBUTION:		IN SITU TESTS:	
		STANDARD PENETRATION TEST:	-
DISTURBED SAMPLES	18	POCKET VANE TEST:	-
UNDISTURBED SAMPLES	4	POCKET PENETROMETER:	-
SPT	-	FIELD VANE TEST:	

LEGEND

STANDARD PENETRATION TEST (SPT):
- Split spoon sampler $N=(N_{35}*k_{60})+(N_{\check{S}}*k_{\check{S}})$
- Solid cone $\check{S}=0,75*N$
- "/" - Refusal (>50)

(k_{60}=1,087)

FIELD VANE TEST (TYPE):
- Torvane (pocket in situ)
- Torvane (laboratory on US)
- Geonor

DIRECT SHEAR TEST:
- S Standard
- R Reverse
- KT Krey - Tiedemann

PERMEABILITY OEDOMETER / TRIAXIAL CELL:
- Oedometer
- Triaxial cell

TRIAXIAL SHEAR TEST:
- UU Unconsolidated undrained
- CU Consolidated undrained
- CD Consolidated drained

POCKET PENETROMETER:
- In-situ
- Laboratory

DRY / BULK DENSITY:
- Bulk density
- Dry density
- Specific density

COMMENTS:
- sample S-104-21-01-07 at depth 10,50-10,60 m combustible matter content 10,79%, content of organic matter 5,96%,
- sample S-104-21-01-08 at depth 13,30-13,60 m combustible matter content 15,17%, content of organic matter 6,23%,
- sample S-104-21-01-15 at depth 25,50-25,60 m combustible matter content 17,85%, content of organic matter 15,47% and
- sample S-104-21-01-17 at depth 26,90-27,00 m combustible matter content 17,57%, content of organic matter 11,27%.

GEOKON - ZAGREB d.d.

REPORT ID: E-104-21-01

APPENDIX N⁰: 2.1

PAGE NUM.: 1

CLIENT:

UNIVERSITY OF SPLIT

Faculty of Civil Engineering, Architecture and Geodesy

Matice hrvatske 15, Split

FIELD CLASSIFICATION: Marijana JELIĆ, dipl.ing.geol.

DRILL OPERATOR: Davor RIBIĆ

DRILLING RIG: Nordmeyer DSB 1/3,5

HEAD OF INVSTIGATIONS: prof.dr.sc. Leo Matešić, dipl.ing.građ.

BOREHOLE COORDINATES:
E: 583304,18
N: 4762640,16

GROUND LEVEL (m.a.s.l.):
H: 0,46

START DATE: 28.01.2022.

END DATE: 01.02.2022.

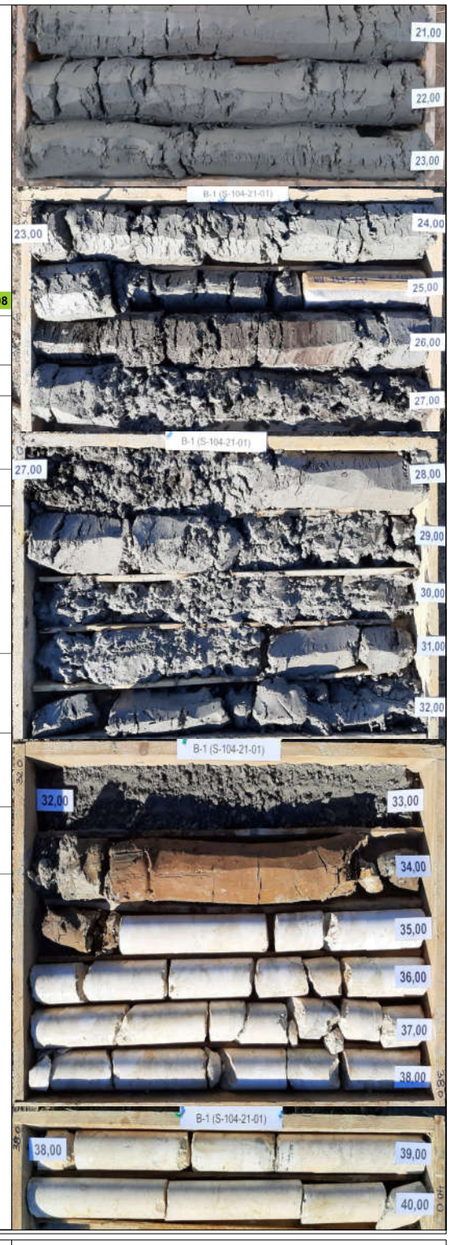
PROJECT: Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation

LOCATION: Lower Neretva

Borehole log: B-1 (S-104-21-01)

Scale: 1:100

DEPTH (m)	GROUND LEVEL (m.a.s.l.)	CORE BARREL DIAMETER (mm)	PROTECTIVE CASING DIAMETER (mm)	GWO (m)	GWL (m)	SYMBOL	INTERVAL (m)	GROUP OF MATERIALS	SOIL DESCRIPTION	STANDARD PENETRATION TEST (Blow count) N_0	N_1	N_2	N	N_{60}	POCKET PENETROMETER q_U (kPa)	FIELD VANE TEST c_U (kPa)	c_r (kPa)	SAMPLE TYPE	SAMPLE ID	INTERVAL (m) FROM	TO	PLASTICITY LIMITS w_L (%)	w_P (%)	PLASTICITY INDEX I_P (%)	CONSISTENCY INDEX I_c	WATER CONTENT w_c (%)	DRY / BULK DENSITY ρ (g/cm³)	ρ_d (g/cm³)	ρ_s (g/cm³)	PARTICLE SIZE ANALYSIS G (%)	S (%)	M (%)	C (%)	Permeability (accord. to USBR) k (cm/s)	SHEAR TESTS c/C_u (kPa)	ϕ (°)	TIP	UNCONFINED COMPRESSION STRENGHT q_u (kPa)	OEDOMETER TEST (MPa) σ_{30}	σ_{50}	σ_{100}	σ_{200}	σ_{400}	σ_{800}	σ_{1600}	σ_{3200}	PERMEABILITY OEDOMETER / TRIAXIAL CELL k (cm/s) $\sigma_{100}/\sigma_{300}$	$\sigma_{200}/\sigma_{400}$	$\sigma_{400}/\sigma_{800}$	σ_{800}	σ_{1600}	PHOTO DOCUMENTATION
21,0						CL			Lean clay, soft consistency, gray color, in places contains manganes concretions and shell fragments.									PU	12	20.50	20.80	40.20	23.24	16.96	0.08	38.89	1.86	1.37	2.73		6.40	75.00	18.60	2.17E-06																						
22,0		146																																																	
23,0																		PU	13	22.50	22.60	41.14	23.28	17.86	0.21	37.43			2.73		4.70	76.70	18.60	2.30E-06																						
24,0																																																		
25,0	-24.64	101					25,10											NU	14	24.70	25.00	37.31	22.49	14.83	0.10	35.79	1.90	1.42	2.74		3.00	75.20	21.80	1.18E-06																				2.50E-07	1.20E-07	3.60E-08		
26,0	-25.44					OH	25,90		Organic clay, black color with gray, in places contains peat.									PU	15	25.50	25.60	94.01	26.80	67.20	0.61	53.18			2.58		5.50	76.90	17.60	5.88E-06																						
	-25.94					SC	26,40		Clayey sand, fine, gray color.									PU	16	26.10	26.20					20.48			2.76		71.40	16.50	12.10	1.52E-04																						
27,0	-27.14					CL	27,60		Lean clay with sand, soft consistency, gray color with black, organic smell, in places contains peat.									PU	17	26.90	27.00	44.00	21.89	22.11		50.58			2.70		26.90	51.20	21.90	9.00E-07																						
28,0	-27.74					CL	28,20		Lean clay, medium to stiff consistency, gray color, contains manganes concretions and shell fragments.									PU	18	27.80	27.90	35.91	22.95	12.96	1.25	29.78			2.71		2.50	53.40	44.10																						
29,0		131				SC			Clayey sand, fine, gray color.									PU	19	29.40	29.50	27.91	20.87	7.04		28.69			2.75		62.90	25.00	12.10	2.83E-05																						
30,0	-30.14						30,60																																											
31,0						CL	31,90		Lean clay, medium consistency, gray color, contains shell fragments.									PU	20	31.20	31.30	37.20	22.17	15.04	0.38	31.49			2.70		5.50	51.40	43.10																						
32,0	-31.44					SC			Clayey sand, fine, gray color, at the end of the interval some gravel.									PU	21	32.50	32.60					19.46			2.77		70.00	20.20	9.80	1.54E-04																						
33,0	-32.64						33,10																																											
34,0	-33.74					CH	34,20		Fat clay, stiff consistency, reddish brown color, contains FeO and small fragments of limestone at the end of interval.									PU	22	33.50	33.60	53.86	24.19	29.67	0.90	27.17			2.72		5.10	29.50	65.40																						
35,0																																																		
36,0																																																		
37,0		101				V			Limestone, micritic to fine-crystalline, white to yellowish color, in some places contains thin calcite veins. Weathering rock class according to ISRM (1981) is W1 Fresh rock. DISCONTINUITIES SET 1: incline 0-10°, separation (aparture) 0,1-1,0 mm, infilling none or hard infilling, roughness slightly rough and weathering unweathered. JRC10 with Barton comb is 10-12. SET 2: incline 35-45°, separation (aparture) 0,1-1,0 mm, infilling none or hard infilling, roughness rough and weathering slightly weathered. JRC10 with Barton comb is 14-16. LIMESTONE; UPPER CRETACEOUS; V; K22,3 BEDROCK																																																	
38,0																																																		
39,0																																																		
40,0	-39.54						40,00																																												



SAMPLE DISTRIBUTION:		**IN SITU TESTS:**	
DISTURBED SAMPLES	18	STANDARD PENETRATION TEST:	-
UNDISTURBED SAMPLES	4	POCKET VANE TEST:	-
SPT	-	POCKET PENETROMETER:	-
		FIELD VANE TEST:	

LEGEND

STANDARD PENETRATION TEST (SPT):
- Split spoon sampler $N=(N_{30}*k_{60})+(N_{\sigma}*k_{60})$
- Solid cone $\hat{S}=0,75*N$

"/" - Refusal (>50) (k_{60}=1,087)

FIELD VANE TEST (TYPE):
- Torvane (pocket in situ)
- Torvane (laboratory on US)
- Geonor

DIRECT SHEAR TEST:
- S Standard
- R Reverse
- KT Krey - Tiedemann

PERMEABILITY OEDOMETER / TRIAXIAL CELL:
- Oedometer
- Triaxial cell

TRIAXIAL SHEAR TEST:
- UU Unconsolidated undrained
- CU Consolidated undrained
- CD Consolidated drained

POCKET PENETROMETER:
- In-situ
- Laboratory

DRY / BULK DENSITY:
- Bulk density
- Dry density
- Specific density

COMMENTS:
- sample S-104-21-01-07 at depth 10,50-10,60 m combustible matter content 10,79%, content of organic matter 5,96%,
- sample S-104-21-01-08 at depth 13,30-13,60 m combustible matter content 15,17%, content of organic matter 6,23%,
- sample S-104-21-01-15 at depth 25,50-25,60 m combustible matter content 17,85%, content of organic matter 15,47% and
- sample S-104-21-01-17 at depth 26,90-27,00 m combustible matter content 17,57%, content of organic matter 11,27%.

GEOKON - ZAGREB d.d.

REPORT ID: E-104-21-01

APPENDIX N⁰: 2.1

PAGE NUM.: 2

CLIENT:

UNIVERSITY OF SPLIT

Faculty of Civil Engineering, Architecture and Geodesy

Matice hrvatske 15, Split

FIELD CLASSIFICATION: Marijana JELIĆ, dipl.ing.geol.

DRILL OPERATOR: Davor RIBIĆ

DRILLING RIG: Nordmeyer DSB 1/3,5

HEAD OF INVSTIGATIONS: prof.dr.sc. Leo Matešić, dipl.ing.građ.

BOREHOLE COORDINATES:
E: 578928,63
N: 4764297,75

GROUND LEVEL (m.a.s.l.):
H: 1,26

START DATE: 03.02.2022.

END DATE: 01.03.2022.

PROJECT: Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation

LOCATION: Lower Neretva

Borehole log: B-2 (S-104-21-02)

Scale: 1:100

DEPTH (m)	GROUND LEVEL (m.a.s.l.)	CORE BARREL DIAMETER (mm)	PROTECTIVE CASING DIAMETER (mm)	GWO (m)	GWL (m)	SYMBOL	INTERVAL (m)	GROUP OF MATERIALS	SOIL DESCRIPTION	STANDARD PENETRATION TEST (Blow count) N_0	N_1	N_2	N	N_{60}	POCKET PENETROMETER q_U (kPa)	FIELD VANE TEST c_U (kPa)	c_r (kPa)	SAMPLE TYPE	SAMPLE ID	INTERVAL (m) FROM	TO	PLASTICITY LIMITS w_L (%)	w_P (%)	PLASTICITY INDEX I_p (%)	CONSISTENCY INDEX I_c	WATER CONTENT w_c (%)	DRY / BULK DENSITY ρ (g/cm³)	ρ_d (g/cm³)	ρ_s (g/cm³)	PARTICLE SIZE ANALYSIS G (%)	S (%)	M (%)	C (%)	Permeability (accord. to USBR) k (cm/s)	SHEAR TESTS c/C_u (kPa)	ϕ (°)	TIP	UNCONFINED COMPRESSION STRENGHT q_u (kPa)	OEDOMETER TEST (MPa) σ_{30}	σ_{50}	σ_{100}	σ_{200}	σ_{400}	σ_{800}	σ_{1600}	σ_{3200}	PERMEABILITY OEDOMETER / TRIAXIAL CELL k (cm/s)				PHOTO DOCUMENTATION
0,0																																																								
1,0						SP			Poorly graded sand, fine, brown color, at the end of the interval contains some clay and fragment of concrete.									PU	1	1.00	1.10											3.60	95.40	1.00		1.51E-02																								
2,0	-1.14				1.9		2,40																																																	
3,0						SC			Clayey sand, fine, gray color.									PU	2	4.20	4.30										2.75		71.00	18.00	11.00	3.98E-04																								
4,0																																																						
5,0																																																						
6,0	-5.04						6,30																																																
7,0	-5.74					CL/SC	7,00		Sandy lean clay to clayey sand, soft consistency, gray color, in places contains peat.									PU	3	6.70	6.80	48.96	24.09	24.87		53.81			2.74		46.90	34.50	18.60	3.67E-06																								
8,0		146																																																				
9,0																																																						
10,0						SC			Clayey sand, fine, gray color, in places contains peat.									PU	4	8.50	8.60								2.76		70.80	17.10	12.10	8.90E-05																								
11,0																																																					
12,0	-11.24						12,50													PU	5	11.50	11.60				2.76		77.30	14.00	8.70	4.68E-04																								
13,0						CL			Lean clay, medium consistency, dark gray to black color, organic smell.									PU	6	13.50	13.60	45.17	25.36	19.80	0.56	34.17			2.68		16.50	61.50	22.00	5.06E-07																								
14,0																																																					
15,0																																																					
16,0																				PU	7	15.50	15.60	40.75	24.35	16.40	0.40	34.16			2.71		5.10	59.30	35.60	1.13E-07																								
17,0		101																																																			
18,0	-16.74						18,00													NU	8	17.60	17.90	46.36	23.56	22.80	0.29	39.81	1.86	1.37	2.72		0.30	62.60	37.10																						7.70E-08	6.00E-08	5.30E-08	
19,0		146																		PU	9	18.50	18.60	41.15	23.76	17.39	0.22	37.32			2.69		1.20	47.10	51.70																								
20,0																																																				

SAMPLE DISTRIBUTION:

DISTURBED SAMPLES	68
UNDISTURBED SAMPLES	3
SPT	-

IN SITU TESTS:

STANDARD PENETRATION TEST:	-
POCKET VANE TEST:	-
POCKET PENETROMETER:	-
FIELD VANE TEST:	

LEGEND

STANDARD PENETRATION TEST (SPT):
- Split spoon sampler $N=(N_{35}*k_{60})+(N_{\check{S}}*k_{\check{S}})$
- Solid cone $\check{S}=0,75*N$

"/" - Refusal (>50)
(k_{60}=1,087)

FIELD VANE TEST (TYPE):
- Torvane (pocket in situ)
- Torvane (laboratory on US)
- Geonor

DIRECT SHEAR TEST:
- S Standard
- R Reverse
- KT Krey - Tiedemann

PERMEABILITY OEDOMETER / TRIAXIAL CELL:
- Oedometer
- Triaxial cell

TRIAXIAL SHEAR TEST:
- UU Unconsolidated undrained
- CU Consolidated undrained
- CD Consolidated drained

POCKET PENETROMETER:
- In-situ
- Laboratory

DRY / BULK DENSITY:
- Bulk density
- Dry density
- Specific density

COMMENTS:
- sample S-104-21-02-06 at depth 13,50-13,60 m combustible matter content 13,93%, content of organic matter 4,19%,
- sample S-104-21-02-07 at depth 15,50-15,60 m combustible matter content 13,86%, content of organic matter 5,16%,
- sample S-104-21-02-08 at depth 17,60-17,90 m combustible matter content 11,11%, content of organic matter 2,67%,
- sample S-104-21-02-10 at depth 20,40-20,80 m combustible matter content 9,30%, content of organic matter 2,22% and
- sample S-104-21-02-16 at depth 30,70-30,80 m combustible matter content 12,52%, content of organic matter 35,12%.

GEOKON - ZAGREB d.d.

REPORT ID: E-104-21-01

APPENDIX N⁰: 2.2

CLIENT:

UNIVERSITY OF SPLIT

Faculty of Civil Engineering, Architecture and Geodesy

Matice hrvatske 15, Split

FIELD CLASSIFICATION: Marijana JELIĆ, dipl.ing.geol.

DRILL OPERATOR: Davor RIBIĆ

DRILLING RIG: Nordmeyer DSB 1/3,5

HEAD OF INVSTIGATIONS: prof.dr.sc. Leo Matešić, dipl.ing.građ.

BOREHOLE COORDINATES:
E: 578928,63
N: 4764297,75

GROUND LEVEL (m.a.s.l.):
H: 1,26

START DATE: 03.02.2022.

END DATE: 01.03.2022.

PROJECT: Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation

LOCATION: Lower Neretva

Borehole log: B-2 (S-104-21-02)

Scale: 1:100

DEPTH (m)	GROUND LEVEL (m.a.s.l.)	CORE BARREL DIAMETER (mm)	PROTECTIVE CASING DIAMETER (mm)	GWO (m)	GWL (m)	SYMBOL	INTERVAL (m)	GROUP OF MATERIALS	SOIL DESCRIPTION	STANDARD PENETRATION TEST (Blow count) N_0	N_1	N_2	N	N_{60}	POCKET PENETROMETER q_U (kPa)	FIELD VANE TEST c_U (kPa)	c_r (kPa)	SAMPLE TYPE	SAMPLE ID	INTERVAL (m) FROM	TO	PLASTICITY LIMITS w_L (%)	w_P (%)	PLASTICITY INDEX I_p (%)	CONSISTENCY INDEX I_c	WATER CONTENT w_c (%)	DRY / BULK DENSITY ρ (g/cm³)	ρ_d (g/cm³)	ρ_s (g/cm³)	PARTICLE SIZE ANALYSIS G (%)	S (%)	M (%)	C (%)	Permeability (accord. to USBR) k (cm/s)	SHEAR TESTS c/C_u (kPa)	ϕ (°)	TIP	UNCONFINED COMPRESSION STRENGHT q_u (kPa)	OEDOMETER TEST (MPa) σ_{30}	σ_{50}	σ_{100}	σ_{200}	σ_{400}	σ_{800}	σ_{1600}	σ_{3200}	PERMEABILITY OEDOMETER / TRIAXIAL CELL k (cm/s) $\sigma_{100}/\sigma_{300}$	$\sigma_{200}/\sigma_{400}$	$\sigma_{400}/\sigma_{800}$	σ_{800}	σ_{1600}	PHOTO DOCUMENTATION
21,0		101				CL			Lean clay, soft to medium consistency, gray color.									NU	10	20.40	20.80	46.94	23.48	23.46	0.33	39.25	1.88	1.40	2.70		0.30	71.40	28.30	3.07E-07															1.30E-07	6.50E-08	3.40E-08	
22,0		146																		PU	11	22.00	22.10	44.97	24.62	20.34	0.34	38.07			2.69		0.10	45.20	54.70																		
23,0		101																		NU	12	23.50	23.90	51.17	27.35	23.82	0.50	39.35	1.85	1.42	2.68		1.10	51.90	47.00																2.90E-08	2.70E-08	1.40E-08	
24,0	-22.74		178				24,00																																									
25,0		146				CL			Lean clay, soft consistency, gray color, contains shell fragments.									PU	13	24.50	24.60	48.38	23.57	24.81	0.26	41.87			2.70		2.80	73.00	24.20	3.65E-07																		
26,0	-25.24						26,50																																									
27,0						SC			Clayey sand, fine, gray color, in places contains shell fragments.									PU	14	27.50	27.60								2.76		81.90	12.00	6.10	9.73E-04																		
28,0																																															
29,0	-27.74						29,00																																									
30,0		131				SC/CL			Clayey sand to sandy lean clay, fine sand, gray color.									PU	15	29.50	29.60								2.68		56.90	29.10	14.00	6.20E-06																		
	-29.24						30,50																																									
31,0	-29.74					OH	31,00		Organic clay with sand, black color with gray, contains peat.									PU	16	30.70	30.80	88.88	29.54	59.33	0.58	54.46			2.57		24.10	46.70	29.20	1.91E-07																		
	-30.24					CL	31,50		Lean clay, stiff consistency, gray color, contains shell fragments.									PU	17	31.20	31.30	39.69	22.91	16.78	0.78	26.66			2.69		3.00	40.80	56.20																				
32,0	-31.14					SC	32,40		Clayey sand, fine, gray color, organic smell.									PU	18	31.90	32.00					16.89			2.78		63.10	27.10	9.80	2.92E-05																		
33,0																				PU	19	33.00	33.10									48.90	32.10	12.80	6.20	2.73E-03																	
34,0																																															
35,0																				PU	32	34.90	35.00									56.20	30.10	6.80	6.90	1.40E-02																	
36,0																				PU	20	36.00	36.10									47.70	35.60	9.60	7.10	7.02E-03																	
		146				GC			Clayey gravel with sand, fine, gray color, rounded, maximum particle size up to 10 cm.									PU	33	37.90	38.00										48.60	32.90	9.20	9.30	2.71E-03																	
																				PU	21	39.00	39.10									54.90	33.60	5.80	5.70	1.03E-01																	
																				PU	34	40.00	40.10									39.20	42.00	8.60	10.20	2.73E-03																	

SAMPLE DISTRIBUTION:		IN SITU TESTS:	
DISTURBED SAMPLES	68	STANDARD PENETRATION TEST:	-
UNDISTURBED SAMPLES	3	POCKET VANE TEST:	-
SPT	-	POCKET PENETROMETER:	-
		FIELD VANE TEST:	

LEGEND

STANDARD PENETRATION TEST (SPT):
- Split spoon sampler $N=(N_{10}*k_{60})+(N_{40}*k_{60})$
- Solid cone $\hat{S}=0,75*N$
- "/" - Refusal (>50)

(k_{60}=1,087)

FIELD VANE TEST (TYPE):
- Torvane (pocket in situ)
- Torvane (laboratory on US)
- Geonor

DIRECT SHEAR TEST:
- S Standard
- R Reverse
- KT Krey - Tiedemann

PERMEABILITY OEDOMETER / TRIAXIAL CELL:
- Oedometer
- Triaxial cell

TRIAXIAL SHEAR TEST:
- UU Unconsolidated undrained
- CU Consolidated undrained
- CD Consolidated drained

POCKET PENETROMETER:
- In-situ
- Laboratory

DRY / BULK DENSITY:
- Bulk density
- Dry density
- Specific density

COMMENTS:
- sample S-104-21-02-06 at depth 13,50-13,60 m combustible matter content 13,93%, content of organic matter 4,19%,
- sample S-104-21-02-07 at depth 15,50-15,60 m combustible matter content 13,86%, content of organic matter 5,16%,
- sample S-104-21-02-08 at depth 17,60-17,90 m combustible matter content 11,11%, content of organic matter 2,67%,
- sample S-104-21-02-10 at depth 20,40-20,80 m combustible matter content 9,30%, content of organic matter 2,22% and
- sample S-104-21-02-16 at depth 30,70-30,80 m combustible matter content 12,52%, content of organic matter 35,12%.

GEOKON - ZAGREB d.d.

REPORT ID: E-104-21-01

APPENDIX N⁰: 2.2

CLIENT:

UNIVERSITY OF SPLIT

Faculty of Civil Engineering, Architecture and Geodesy

Matice hrvatske 15, Split

FIELD CLASSIFICATION: Marijana JELIĆ, dipl.ing.geol.

DRILL OPERATOR: Davor RIBIĆ

DRILLING RIG: Nordmeyer DSB 1/3,5

HEAD OF INVSTIGATIONS: prof.dr.sc. Leo Matešić, dipl.ing.građ.

BOREHOLE COORDINATES:
E: 578928,63
N: 4764297,75

GROUND LEVEL (m.a.s.l.):
H: 1,26

START DATE: 03.02.2022.

END DATE: 01.03.2022.

PROJECT: Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation

LOCATION: Lower Neretva

Borehole log: B-2 (S-104-21-02)

Scale: 1:100

DEPTH (m)	GROUND LEVEL (m.a.s.l.)	CORE BARREL DIAMETER (mm)	PROTECTIVE CASING DIAMETER (mm)	GWO (m)	GWL (m)	SYMBOL	INTERVAL (m)	GROUP OF MATERIALS	SOIL DESCRIPTION
-42.44		131				GC, GP-GC	43,70		Clayey gravel with sand to poorly graded gravel with clay and sand, fine, gray color, rounded, maximum particle size up to 8 cm, in next intervals contains conglomerate fragments up to 8 cm: 43,7-43,9 m, 45,0-45,1 m, 47,9-48,0 m.
-48.74							50,00		
-53.14		116				GC/Kan	54,40		Clayey gravel with sand and Conglomerate, yellowish gray color, fine gravel, rounded, maximum particle size up to 8 cm, conglomerate fragments from 5 to 10 cm, clasts of different lithological composition, clast supported, rounded clasts.
-54.44						CL	55,70		Lean clay, medium consistency, brown and gray color, contains shell fragments.

SAMPLE TYPE	SAMPLE ID	INTERVAL (m) FROM	INTERVAL (m) TO	PLASTICITY LIMITS w_L (%)	PLASTICITY LIMITS w_P (%)	PLASTICITY INDEX I_p (%)	CONSISTENCY INDEX I_c	WATER CONTENT w_c (%)	DRY / BULK DENSITY ρ (g/cm³)	DRY / BULK DENSITY ρ_d (g/cm³)	DRY / BULK DENSITY ρ_s (g/cm³)	PARTICLE SIZE ANALYSIS G (%)	S (%)	M (%)	C (%)	Permeability (accord. to USBR) k (cm/s)
PU	35	41.50	41.60									53.60	34.00	6.10	6.30	1.05E-01
PU	22	42.00	42.10									56.00	31.10	6.10	6.80	7.51E-02
PU	36	43.00	43.10									64.90	25.50	4.90	4.70	5.21E-01
PU	23	43.90	44.00									65.50	25.60	4.20	4.70	7.91E-01
PU	37	45.00	45.10									45.00	40.00	7.60	7.40	6.72E-02
PU	24	46.90	47.00									65.70	27.40	3.80	3.10	5.08E-01
PU	38	47.90	48.00									56.90	30.20	6.50	6.40	3.01E-02
PU	39	48.90	49.00									40.40	38.20	8.80	12.60	3.53E-04
PU	25	49.90	50.00									33.00	38.50	11.70	16.80	6.82E-06
PU	40	50.90	50.10									51.50	34.70	6.50	7.30	2.65E-02
PU	42	50.00	53.00													
PU	41	51.90	52.00									50.80	33.10	7.60	8.50	4.89E-02
PU	26	52.90	53.00									52.20	29.80	7.60	10.40	2.41E-02
PU	43	53.90	54.00									62.30	23.40	6.70	7.60	2.97E-02
PU	27	54.70	55.00	39.21	24.28	14.93	0.61	30.04	1.91	1.46	2.67		2.60	68.90	28.50	4.88E-07
PU	44	56.00	56.10									45.80	25.40	11.00	17.80	4.80E-06
PU	28	57.00	57.10									45.10	34.10	9.00	11.80	3.79E-04
PU	45	58.00	58.10									58.00	26.70	6.60	8.70	2.27E-02
PU	46	59.00	59.10									57.30	23.00	7.10	12.60	3.61E-03
PU	29	60.00	60.10									51.30	34.00	5.60	9.10	9.31E-02

SHEAR TESTS c/C_u (kPa)	ϕ (°)	TIP	UNCONFINED COMPRESSION STRENGHT q_u (kPa)	OEDOMETER TEST (MPa) σ_{30}	σ_{50}	σ_{100}	σ_{200}	σ_{400}	σ_{800}	σ_{1600}	σ_{3200}	PERMEABILITY OEDOMETER / TRIAXIAL CELL k (cm/s) $\sigma_{100}/\sigma_{300}$	$\sigma_{200}/\sigma_{400}$	$\sigma_{400}/\sigma_{800}$	σ_{800}	σ_{1600}

PHOTO DOCUMENTATION

SAMPLE DISTRIBUTION:

DISTURBED SAMPLES	68
UNDISTURBED SAMPLES	3
SPT	-

IN SITU TESTS:

STANDARD PENETRATION TEST:	-
POCKET VANE TEST:	-
POCKET PENETROMETER:	-
FIELD VANE TEST:	

LEGEND

STANDARD PENETRATION TEST (SPT):
- Split spoon sampler $N=(N_{30}*k_{30})+(N_{50}*k_{50})$
- Solid cone $\check{S}=0,75*N$

"/" - Refusal (>50) (k_{50}=1,087)

FIELD VANE TEST (TYPE):
- Torvane (pocket in situ)
- Torvane (laboratory on US)
- Geonor

DIRECT SHEAR TEST:
- S Standard
- R Reverse
- KT Krey - Tiedemann

PERMEABILITY OEDOMETER / TRIAXIAL CELL:
- Oedometer
- Triaxial cell

TRIAXIAL SHEAR TEST:
- UU Unconsolidated undrained
- CU Consolidated undrained
- CD Consolidated drained

POCKET PENETROMETER:
- In-situ
- Laboratory

DRY / BULK DENSITY:
- Bulk density
- Dry density
- Specific density

COMMENTS:
- sample S-104-21-02-06 at depth 13,50-13,60 m combustible matter content 13,93%, content of organic matter 4,19%,
- sample S-104-21-02-07 at depth 15,50-15,60 m combustible matter content 13,86%, content of organic matter 5,16%,
- sample S-104-21-02-08 at depth 17,60-17,90 m combustible matter content 11,11%, content of organic matter 2,67%,
- sample S-104-21-02-10 at depth 20,40-20,80 m combustible matter content 9,30%, content of organic matter 2,22% and
- sample S-104-21-02-16 at depth 30,70-30,80 m combustible matter content 12,52%, content of organic matter 35,12%.

GEOKON
GEOKON - ZAGREB d.d.

REPORT ID: E-104-21-01

APPENDIX N⁰: 2.2

CLIENT:

UNIVERSITY OF SPLIT

Faculty of Civil Engineering, Architecture and Geodesy

Matice hrvatske 15, Split

FIELD CLASSIFICATION: Marijana JELIĆ, dipl.ing.geol.

DRILL OPERATOR: Davor RIBIĆ

DRILLING RIG: Nordmeyer DSB 1/3,5

HEAD OF INVSTIGATIONS: prof.dr.sc. Leo Matešić, dipl.ing.građ.

BOREHOLE COORDINATES:
E: 578928,63
N: 4764297,75

GROUND LEVEL (m.a.s.l.):
H: 1,26

START DATE: 03.02.2022.

END DATE: 01.03.2022.

PROJECT: Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation

LOCATION: Lower Neretva

Borehole log: B-2 (S-104-21-02)

Scale: 1:100

DEPTH (m)	GROUND LEVEL (m.a.s.l.)	CORE BARREL DIAMETER (mm)	PROTECTIVE CASING DIAMETER (mm)	GWO (m)	GWL (m)	SYMBOL	INTERVAL (m)	GROUP OF MATERIALS	SOIL DESCRIPTION
0,00									
			116						
		101				GC			Clayey gravel with sand, fine, light brown to gray color, rounded, maximum particle size up to 8 cm, in next intervals contains conglomerate fragments up to 5 cm: 59,6-59,7 m, 60,8-60,9 m, 65,9-66,0 m, 66,8-66,9 m, 67,0-67,1 m, 70,9-71,0 m, 75,5-75,6 m, 76,9-77,0 m i 82,5-82,6 m.

STANDARD PENETRATION TEST (Blow count)					POCKET PENETROMETER	FIELD VANE TEST		SAMPLE TYPE	SAMPLE ID	INTERVAL (m)		PLASTICITY LIMITS		PLASTICITY INDEX	CONSISTENCY INDEX	WATER CONTENT
N_0	N_1	N_2	N	N_{60}	q_U (kPa)	c_U (kPa)	c_r (kPa)			FROM	TO	w_L (%)	w_P (%)	I_p (%)	I_c	w_c (%)
								PU	47	61.00	61.10					
								PU	48	62.00	62.10					
								PU	30	63.00	63.10					
								PU	49	63.90	64.00					
								PU	50	64.50	64.60					
								PU	51	65.50	65.60					
								PU	31	66.00	66.10					
								PU	52	67.50	67.60					
								PU	53	68.50	68.60					
								PU	54	69.50	69.60					
								PU	55	70.50	70.60					
								PU	56	71.50	71.60					
								PU	57	72.50	72.60					
								PU	58	73.50	73.60					
								PU	59	74.90	75.00					
								PU	60	75.90	76.00					
								PU	61	76.90	77.00					
								PU	62	77.90	78.00					
								PU	63	78.90	79.00					
								PU	64	79.90	80.00					

DRY / BULK DENSITY			PARTICLE SIZE ANALYSIS				Permeability (accord. to USBR)	SHEAR TESTS			UNCONFINED COMPRESSION STRENGHT	OEDOMETER TEST (MPa)				PERMEABILITY OEDOMETER / TRIAXIAL CELL k (cm/s)		
ρ (g/cm³)	ρ_d (g/cm³)	ρ_s (g/cm³)	G (%)	S (%)	M (%)	C (%)	k (cm/s)	c/C_u (kPa)	ϕ (°)	TIP	q_u (kPa)	σ_{30}	σ_{50}	σ_{100}	σ_{200}	$\sigma_{100}/\sigma_{300}$	$\sigma_{200}/\sigma_{400}$	$\sigma_{400}/\sigma_{500}$
												σ_{400}	σ_{800}	σ_{1600}	σ_{3200}	σ_{800}	σ_{1600}	
			31.90	39.70	12.30	16.10	6.54E-06											
			52.80	30.40	6.90	9.90	4.19E-02											
			40.50	34.10	9.70	15.70	2.29E-05											
			72.50	25.10	1.50	0.90	9.48E-01											
			60.10	26.50	5.80	7.60	1.01E-01											
			51.20	25.60	8.60	14.60	1.21E-04											
			66.10	23.50	4.50	5.90	1.90E-01											
			61.90	26.20	6.00	5.90	4.99E-02											
			47.30	32.20	7.80	12.70	6.13E-04											
			66.70	21.70	6.20	5.40	1.00E-01											
			67.40	23.00	4.50	5.10	3.50E-01											
			56.30	29.90	5.10	8.70	3.77E-02											
			54.40	29.80	6.00	9.80	3.60E-02											
			52.80	29.60	8.10	9.50	6.74E-03											
			61.70	27.70	4.90	5.70	1.60E-01											
			46.50	34.60	7.20	11.70	2.60E-03											
			58.40	28.40	6.00	7.20	1.26E-01											
			48.10	31.50	6.80	13.60	3.69E-04											
			47.40	30.40	7.80	14.40	2.35E-04											
			41.00	32.80	8.70	17.50	9.07E-06											

PHOTO DOCUMENTATION

SAMPLE DISTRIBUTION:	
DISTURBED SAMPLES	68
UNDISTURBED SAMPLES	3
SPT	-

IN SITU TESTS:	
STANDARD PENETRATION TEST:	-
POCKET VANE TEST:	-
POCKET PENETROMETER:	-
FIELD VANE TEST:	

LEGEND

STANDARD PENETRATION TEST (SPT):
- Split spoon sampler $N=(N_{35}*k_{60})+(N_{45}*k_{60})$
- Solid cone $\check{S}=0,75*N$
- "/" - Refusal (>50)

(k_{60}=1,087)

FIELD VANE TEST (TYPE):
- Torvane (pocket in situ)
- Torvane (laboratory on US)
- Geonor

DIRECT SHEAR TEST:
- S Standard
- R Reverse
- KT Krey - Tiedemann

PERMEABILITY OEDOMETER / TRIAXIAL CELL:
- Oedometer
- Triaxial cell

TRIAXIAL SHEAR TEST:
- UU Unconsolidated undrained
- CU Consolidated undrained
- CD Consolidated drained

POCKET PENETROMETER:
- In-situ
- Laboratory

DRY / BULK DENSITY:
- Bulk density
- Dry density
- Specific density

COMMENTS:
- sample S-104-21-02-06 at depth 13,50-13,60 m combustible matter content 13,93%, content of organic matter 4,19%,
- sample S-104-21-02-07 at depth 15,50-15,60 m combustible matter content 13,86%, content of organic matter 5,16%,
- sample S-104-21-02-08 at depth 17,60-17,90 m combustible matter content 11,11%, content of organic matter 2,67%,
- sample S-104-21-02-10 at depth 20,40-20,80 m combustible matter content 9,30%, content of organic matter 2,22% and
- sample S-104-21-02-16 at depth 30,70-30,80 m combustible matter content 12,52%, content of organic matter 35,12%.

GEOKON
GEOKON - ZAGREB d.d.

REPORT ID:	APPENDIX N⁰: 2.2
E-104-21-01	PAGE NUM.: 4

CLIENT:

UNIVERSITY OF SPLIT

Faculty of Civil Engineering, Architecture and Geodesy

Matice hrvatske 15, Split

FIELD CLASSIFICATION: Marijana JELIĆ, dipl.ing.geol.

DRILL OPERATOR: Davor RIBIĆ

DRILLING RIG: Nordmeyer DSB 1/3,5

HEAD OF INVSTIGATIONS: prof.dr.sc. Leo Matešić, dipl.ing.građ.

BOREHOLE COORDINATES:
E: 578928,63
N: 4764297,75

GROUND LEVEL (m.a.s.l.):
H: 1,26

START DATE: 03.02.2022.

END DATE: 01.03.2022.

PROJECT: Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation

LOCATION: Lower Neretva

Borehole log: B-2 (S-104-21-02)

Scale: 1:100

DEPTH (m)	GROUND LEVEL (m.a.s.l.)	CORE BARREL DIAMETER (mm)	PROTECTIVE CASING DIAMETER (mm)	GWO (m)	GWL (m)	SYMBOL	INTERVAL (m)	GROUP OF MATERIALS	SOIL DESCRIPTION	STANDARD PENETRATION TEST (Blow count) N_0	N_1	N_2	N	N_{60}	POCKET PENETROMETER q_U (kPa)	FIELD VANE TEST c_U (kPa)	c_r (kPa)	SAMPLE TYPE	SAMPLE ID	INTERVAL (m) FROM	TO	PLASTICITY LIMITS w_L (%)	w_P (%)	PLASTICITY INDEX I_P (%)	CONSISTENCY INDEX I_c	WATER CONTENT w_c (%)	DRY / BULK DENSITY ρ (g/cm³)	ρ_d (g/cm³)	ρ_s (g/cm³)	PARTICLE SIZE ANALYSIS G (%)	S (%)	M (%)	C (%)	Permeability (accord. to USBR) k (cm/s)	SHEAR TESTS c/C_u (kPa)	ϕ (°)	TIP	UNCONFINED COMPRESSION STRENGHT q_u (kPa)	OEDOMETER TEST (MPa) σ_{30}	σ_{50}	σ_{100}	σ_{200}	σ_{400}	σ_{800}	σ_{1600}	σ_{3200}	PERMEABILITY OEDOMETER / TRIAXIAL CELL k (cm/s) $\sigma_{100}/\sigma_{300}$	$\sigma_{200}/\sigma_{400}$	$\sigma_{400}/\sigma_{800}$	σ_{800}	σ_{1600}	PHOTO DOCUMENTATION
-88.74							90.00											PU	65	81.00	81.10											65.30	19.20	6.70	8.80	3.84E-02																						
																		PU	66	82.00	82.10											54.10	29.80	7.50	8.60	1.19E-02																						
																		PU	67	83.00	83.10											56.20	30.10	4.70	9.00	7.84E-02																						
																		PU	68	84.00	84.10											63.50	26.90	4.50	5.10	3.90E-01																						
																		PU	69	85.00	85.10											85.30	10.60	2.90	1.20	1.91E+01																						
																		PU	70	86.50	86.60											78.80	16.20	3.10	1.90	9.65E+00																						
																		PU	71	88.00	88.10											75.30	21.40	1.80	1.50	5.45E+00																						
																		PU	72	89.90	90.00											55.40	31.70	6.50	6.40	9.20E-02																						

SAMPLE DISTRIBUTION:	
DISTURBED SAMPLES	68
UNDISTURBED SAMPLES	3
SPT	-

IN SITU TESTS:	
STANDARD PENETRATION TEST:	-
POCKET VANE TEST:	-
POCKET PENETROMETER:	-
FIELD VANE TEST:	

LEGEND

STANDARD PENETRATION TEST (SPT):
- Split spoon sampler $N=(N_{30}*k_{60})+(N_{40}*k_{60})$
- Solid cone $\hat{S}=0,75*N$

"/" - Refusal (>50)
(k_{60}=1,087)

FIELD VANE TEST (TYPE):
- Torvane (pocket in situ)
- Torvane (laboratory on US)
- Geonor

DIRECT SHEAR TEST:
- S Standard
- R Reverse
- KT Krey - Tiedemann

PERMEABILITY OEDOMETER / TRIAXIAL CELL:
- Oedometer
- Triaxial cell

TRIAXIAL SHEAR TEST:
- UU Unconsolidated undrained
- CU Consolidated undrained
- CD Consolidated drained

POCKET PENETROMETER:
- In-situ
- Laboratory

DRY / BULK DENSITY:
- Bulk density
- Dry density
- Specific density

COMMENTS:
- sample S-104-21-02-06 at depth 13,50-13,60 m combustible matter content 13,93%, content of organic matter 4,19%,
- sample S-104-21-02-07 at depth 15,50-15,60 m combustible matter content 13,86%, content of organic matter 5,16%,
- sample S-104-21-02-08 at depth 17,60-17,90 m combustible matter content 11,11%, content of organic matter 2,67%,
- sample S-104-21-02-10 at depth 20,40-20,80 m combustible matter content 9,30%, content of organic matter 2,22% and
- sample S-104-21-02-16 at depth 30,70-30,80 m combustible matter content 12,52%, content of organic matter 35,12%.

GEOKON - ZAGREB d.d.

REPORT ID: E-104-21-01

APPENDIX N⁰: 2.2

CLIENT:			
UNIVERSITY OF SPLIT Faculty of Civil Engineering, Architecture and Geodesy Matice hrvatske 15, Split	FIELD CLASSIFICATION:	Marijana JELIĆ, dipl.ing.geol.	
	DRILL OPERATOR:	Davor RIBIĆ	
	DRILLING RIG:	Nordmeyer DSB 1/3,5	
	HEAD OF INVSTIGATIONS:	prof.dr.sc. Leo Matešić, dipl.ing.građ.	

BOREHOLE COORDINATES: E: 578606,07 N: 4764959,54

GROUND LEVEL (m.a.s.l.): H: -0,81

START DATE: 08.03.2022.

END DATE: 09.03.2022.

PROJECT: Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation

LOCATION: Lower Neretva

Borehole log: B-3 (S-104-21-03)

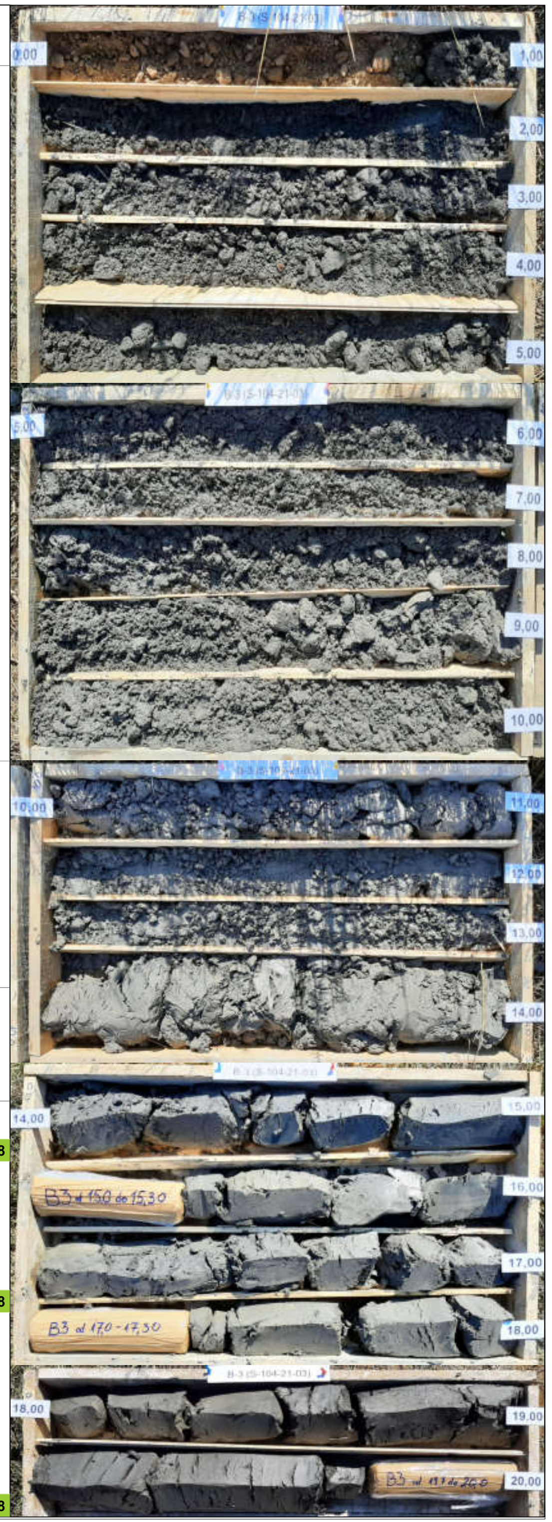
Scale: 1:100

DEPTH (m)	GROUND LEVEL (m.a.s.l.)	CORE BARREL DIAMETER (mm)	PROTECTIVE CASING DIAMETER (mm)	GWO (m)	GWL (m)	SYMBOL	INTERVAL (m)	GROUP OF MATERIALS	SOIL DESCRIPTION
0,0 – 0,80	-1.61	146	178		0.8	SC	0,80		Clayey sand, medium size, brown color.
0,80 – 10,00	-10.81					SP	10,00		Poorly graded sand, medium size, gray color, at the beginning of the interval with gravel.
10,00 – 13,00	-13.81					SC	13,00		Clayey sand, fine, gray color.
13,00 – 14,50	-15.31					SC/CL	14,50		Clayey sand to sandy lean clay, fine sand, gray color, organic smell.
14,50 – 20,00	-20.81					CL	20,00		Lean clay, soft to medium consistency, gray color, at the end of the interval sandy, contains manganes concretions and shell fragments.

Standard penetration test (Blow count) N_0, N_1, N_2, N, N_{60}; Pocket penetrometer q_u (kPa); Field vane test c_u (kPa), c_r (kPa); Shear tests c/C_u (kPa), ϕ (°), TIP; Unconfined compression strenght q_u (kPa); Oedometer test (MPa) σ_{30}, σ_{50}, σ_{100}, σ_{200}, σ_{400}, σ_{800}, σ_{1600}, σ_{3200}: no values.

SAMPLE TYPE	SAMPLE ID	FROM (m)	TO (m)	w_L (%)	w_P (%)	I_P (%)	I_c	w_0 (%)	ρ (g/cm³)	ρ_d (g/cm³)	ρ_s (g/cm³)	G (%)	S (%)	M (%)	C (%)	k (cm/s) (accord. to USBR)	k (cm/s) σ_{100}/σ_{300} / σ_{800}	k (cm/s) σ_{200}/σ_{400} / σ_{1600}	k (cm/s) σ_{400}/σ_{500}
PU	1	0.50	0.60								2.75	0.90	71.60	10.30	17.20	9.32E-06			
PU	2	1.50	1.60								2.78	15.20	84.60	0.20		3.36E-02			
PU	3	4.50	4.60								2.78	10.40	89.00	0.60		2.57E-02			
PU	4	7.50	7.60								2.78	9.90	89.90	0.20		5.61E-02			
PU	5	10.00	10.10								2.78		74.90	17.50	7.60	3.42E-04			
PU	6	12.50	12.60								2.78		75.40	17.00	7.60	3.42E-04			
PU	7	13.50	13.60	32.23	22.41	9.82		34.33			2.78		56.50	26.60	16.90	3.33E-06			
NU	8	15.00	15.30	44.84	21.48	23.37	0.28	38.36	1.88	1.41	2.69		4.80	58.40	36.80	2.59E-07	4.10E-08	2.10E-08	1.30E-08
NU	9	17.00	17.30	46.75	22.70	24.05	0.35	38.43	1.85	1.36	2.69		3.10	53.70	43.20		3.70E-08	2.60E-08	2.20E-08
NU	10	19.70	20.00	49.79	23.13	26.66	0.44	38.09	1.83	1.34	2.69		33.20	34.20	32.60		2.60E-08	2.20E-08	2.10E-08

PHOTO DOCUMENTATION



SAMPLE DISTRIBUTION:		IN SITU TESTS:	
		STANDARD PENETRATION TEST:	-
DISTURBED SAMPLES	7	POCKET VANE TEST:	-
UNDISTURBED SAMPLES	3	POCKET PENETROMETER:	-
SPT	-	FIELD VANE TEST:	

LEGEND

STANDARD PENETRATION TEST (SPT):
- Split spoon sampler $N=(N_{30}*k_{60})+(N_{45}*k_{60})$
- Solid cone Š=0,75*N

"/" - Refusal (>50) (k_{60}=1,087)

FIELD VANE TEST (TYPE): Torvane (pocket in situ); Torvane (laboratory on US); Geonor

DIRECT SHEAR TEST: S Standard; R Reverse; KT Krey - Tiedemann

PERMEABILITY OEDOMETER / TRIAXIAL CELL: - Oedometer; - Triaxial cell

TRIAXIAL SHEAR TEST: UU Unconsolidated undrained; CU Consolidated undrained; CD Consolidated drained

POCKET PENETROMETER: In-situ; Laboratory

DRY / BULK DENSITY: Bulk density; Dry density; Specific density

COMMENTS:
- sample S-104-21-03-07 at depth 13,50-13,60 m combustible matter content 9,12%, content of organic matter 1,76%.

GEOKON - ZAGREB d.d.

REPORT ID: E-104-21-01

APPENDIX N⁰: 2.3

PAGE NUM.: 1

Test report for the borehole S-104-21-01 (B-1)

Kind of test	Name of the test report	Number of pages
01	Test report of water content determination	3
02	Test report of specific gravity – S-104-21-01	3
03	Test report of bulk density determination – S-104-21-01	1
04	Test report of particle size analysis of solis – S-104-21-01	4
05	Test report of consistency limits determination (Atterberg limits) – S-104-21-01	2
09	Test report of determination of permealibity coefficient – S-104-21-01-02 / 2,00-2,30	1
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-01-08 / 13,30-13,60	1
09	Test report of determination of permealibity coefficient in the triaxial cell (ASTM) – S-104-21-01-08 / 13,30-13,60	1
09	Test report of determination of permealibity coefficient – S-104-21-01-09 / 15,50-15,80	1
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-01-11 / 18,50-18,80	1
09	Test report of determination of permealibity coefficient in the triaxial cell (ASTM) – S-104-21-01-11 / 18,50-18,80	1
09	Test report of determination of permealibity coefficient – S-104-21-01-12 / 20,50-20,80	1
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-01-14 / 24,70-25,00	1
09	Test report of determination of permealibity coefficient in the triaxial cell (ASTM) – S-104-21-01-14 / 24,70-25,00	1
09	Test report of determination of permealibity coefficient – S-104-21-01-02 / 2,00-2,30	1
09	Test report of determination of permealibity coefficient – S-104-21-01-02 / 2,00-2,30	1
11	Test report for determination of combustible and organic matter content – S-104-21-01-07 / 10,50-10,60	1
11	Test report for determination of combustible and organic matter content – S-104-21-01-08 / 25,50-25,60	1
11	Test report for determination of combustible and organic matter content – S-104-21-01-15 / 2,00-2,30	1
11	Test report for determination of combustible and organic matter content – S-104-21-01-17 / 26,90-27,00	1

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Water content determination

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-01-01 v.1.3**

Project: 104-21
Location: Dolina Neretve

Facility: Dolina Neretve

Borehole ID: S-104-21-01 (B-1)

Test ID: **S-104-21-01-01-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 1,00-1,10 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 55,29 Wet mass (g): 173,30 Dry mass (g): 150,78 **Water content (%): 23,58**
Remark:

Test ID: **S-104-21-01-02-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 2,00-2,30 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 62,27 Wet mass (g): 198,40 Dry mass (g): 153,79 **Water content (%): 48,74**
Remark:

Test ID: **S-104-21-01-03-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 3,40-3,50 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 55,73 Wet mass (g): 201,60 Dry mass (g): 165,74 **Water content (%): 32,60**
Remark:

Test ID: **S-104-21-01-04-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 4,50-4,60 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 61,81 Wet mass (g): 191,17 Dry mass (g): 154,90 **Water content (%): 38,96**
Remark:

Test ID: **S-104-21-01-05-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 6,80-6,90 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 60,19 Wet mass (g): 186,63 Dry mass (g): 149,32 **Water content (%): 41,86**
Remark:

Test ID: **S-104-21-01-07-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 10,50-10,60 Starting test date: 14.2.2022. Test date: 16.2.2022.
Tare weight (g): 55,93 Wet mass (g): 191,71 Dry mass (g): 154,38 **Water content (%): 37,92**
Remark:

Test ID: **S-104-21-01-08-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 13,30-13,60 Starting test date: 14.2.2022. Test date: 16.2.2022.
Tare weight (g): 61,77 Wet mass (g): 191,60 Dry mass (g): 157,67 **Water content (%): 35,38**
Remark:

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Water content determination

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-01-01 v.1.3**

Project: 104-21
Location: Dolina Neretve

Test ID: **S-104-21-01-09-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 15,50-15,80 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 56,65 Wet mass (g): 157,07 Dry mass (g): 130,24 **Water content (%): 36,46**
Remark:

Test ID: **S-104-21-01-10-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 17,50-17,60 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 35,92 Wet mass (g): 155,36 Dry mass (g): 123,77 **Water content (%): 35,96**
Remark:

Test ID: **S-104-21-01-11-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 18,50-18,80 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 55,61 Wet mass (g): 201,97 Dry mass (g): 160,78 **Water content (%): 39,17**
Remark:

Test ID: **S-104-21-01-12-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 20,50-20,80 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 56,09 Wet mass (g): 177,88 Dry mass (g): 143,78 **Water content (%): 38,89**
Remark:

Test ID: **S-104-21-01-13-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 22,50-22,60 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 62,45 Wet mass (g): 206,90 Dry mass (g): 167,56 **Water content (%): 37,43**
Remark:

Test ID: **S-104-21-01-14-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 24,70-25,00 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 62,89 Wet mass (g): 209,79 Dry mass (g): 171,07 **Water content (%): 35,79**
Remark:

Test ID: **S-104-21-01-15-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 25,50-25,60 Starting test date: 14.2.2022. Test date: 16.2.2022.
Tare weight (g): 55,32 Wet mass (g): 168,63 Dry mass (g): 129,29 **Water content (%): 53,18**
Remark:

Test ID: **S-104-21-01-16-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 26,10-26,20 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 67,03 Wet mass (g): 214,64 Dry mass (g): 189,55 **Water content (%): 20,48**
Remark:

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Water content determination

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-01-01 v.1.3**

Project: 104-21
Location: Dolina Neretve

Test ID: **S-104-21-01-17-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 26,90-27,00 Starting test date: 14.2.2022. Test date: 16.2.2022.
Tare weight (g): 62,11 Wet mass (g): 209,86 Dry mass (g): 160,23 **Water content (%): 50,58**
Remark:

Test ID: **S-104-21-01-18-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 27,80-27,90 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 60,98 Wet mass (g): 188,74 Dry mass (g): 159,42 **Water content (%): 29,78**
Remark:

Test ID: **S-104-21-01-19-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 29,40-29,50 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 61,01 Wet mass (g): 204,24 Dry mass (g): 172,31 **Water content (%): 28,69**
Remark:

Test ID: **S-104-21-01-20-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 31,20-31,30 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 33,72 Wet mass (g): 190,67 Dry mass (g): 153,08 **Water content (%): 31,49**
Remark:

Test ID: **S-104-21-01-21-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 32,50-32,60 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 56,08 Wet mass (g): 204,25 Dry mass (g): 180,11 **Water content (%): 19,46**
Remark:

Test ID: **S-104-21-01-22-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 33,50-33,60 Starting test date: 14.2.2022. Test date: 15.2.2022.
Tare weight (g): 54,75 Wet mass (g): 219,33 Dry mass (g): 184,17 **Water content (%): 27,17**
Remark:

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.
Test report date: 17.2.2022.

17025 · HAA
1089
TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Specific gravity

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-02-01 v.1.3**

Subject: 104-21
Facility: Dolina Neretve

Structuret: Dolina Neretve

Borehole ID: S-104-21-01 (B-1)

Test ID: **S-104-21-01-01-1-02** Standard: ASTM D 854-14
Depth (m): 1,00-1,10 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,72**
Remarks:

Test ID: **S-104-21-01-02-1-02** Standard: ASTM D 854-14
Depth (m): 2,00-2,30 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,69**
Remarks:

Test ID: **S-104-21-01-03-1-02** Standard: ASTM D 854-14
Depth (m): 3,40-3,50 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,73**
Remarks:

Test ID: **S-104-21-01-04-1-02** Standard: ASTM D 854-14
Depth (m): 4,50-4,60 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,76**
Remarks:

Test ID: **S-104-21-01-05-1-02** Standard: ASTM D 854-14
Depth (m): 6,80-6,90 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,68**
Remarks:

Test ID: **S-104-21-01-07-1-02** Standard: ASTM D 854-14
Depth (m): 10,50-10,60 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,71**
Remarks:

Test ID: **S-104-21-01-08-1-02** Standard: ASTM D 854-14
Depth (m): 13,30-13,60 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,67**
Remarks:

Test ID: **S-104-21-01-09-1-02** Standard: ASTM D 854-14
Depth (m): 15,50-15,80 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,68**
Remarks:

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Specific gravity

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-02-01 v.1.3**

Subject: 104-21
Facility: Dolina Neretve

Test ID: **S-104-21-01-10-1-02** Standard: ASTM D 854-14
Depth (m): 17,50-17,60 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,67**
Remarks:

Test ID: **S-104-21-01-11-1-02** Standard: ASTM D 854-14
Depth (m): 18,50-18,80 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,69**
Remarks:

Test ID: **S-104-21-01-12-1-02** Standard: ASTM D 854-14
Depth (m): 20,50-20,80 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,73**
Remarks:

Test ID: **S-104-21-01-13-1-02** Standard: ASTM D 854-14
Depth (m): 22,50-22,60 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,73**
Remarks:

Test ID: **S-104-21-01-14-1-02** Standard: ASTM D 854-14
Depth (m): 24,70-25,00 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,74**
Remarks:

Test ID: **S-104-21-01-15-1-02** Standard: ASTM D 854-14
Depth (m): 25,50-25,60 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,58**
Remarks:

Test ID: **S-104-21-01-16-1-02** Standard: ASTM D 854-14
Depth (m): 26,10-26,20 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,76**
Remarks:

Test ID: **S-104-21-01-17-1-02** Standard: ASTM D 854-14
Depth (m): 26,90-27,00 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,70**
Remarks:

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Specific gravity

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-02-01 v.1.3**

Subject: 104-21
Facility: Dolina Neretve

Test ID: **S-104-21-01-18-1-02** Standard: ASTM D 854-14
Depth (m): 27,80-27,90 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,71**
Remarks:

Test ID: **S-104-21-01-19-1-02** Standard: ASTM D 854-14
Depth (m): 29,40-29,50 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,75**
Remarks:

Test ID: **S-104-21-01-20-1-02** Standard: ASTM D 854-14
Depth (m): 31,20-31,30 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,70**
Remarks:

Test ID: **S-104-21-01-21-1-02** Standard: ASTM D 854-14
Depth (m): 32,50-32,60 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,77**
Remarks:

Test ID: **S-104-21-01-22-1-02** Standard: ASTM D 854-14
Depth (m): 33,50-33,60 Starting test date: 15.2.2022. Test date: 21.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,72**
Remarks:

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.
Print date: 21.2.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

BULK DENSITY DETERMINATION

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-03-01 v.1.3**

Subject: 104-21
Location: Dolina Neretve

Facility: Dolina Neretve

Borehole ID: S-104-21-01 (B-1)

Test ID: **S-104-21-01-02-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 2,00-2,30 Starting test date: 15.2.2022. Test date: 8.3.2022.
Moist density (g/cm^3): 1,80 **Dry density (g/cm^3): 1,28**
Remark:

Test ID: **S-104-21-01-08-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 13,30-13,60 Starting test date: 15.2.2022. Test date: 23.3.2022.
Moist density (g/cm^3): 1,64 **Dry density (g/cm^3): 1,42**
Remark:

Test ID: **S-104-21-01-09-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 15,50-15,80 Starting test date: 15.2.2022. Test date: 17.3.2022.
Moist density (g/cm^3): 1,89 **Dry density (g/cm^3): 1,43**
Remark:

Test ID: **S-104-21-01-11-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 18,50-18,80 Starting test date: 15.2.2022. Test date: 17.3.2022.
Moist density (g/cm^3): 1,83 **Dry density (g/cm^3): 1,33**
Remark:

Test ID: **S-104-21-01-12-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 20,50-20,80 Starting test date: 15.2.2022. Test date: 17.3.2022.
Moist density (g/cm^3): 1,86 **Dry density (g/cm^3): 1,37**
Remark:

Test ID: **S-104-21-01-14-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 24,70-25,00 Starting test date: 15.2.2022. Test date: 23.3.2022.
Moist density (g/cm^3): 1,90 **Dry density (g/cm^3): 1,42**
Remark:

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 23.3.2022.

17025·HAA
1089
TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

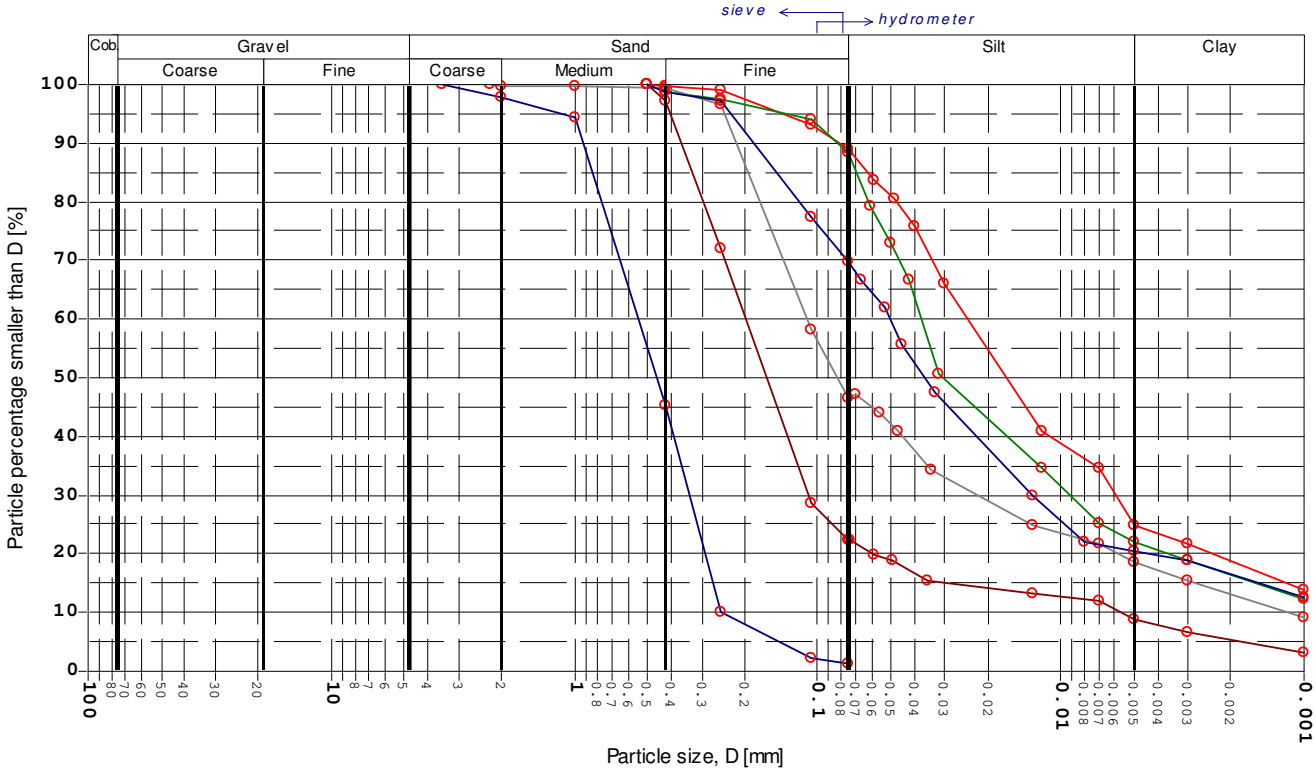
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 21.2.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-01-01-1-04 S-104-21-01-02-1-04 S-104-21-01-03-1-04
S-104-21-01-04-1-04 S-104-21-01-05-1-04 S-104-21-01-06-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-01-01-1-04	0,024	0,006	-	-	-	n/a	11,0	64,0	25,0
S-104-21-01-02-1-04	0,038	0,009	-	-	-	n/a	11,5	66,5	22,0
S-104-21-01-03-1-04	0,111	0,022	0,001	95,610	3,674	n/a	53,4	28,0	18,6
S-104-21-01-04-1-04	0,197	0,109	0,006	34,793	10,571	n/a	77,7	13,6	8,7
S-104-21-01-05-1-04	0,050	0,013	-	-	-	n/a	30,1	49,5	20,4
S-104-21-01-06-1-04	0,548	0,337	0,246	2,231	0,843	2,2	96,6	M(%) + C(%)= 1,2	

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-1	1,00-1,10	S-104-21-01-01-1-04	0,5	n/a	soft	2,72	mixer	10
B-1	2,00-2,30	S-104-21-01-02-1-04	0,5	n/a	soft	2,69	mixer	10
B-1	3,40-3,50	S-104-21-01-03-1-04	2,2	sharp	hard & solid	2,73	mixer	10
B-1	4,50-4,60	S-104-21-01-04-1-04	0,5	sharp	hard & solid	2,76	mixer	10
B-1	6,80-6,90	S-104-21-01-05-1-04	0,5	n/a	soft	2,68	mixer	10
B-1	8,90-9,00	S-104-21-01-06-1-04	3,5	sharp	hard & solid	2,78		0

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 22.2.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

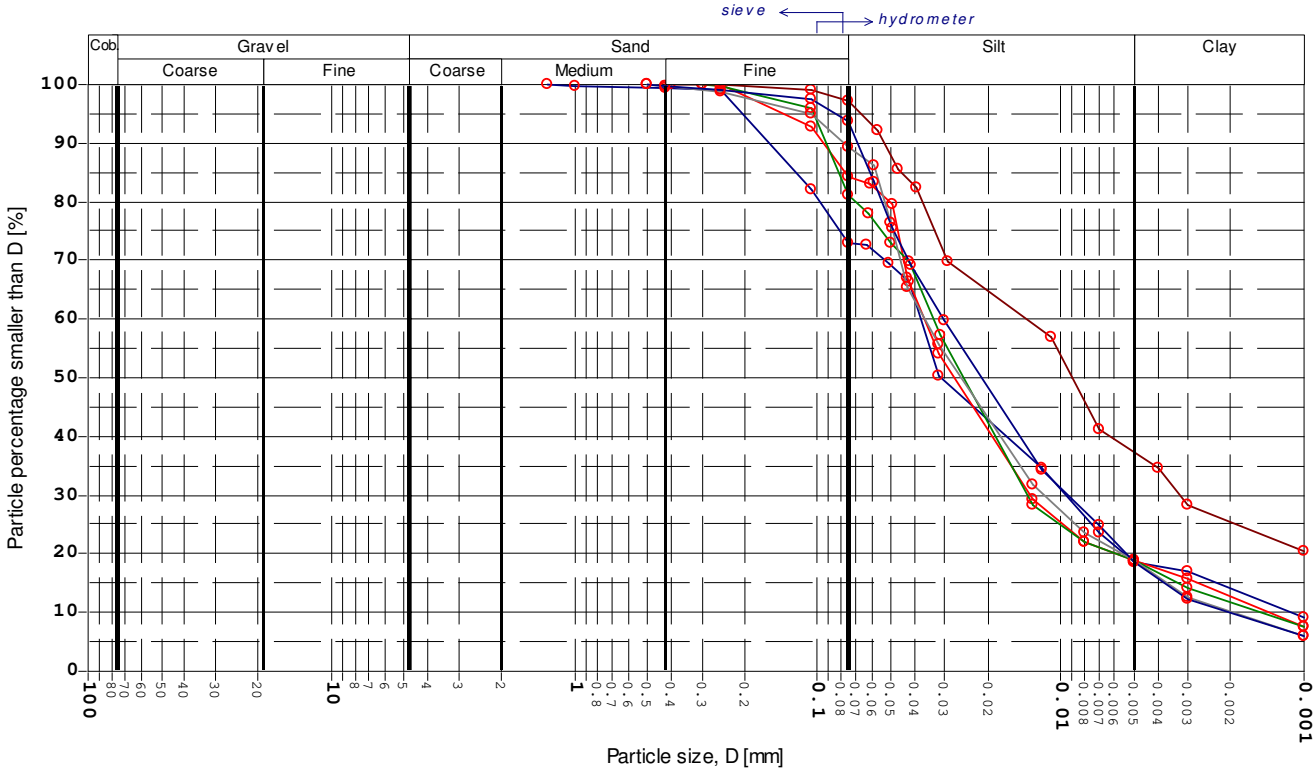
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 21.2.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-01-07-1-04 S-104-21-01-08-1-04 S-104-21-01-09-1-04
S-104-21-01-10-1-04 S-104-21-01-11-1-04 S-104-21-01-12-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-01-07-1-04	0,038	0,010	0,001	33,724	2,192	n/a	27,2	54,1	18,7
S-104-21-01-08-1-04	0,037	0,013	0,001	26,665	3,568	n/a	15,8	65,3	18,9
S-104-21-01-09-1-04	0,033	0,014	0,001	22,176	3,748	n/a	18,8	62,4	18,8
S-104-21-01-10-1-04	0,037	0,012	0,002	18,640	1,923	n/a	10,6	70,5	18,9
S-104-21-01-11-1-04	0,014	0,003	-	-	-	n/a	2,8	60,4	36,8
S-104-21-01-12-1-04	0,030	0,009	0,002	15,108	1,432	n/a	6,4	75,0	18,6

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-1	10,50-10,60	S-104-21-01-07-1-04	1,3	sharp	hard & solid	2,71	mixer	10
B-1	13,30-13,60	S-104-21-01-08-1-04	0,3	n/a	soft	2,67	mixer	10
B-1	15,50-15,80	S-104-21-01-09-1-04	0,3	n/a	soft	2,68	mixer	10
B-1	17,50-17,60	S-104-21-01-10-1-04	0,5	n/a	soft	2,67	mixer	10
B-1	18,50-18,80	S-104-21-01-11-1-04	0,4	sharp	hard & solid	2,69	mixer	10
B-1	20,50-20,80	S-104-21-01-12-1-04	0,5	sharp	hard & solid	2,73	mixer	10

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 22.2.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

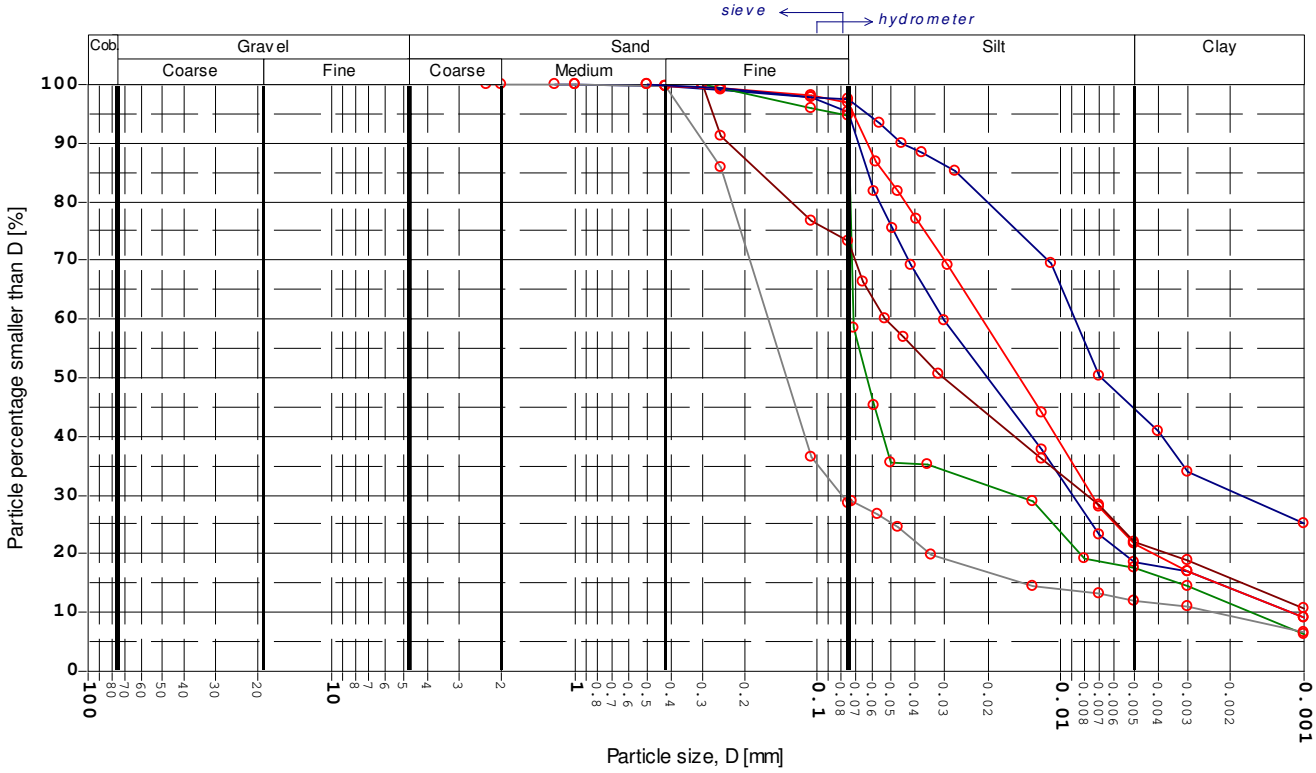
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 21.2.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-01-13-1-04 S-104-21-01-14-1-04 S-104-21-01-15-1-04
S-104-21-01-16-1-04 S-104-21-01-17-1-04 S-104-21-01-18-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-01-13-1-04	0,030	0,009	0,001	26,949	2,377	n/a	4,7	76,7	18,6
S-104-21-01-14-1-04	0,021	0,007	0,001	18,723	2,354	n/a	3,0	75,2	21,8
S-104-21-01-15-1-04	0,071	0,015	0,002	42,728	1,910	n/a	5,5	76,9	17,6
S-104-21-01-16-1-04	0,159	0,080	0,002	67,471	16,875	n/a	71,4	16,5	12,1
S-104-21-01-17-1-04	0,053	0,008	-	-	-	n/a	26,9	51,2	21,9
S-104-21-01-18-1-04	0,009	0,002	-	-	-	n/a	2,5	53,4	44,1

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-1	22,50-22,60	S-104-21-01-13-1-04	1,2	sharp	hard & solid	2,73	mixer	10
B-1	24,70-25,00	S-104-21-01-14-1-04	0,5	sharp	hard & solid	2,73	mixer	10
B-1	25,50-25,60	S-104-21-01-15-1-04	0,3	n/a	soft	2,58	mixer	10
B-1	26,10-26,20	S-104-21-01-16-1-04	2,3	sharp	hard & solid	2,76	mixer	10
B-1	26,90-27,00	S-104-21-01-17-1-04	0,3	n/a	soft	2,70	mixer	10
B-1	27,80-27,90	S-104-21-01-18-1-04	0,5	n/a	soft	2,71	mixer	10

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 22.2.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

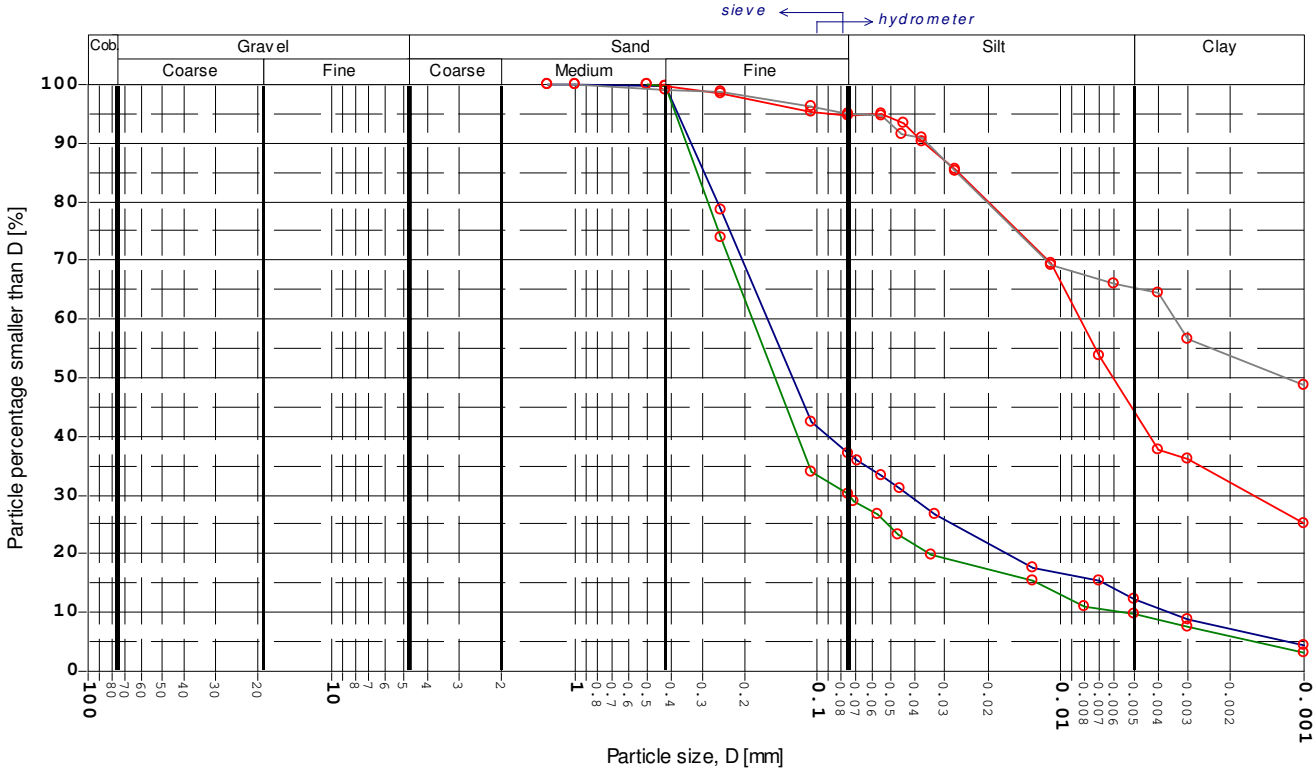
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 21.2.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-01-19-1-04 S-104-21-01-20-1-04 S-104-21-01-21-1-04 S-104-21-01-22-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-01-19-1-04	0,161	0,042	0,004	44,409	3,032	n/a	62,9	25,0	12,1
S-104-21-01-20-1-04	0,008	0,002	-	-	-	n/a	5,5	51,4	43,1
S-104-21-01-21-1-04	0,185	0,075	0,005	34,660	5,650	n/a	70,0	20,2	9,8
S-104-21-01-22-1-04	0,003	-	-	-	-	n/a	5,1	29,5	65,4

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-1	29,40-29,50	S-104-21-01-19-1-04	1,3	sharp	hard & solid	2,75	mixer	10
B-1	31,20-31,30	S-104-21-01-20-1-04	0,5	n/a	soft	2,70	mixer	10
B-1	32,50-32,60	S-104-21-01-21-1-04	0,5	sharp	hard & solid	2,77	mixer	10
B-1	33,50-33,60	S-104-21-01-22-1-04	1,3	sharp	hard & solid	2,72	mixer	10

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 22.2.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

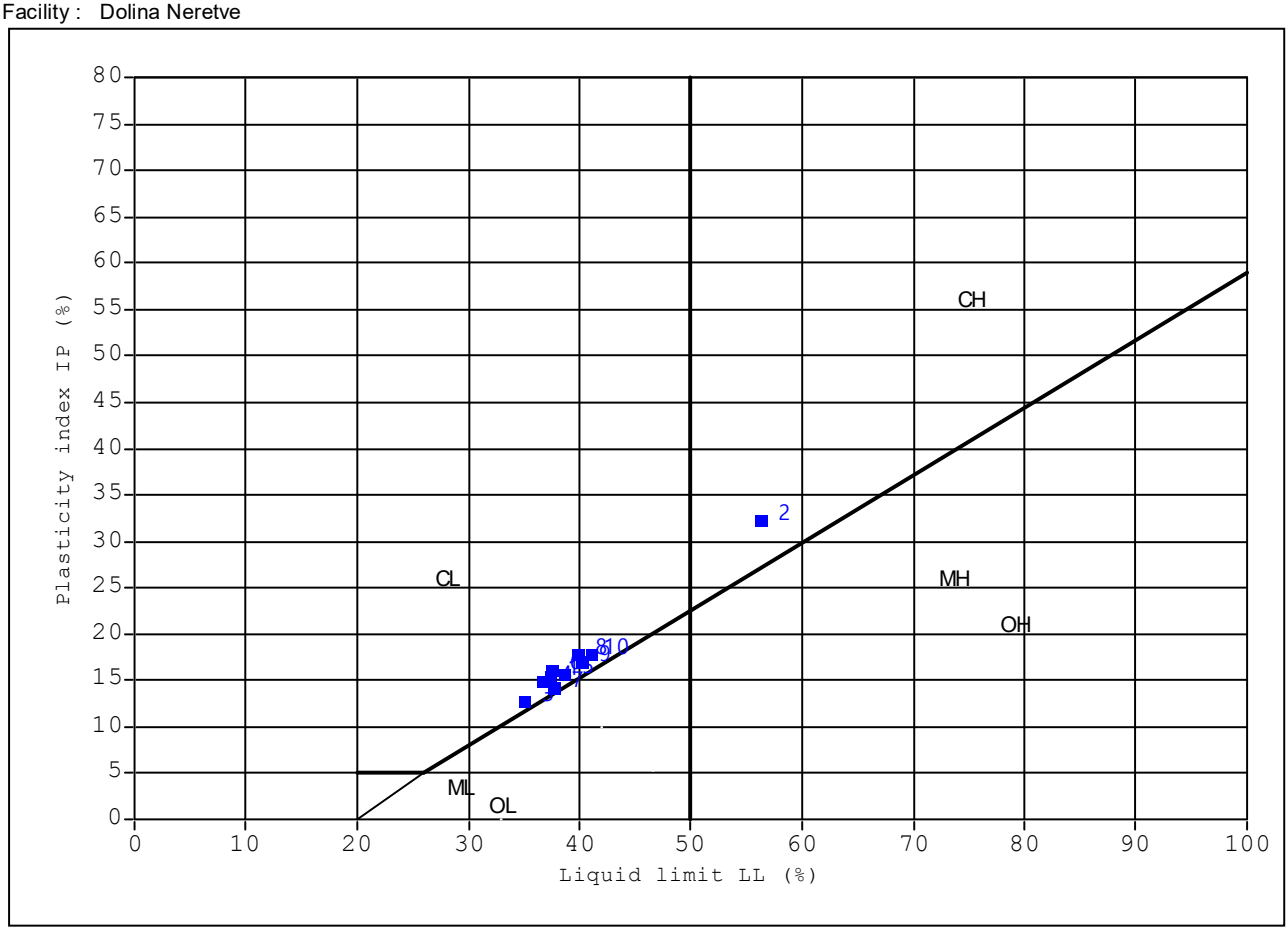
Consistency limits determination (Atterberg limits) according to ASTM D4318-17

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-05-01 v.1.2**

Location: Dolina Neretve

Report date: 16.2.2022.

Facility : Dolina Neretve



Nr.	Borehole ID	Depth (m)	Test ID	Sym-bol	wl (%)	wp (%)	IP (%)	LOS (%)	pv / ps
1	B-1	1,00-1,10	S-104-21-01-01-1-05	CL	37,32	21,78	15,54	0,00	pv
2	B-1	2,00-2,30	S-104-21-01-02-1-05	CH	56,37	24,02	32,34	0,00	pv
3	B-1	3,40-3,50	S-104-21-01-03-1-05	CL	35,06	22,42	12,64	0,00	pv
4	B-1	10,50-10,60	S-104-21-01-07-1-05	CL	36,64	21,79	14,86	0,00	pv
5	B-1	13,30-13,60	S-104-21-01-08-1-05	CL	38,63	22,98	15,65	0,00	pv
6	B-1	15,50-15,80	S-104-21-01-09-2-05	CL	37,56	21,34	16,22	0,00	pv
7	B-1	17,50-17,60	S-104-21-01-10-1-05	CL	37,73	23,59	14,14	0,00	pv
8	B-1	18,50-18,80	S-104-21-01-11-1-05	CL	39,90	22,02	17,88	0,00	pv
9	B-1	20,50-20,80	S-104-21-01-12-1-05	CL	40,20	23,24	16,96	0,00	pv
10	B-1	22,50-22,60	S-104-21-01-13-1-05	CL	41,14	23,28	17,86	0,00	pv

LEGEND:
CH - fat plasticity clay (inorganic) **MH** - fat plasticity silt **CL** - lean plasticity clay (inorganic) **ML** - lean plasticity silt
OH - fat plasticity clay (organic) **SM** - Silty sand **SC** - clayey sand **OL** - lean plasticity clay (organic)
LOS - left on sieve No.40 (0,425 mm) % **pv** - sample prepaired in naturally wet conditions **ps** - sample prepaired in dry conditions
L.L. - liquid limit **P.L.** - plastic limit **PI** - plasticity index

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 16.2.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

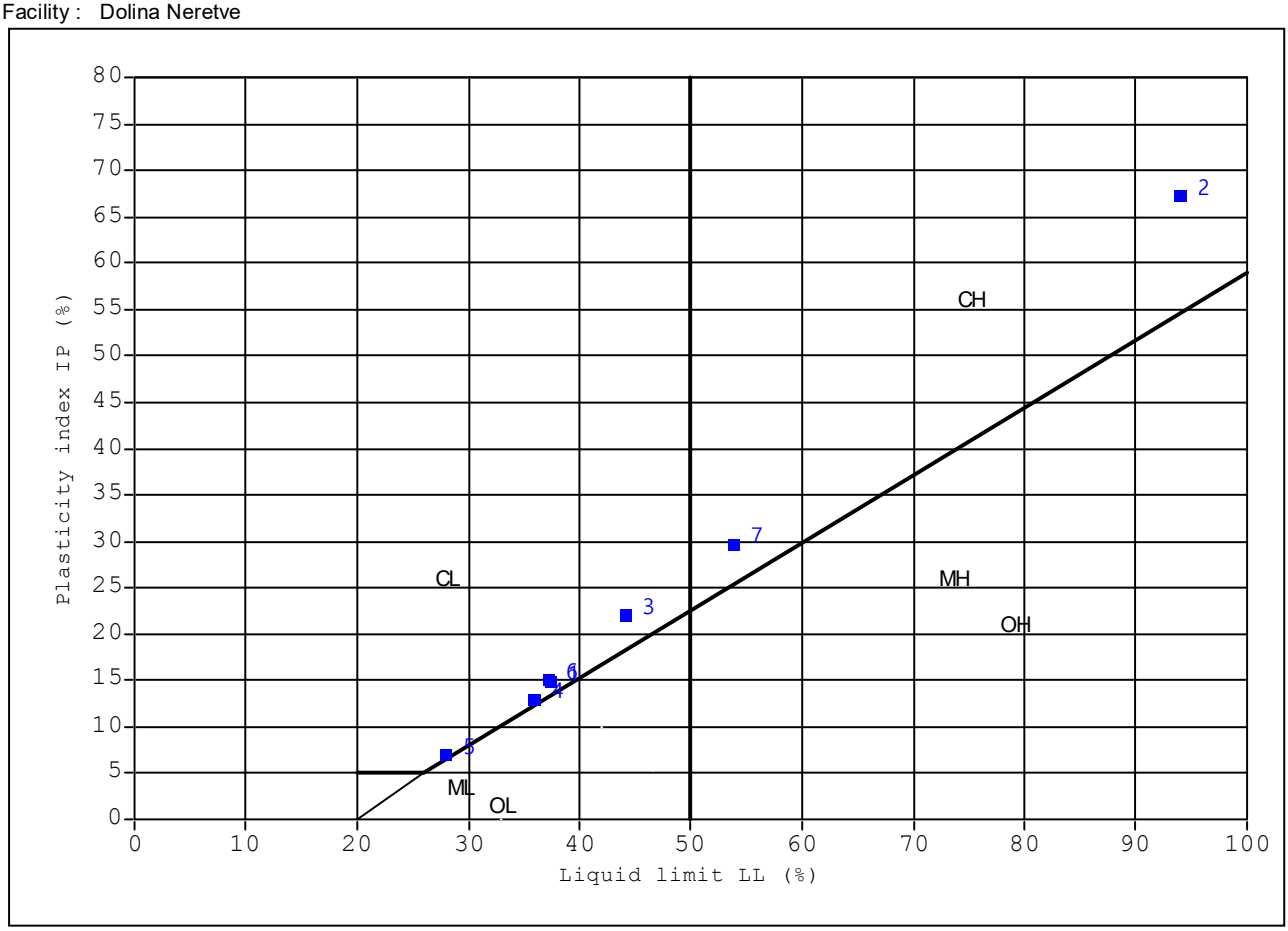
Consistency limits determination (Atterberg limits) according to ASTM D4318-17

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-05-01 v.1.2**

Location: Dolina Neretve

Report date: 16.2.2022.

Facility : Dolina Neretve



Nr.	Borehole ID	Depth (m)	Test ID	Sym-bol	wl (%)	wp (%)	IP (%)	LOS (%)	pv / ps
1	B-1	24,70-25,00	S-104-21-01-14-1-05	CL	37,31	22,49	14,83	0,00	pv
2	B-1	25,50-25,60	S-104-21-01-15-1-05	CH	94,01	26,80	67,20	0,00	pv
3	B-1	26,90-27,00	S-104-21-01-17-1-05	CL	44,00	21,89	22,11	0,00	pv
4	B-1	27,80-27,90	S-104-21-01-18-1-05	CL	35,91	22,95	12,96	0,00	pv
5	B-1	29,40-29,50	S-104-21-01-19-1-05	CL	27,91	20,87	7,04	0,00	pv
6	B-1	31,20-31,30	S-104-21-01-20-1-05	CL	37,20	22,17	15,04	0,00	pv
7	B-1	33,50-33,60	S-104-21-01-22-1-05	CH	53,86	24,19	29,67	0,00	pv

LEGEND:
CH - fat plasticity clay (inorganic) **MH** - fat plasticity silt **CL** - lean plasticity clay (inorganic) **ML** - lean plasticity silt
OH - fat plasticity clay (organic) **SM** - Silty sand **SC** - clayey sand **OL** - lean plasticity clay (organic)
LOS - left on sieve No.40 (0,425 mm) % **pv** - sample prepaired in naturally wet conditions **ps** - sample prepaired in dry conditions
L.L. - liquid limit **P.L.** - plastic limit **PI** - plasticity index

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 16.2.2022.

17025·HAA 1089 TEST

Determination of permeability coefficient using a Flexible Wall Permeamete by ASTM D 5084-97 - metoda: A

Client :
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i geodezije Ul. Matice hrvatske 15 21000, Split

Template id: OL-5.4-09_03 V1.1

Project ID: E-104-21-01
Location: Dolina Neretve
Structure: Dolina Neretve
Borehole ID: S-104-21-01 **Depth:** 2,00-2,30
Test ID: S-104-21-01-02-2-09 **Test date:** 14.2.2022
Test device: Produced by "ELE international" Tri-Flex 2
Sample type: Undisturbed sample **Spec. gravity, rs [g/cm3] =** 2,69
Sample description: gray color

Desc. of correction: n/a

	test condition
height [mm]	50,00
diameter [mm]	70,00
w [%]	37,6
ρ [g/cm^3]	1,81
ρ_d [g/cm^3]	1,31
e []	1,05
S_r [%]	96,41

σr [kPa]	u [kPa]	Δu [kPa]	e []	k [cm/s]
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
300,0	200	30	1,030	6,3E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
400,0	200	30	1,084	4,6E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
500,0	200	30	1,081	2,5E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Test report prepared by: Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 16.3.2022.

Determination of permeability coefficient using a Flexible Wall Permeamete by ASTM D 5084-97 - metoda: A

Client :
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i geodezije Ul. Matice hrvatske 15 21000, Split

Template id: OL-5.4-09_03 V1.1

Project ID: E-104-21-01
Location: Dolina Neretve
Structure: Dolina Neretve
Borehole ID: S-104-21-01 **Depth:** 13,30-13,60
Test ID: S-104-21-01-08-2-09 **Test date:** 14.4.2022
Test device: Produced by "ELE international" Tri-Flex 2
Sample type: Undisturbed sample **Spec. gravity, rs [g/cm3] =** 2,67
Sample description: gray color

Desc. of correction: n/a

	test condition
height [mm]	50,00
diameter [mm]	70,00
w [%]	34,4
ρ [g/cm^3]	1,84
ρ_d [g/cm^3]	1,37
e []	0,95
S_r [%]	96,82

σr [kPa]	u [kPa]	Δu [kPa]	e []	k [cm/s]
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
300,0	200	30	0,964	8,7E-08
400,0	200	30	0,900	5,9E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
500,0	200	30	0,930	3,9E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Test report prepared by: Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 25.4.2022.

Determination of permeability coefficient using a Flexible Wall Permeamete by ASTM D 5084-97 - metoda: A

Client :
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i geodezije Ul. Matice hrvatske 15 21000, Split

Template id: OL-5.4-09_03 V1.1

Project ID: E-104-21-01
Location: Dolina Neretve
Structure: Dolina Neretve
Borehole ID: S-104-21-01 **Depth:** 18,50-18,80
Test ID: S-104-21-01-11-2-09 **Test date:** 14.2.2022
Test device: Produced by "ELE international" Tri-Flex 2
Sample type: Undisturbed sample **Spec. gravity, rs [g/cm3] =** 2,67
Sample description: gray color

Desc. of correction: n/a

	test condition
height [mm]	50,00
diameter [mm]	70,00
w [%]	38,8
ρ [g/cm^3]	1,81
ρ_d [g/cm^3]	1,30
e []	1,05
S_r [%]	98,44

σr [kPa]	u [kPa]	Δu [kPa]	e []	k [cm/s]
0	-	-	-	-
-	-	-	-	-
300,0	200	30	1,023	6,9E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
400,0	200	30	1,033	4,0E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
500,0	200	30	1,029	3,6E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Test report prepared by: Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 16.3.2022.

Determination of permeability coefficient using a Flexible Wall Permeamete by ASTM D 5084-97 - metoda: A

Client :
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i geodezije Ul. Matice hrvatske 15
21000, Split

Template id: OL-5.4-09_03 V1.1

Project ID: E-104-21-01
Location: Dolina Neretve
Structure: Dolina Neretve
Borehole ID: S-104-21-01 **Depth:** 24,70-25,00
Test ID: S-104-21-01-14-2-09 **Test date:** 14.2.2022
Test device: Produced by "ELE international" Tri-Flex 2
Sample type: Undisturbed sample **Spec. gravity, rs [g/cm3] =** 2,74
Sample description: gray color

Desc. of correction: n/a

	test condition
height [mm]	50,00
diameter [mm]	70,00
w [%]	35,9
ρ [g/cm^3]	1,81
ρ_d [g/cm^3]	1,33
e []	1,06
S_r [%]	92,58

σr [kPa]	u [kPa]	Δu [kPa]	e []	k [cm/s]
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
300,0	200	30	1,050	2,5E-07
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
400,0	200	30	1,059	1,2E-07
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
500,0	200	30	0,947	3,6E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Test report prepared by: Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 16.3.2022.

LABORATORY
GEOKON
Storotrnjanska 16c / 10 000 Zagreb, Hrvatska

Standard Test Methods for determination of Combustible and Organic matter content according to HRN U.B1 024

Sveučilište u Splitu, Fakultet građevinarstva, arhitekture
Ul. Matice hrvatske 15
21000, Split

Template OL-5.4-11-01 v.1.3

Project ID:	S-104-21-01		Location:	Dolina Neretve	Structure:	Dolina Neretve	
Borehole ID:	**S-104-21-01**						
Test ID::	S-104-21-01-07-1-11	Depth:	10,50-10,60	Test date:	14.02.2022.	Test Method:	HRN U.B1 024 (1968)
Method of testing:	Combustible		Method of testing:	Hydrogen peroxide	The average value of the content of organic matter [%] (based on two test)		**5,96**
Test ID:	S-104-21-01-07-1-11		Test ID:	S-104-21-01-07-2-11	Test ID:		S-104-21-01-07-3-11
Test date:	16.02.2022.		Test date:	16.02.2022.	Test date:		16.02.2022.
Combustible matter content O_g, [%]	**10,79**		Organic matter content, O_o, [%]	5,76	Organic matter content, O_o, [%]		6,16
Remarks:			Remarks:				

Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 22.02.2022

17025 · HAA
1089
TEST

LABORATORY GEOKON
Storotrnjanska 16c / 10 000 Zagreb, Hrvatska

Standard Test Methods for determination of Combustible and Organic matter content according to HRN U.B1 024

Sveučilište u Splitu, Fakultet građevinarstva, arhitekture
Ul. Matice hrvatske 15
21000, Split

Template OL-5.4-11-01 v.1.3

Project ID:	S-104-21-01		Location:	Dolina Neretve	Structure:	Dolina Neretve	
Borehole ID:	**S-104-21-01**						
Test ID::	S-104-21-01-08-1-11	Depth:	13,30-13,60	Test date:	14.02.2022.	Test Method:	HRN U.B1 024 (1968)
Method of testing:	Combustible		Method of testing:	Hydrogen peroxide	The average value of the content of organic matter [%] (based on two test)		**6,23**
Test ID:	S-104-21-01-08-1-11		Test ID:	S-104-21-01-08-2-11	Test ID:		S-104-21-01-08-3-11
Test date:	16.02.2022.		Test date:	16.02.2022.	Test date:		16.02.2022.
Combustible matter content O_g, [%]	**15,17**		Organic matter content, O_o, [%]	5,97	Organic matter content, O_o, [%]		6,49
Remarks:			Remarks:				

Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 22.02.2022

17025 · HAA
1089
TEST

LABORATORY
GEOKON
Storotrnjanska 16c / 10 000 Zagreb, Hrvatska

Standard Test Methods for determination of Combustible and Organic matter content according to HRN U.B1 024

Sveučilište u Splitu, Fakultet građevinarstva, arhitekture
Ul. Matice hrvatske 15
21000, Split

Template OL-5.4-11-01 v.1.3

Project ID:	S-104-21-01		Location:	Dolina Neretve	Structure:	Dolina Neretve	
Borehole ID:	**S-104-21-01**						
Test ID::	S-104-21-01-15-1-11	Depth:	25,50-25,60	Test date:	14.02.2022.	Test Method:	HRN U.B1 024 (1968)

Method of testing:	Combustible	Method of testing:	Hydrogen peroxide	The average value of the content of organic matter [%] (based on two test)	**15,47**
Test ID:	S-104-21-01-15-1-11	Test ID:	S-104-21-01-15-2-11	Test ID:	S-104-21-01-15-3-11
Test date:	16.02.2022.	Test date:	16.02.2022.	Test date:	16.02.2022.
Combustible matter content O_g, [%]	**17,85**	Organic matter content, O_o, [%]	15,25	Organic matter content, O_o, [%]	15,68
Remarks:		Remarks:			

Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 22.02.2022

17025 · HAA
1089
TEST

LABORATORY GEOKON
Storotrnjanska 16c / 10 000 Zagreb, Hrvatska

Standard Test Methods for determination of Combustible and Organic matter content according to HRN U.B1 024

Sveučilište u Splitu, Fakultet građevinarstva, arhitekture
Ul. Matice hrvatske 15
21000, Split

Template OL-5.4-11-01 v.1.3

Project ID:	S-104-21-01		Location:	Dolina Neretve	Structure:	Dolina Neretve	
Borehole ID:	**S-104-21-01**						
Test ID::	S-104-21-01-17-1-11	Depth:	26,90-27,00	Test date:	14.02.2022.	Test Method:	HRN U.B1 024 (1968)
Method of testing:	Combustible		Method of testing:	Hydrogen peroxide	The average value of the content of organic matter [%] (based on two test)		**11,27**
Test ID:	S-104-21-01-17-1-11		Test ID:	S-104-21-01-17-2-11	Test ID:		S-104-21-01-17-3-11
Test date:	16.02.2022.		Test date:	16.02.2022.	Test date:		16.02.2022.
Combustible matter content O_g, [%]	**17,57**		Organic matter content, O_o, [%]	11,42	Organic matter content, O_o, [%]		11,12
Remarks:			Remarks:				

Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 22.02.2022

17025 · HAA
1089
TEST

Test report for the borehole S-104-21-02 (B-2)

Kind of test	Name of the test report	Number of pages
01	Test report of water content determination – S-104-21-02	2
02	Test report of specific gravity – S-104-21-02	3
03	Test report of bulk density determination – S-104-21-02	1
04	Test report of particle size analysis of solis – S-104-21-02	12
05	Test report of consistency limits determination (Atterberg limits) – S-104-21-02	2
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-02-08 / 17,60-17,90	1
09	Test report of determination of permealibity coefficient in the triaxial cell (ASTM) – S-104-21-02-08 / 17,60-17,90	1
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-02-10 / 20,40-20,80	1
09	Test report of determination of permealibity coefficient in the triaxial cell (ASTM) – S-104-21-02-10 / 20,40-20,80	1
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-02-12 / 23,50-23,90	1
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-02-12 / 23,50-23,90	1
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-02-27 / 54,70-55,00	1
09	Test report of determination of permealibity coefficient in the triaxial cell (ASTM) – S-104-21-02-27 / 54,70-55,00	1
11	Test report of determination of combustible and organic matter content – S-104-21-02-06 / 13,50-13,60	1
11	Test report of determination of combustible and organic matter content – S-104-21-02-07 / 15,50-15,60	1
11	Test report of determination of combustible and organic matter content – S-104-21-02-08 / 17,60-17,90	1
11	Test report of determination of combustible and organic matter content – S-104-21-02-10 / 20,40-20,80	1
11	Test report of determination of combustible and organic matter content – S-104-21-02-16 / 30,70-30,80	1

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Water content determination

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-01-01 v.1.3**

Project: 104-21
Location: Dolina Neretve

Facility: Dolina Neretve

Borehole ID: S-104-21-02 (B-2)

Test ID: **S-104-21-02-03-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 6,70-6,80 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 55,29 Wet mass (g): 196,32 Dry mass (g): 146,98 **Water content (%): 53,81**
Remark:

Test ID: **S-104-21-02-06-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 13,50-13,60 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 56,08 Wet mass (g): 190,29 Dry mass (g): 156,11 **Water content (%): 34,17**
Remark:

Test ID: **S-104-21-02-07-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 15,50-15,60 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 54,75 Wet mass (g): 202,18 Dry mass (g): 164,64 **Water content (%): 34,16**
Remark:

Test ID: **S-104-21-02-08-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 17,60-17,90 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 55,93 Wet mass (g): 171,64 Dry mass (g): 138,69 **Water content (%): 39,81**
Remark:

Test ID: **S-104-21-02-09-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 18,50-18,60 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 56,05 Wet mass (g): 199,92 Dry mass (g): 160,82 **Water content (%): 37,32**
Remark:

Test ID: **S-104-21-02-10-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 20,40-20,80 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 62,45 Wet mass (g): 206,70 Dry mass (g): 166,04 **Water content (%): 39,25**
Remark:

Test ID: **S-104-21-02-11-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 22,00-22,10 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 60,98 Wet mass (g): 198,19 Dry mass (g): 160,36 **Water content (%): 38,07**
Remark:

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Water content determination

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-01-01 v.1.3**

Project: 104-21
Location: Dolina Neretve

Test ID: **S-104-21-02-12-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 23,50-23,90 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 62,11 Wet mass (g): 178,41 Dry mass (g): 145,57 **Water content (%): 39,35**
Remark:

Test ID: **S-104-21-02-13-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 24,50-24,60 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 61,81 Wet mass (g): 189,15 Dry mass (g): 151,57 **Water content (%): 41,87**
Remark:

Test ID: **S-104-21-02-16-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 30,70-30,80 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 56,09 Wet mass (g): 173,85 Dry mass (g): 132,33 **Water content (%): 54,46**
Remark:

Test ID: **S-104-21-02-17-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 31,20-31,30 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 34,60 Wet mass (g): 174,38 Dry mass (g): 144,96 **Water content (%): 26,66**
Remark:

Test ID: **S-104-21-02-18-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 31,90-32,00 Starting test date: 18.2.2022. Test date: 21.2.2022.
Tare weight (g): 62,19 Wet mass (g): 203,71 Dry mass (g): 183,26 **Water content (%): 16,89**
Remark:

Test ID: **S-104-21-02-27-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 54,70-55,00 Starting test date: 1.3.2022. Test date: 2.3.2022.
Tare weight (g): 55,32 Wet mass (g): 250,66 Dry mass (g): 205,54 **Water content (%): 30,04**
Remark:

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.
Test report date: 7.3.2022.

17025 · HAA
1089
TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Specific gravity

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-02-01 v.1.3**

Subject: 104-21
Facility: Dolina Neretve

Structuret: Dolina Neretve

Borehole ID: S-104-21-02 (B-2)

Test ID: **S-104-21-02-02-1-02** Standard: ASTM D 854-14
Depth (m): 4,20-4,30 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,75**
Remarks:

Test ID: **S-104-21-02-03-1-02** Standard: ASTM D 854-14
Depth (m): 6,70-6,80 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,74**
Remarks:

Test ID: **S-104-21-02-04-1-02** Standard: ASTM D 854-14
Depth (m): 8,50-8,60 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,76**
Remarks:

Test ID: **S-104-21-02-05-1-02** Standard: ASTM D 854-14
Depth (m): 11,50-11,60 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,72**
Remarks:

Test ID: **S-104-21-02-06-1-02** Standard: ASTM D 854-14
Depth (m): 13,50-13,60 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,68**
Remarks:

Test ID: **S-104-21-02-07-1-02** Standard: ASTM D 854-14
Depth (m): 15,50-15,60 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,71**
Remarks:

Test ID: **S-104-21-02-08-1-02** Standard: ASTM D 854-14
Depth (m): 17,60-17,90 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,72**
Remarks:

Test ID: **S-104-21-02-09-1-02** Standard: ASTM D 854-14
Depth (m): 18,50-18,60 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,69**
Remarks:

Specific gravity

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-02-01 v.1.3**

Subject: 104-21
Facility: Dolina Neretve

Test ID: **S-104-21-02-10-1-02** Standard: ASTM D 854-14
Depth (m): 20,40-20,80 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,70**
Remarks:

Test ID: **S-104-21-02-11-1-02** Standard: ASTM D 854-14
Depth (m): 22,00-22,10 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,69**
Remarks:

Test ID: **S-104-21-02-12-1-02** Standard: ASTM D 854-14
Depth (m): 23,50-23,90 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,68**
Remarks:

Test ID: **S-104-21-02-13-1-02** Standard: ASTM D 854-14
Depth (m): 24,50-24,60 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,70**
Remarks:

Test ID: **S-104-21-02-14-1-02** Standard: ASTM D 854-14
Depth (m): 27,50-27,60 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,76**
Remarks:

Test ID: **S-104-21-02-15-1-02** Standard: ASTM D 854-14
Depth (m): 29,50-29,60 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,68**
Remarks:

Test ID: **S-104-21-02-16-1-02** Standard: ASTM D 854-14
Depth (m): 30,70-30,80 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,57**
Remarks:

Test ID: **S-104-21-02-17-1-02** Standard: ASTM D 854-14
Depth (m): 31,20-31,30 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,69**
Remarks:

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Specific gravity

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-02-01 v.1.3**

Subject: 104-21
Facility: Dolina Neretve

Test ID: **S-104-21-02-18-1-02** Standard: ASTM D 854-14
Depth (m): 31,90-32,00 Starting test date: 21.2.2022. Test date: 24.2.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,78**
Remarks:

Test ID: **S-104-21-02-27-1-02** Standard: ASTM D 854-14
Depth (m): 54,70-55,00 Starting test date: 2.3.2022. Test date: 2.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,67**
Remarks:

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.
Print date: 7.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

BULK DENSITY DETERMINATION

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-03-01 v.1.3**

Subject: 104-21
Location: Dolina Neretve

Facility: Dolina Neretve

Borehole ID: S-104-21-02 (B-2)

Test ID: **S-104-21-02-08-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 17,60-17,90 Starting test date: 21.2.2022. Test date: 23.3.2022.
Moist density (g/cm^3): 1,86 **Dry density (g/cm^3): 1,37**
Remark:

Test ID: **S-104-21-02-10-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 20,40-20,80 Starting test date: 21.2.2022. Test date: 23.3.2022.
Moist density (g/cm^3): 1,88 **Dry density (g/cm^3): 1,40**
Remark:

Test ID: **S-104-21-02-12-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 23,50-23,90 Starting test date: 21.2.2022. Test date: 23.3.2022.
Moist density (g/cm^3): 1,85 **Dry density (g/cm^3): 1,42**
Remark:

Test ID: **S-104-21-02-27-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 54,70-55,00 Starting test date: 1.3.2022. Test date: 23.3.2022.
Moist density (g/cm^3): 1,91 **Dry density (g/cm^3): 1,46**
Remark:

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.
Print date: 23.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

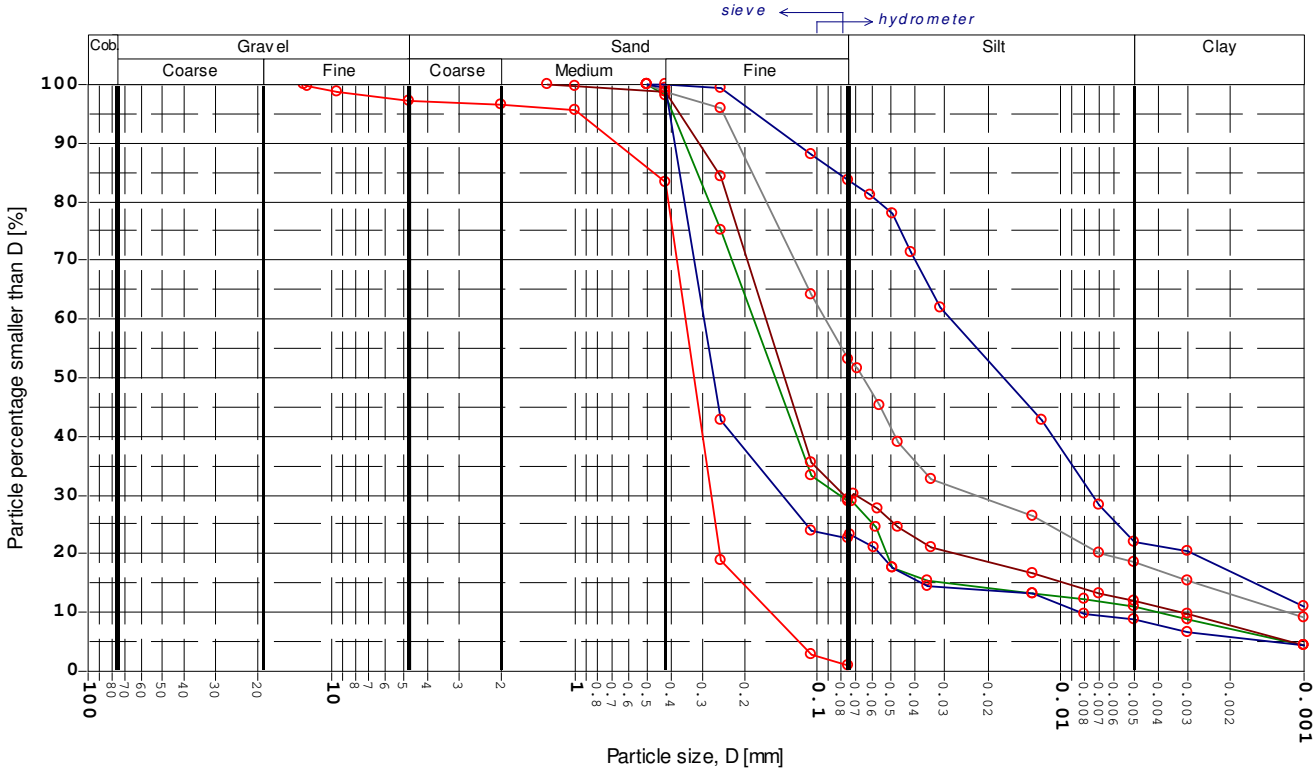
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 22.2.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-01-1-04 S-104-21-02-02-1-04 S-104-21-02-03-1-04
S-104-21-02-04-1-04 S-104-21-02-05-1-04 S-104-21-02-06-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-01-1-04	0,351	0,274	0,155	2,262	1,377	3,6	95,4	M(%) + C(%)= 1,0	
S-104-21-02-02-1-04	0,183	0,082	0,004	46,073	9,127	n/a	71,0	18,0	11,0
S-104-21-02-03-1-04	0,093	0,022	0,001	80,056	4,585	n/a	46,9	34,5	18,6
S-104-21-02-04-1-04	0,163	0,071	0,003	52,696	10,028	n/a	70,8	17,1	12,1
S-104-21-02-05-1-04	0,294	0,140	0,008	36,024	8,148	n/a	77,3	14,0	8,7
S-104-21-02-06-1-04	0,028	0,007	-	-	-	n/a	16,5	61,5	22,0

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-2	1,00-1,10	S-104-21-02-01-1-04	13,0	sharp	hard & solid	2,80		0
B-2	4,20-4,30	S-104-21-02-02-1-04	0,5	sharp	hard & solid	2,75	mixer	10
B-2	6,70-6,80	S-104-21-02-03-1-04	0,5	n/a	soft	2,74	mixer	10
B-2	8,50-8,60	S-104-21-02-04-1-04	1,3	sharp	hard & solid	2,76	mixer	10
B-2	11,50-11,60	S-104-21-02-05-1-04	0,5	sharp	hard & solid	2,76	mixer	10
B-2	13,50-13,60	S-104-21-02-06-1-04	0,5	sharp	hard & solid	2,68	mixer	10

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

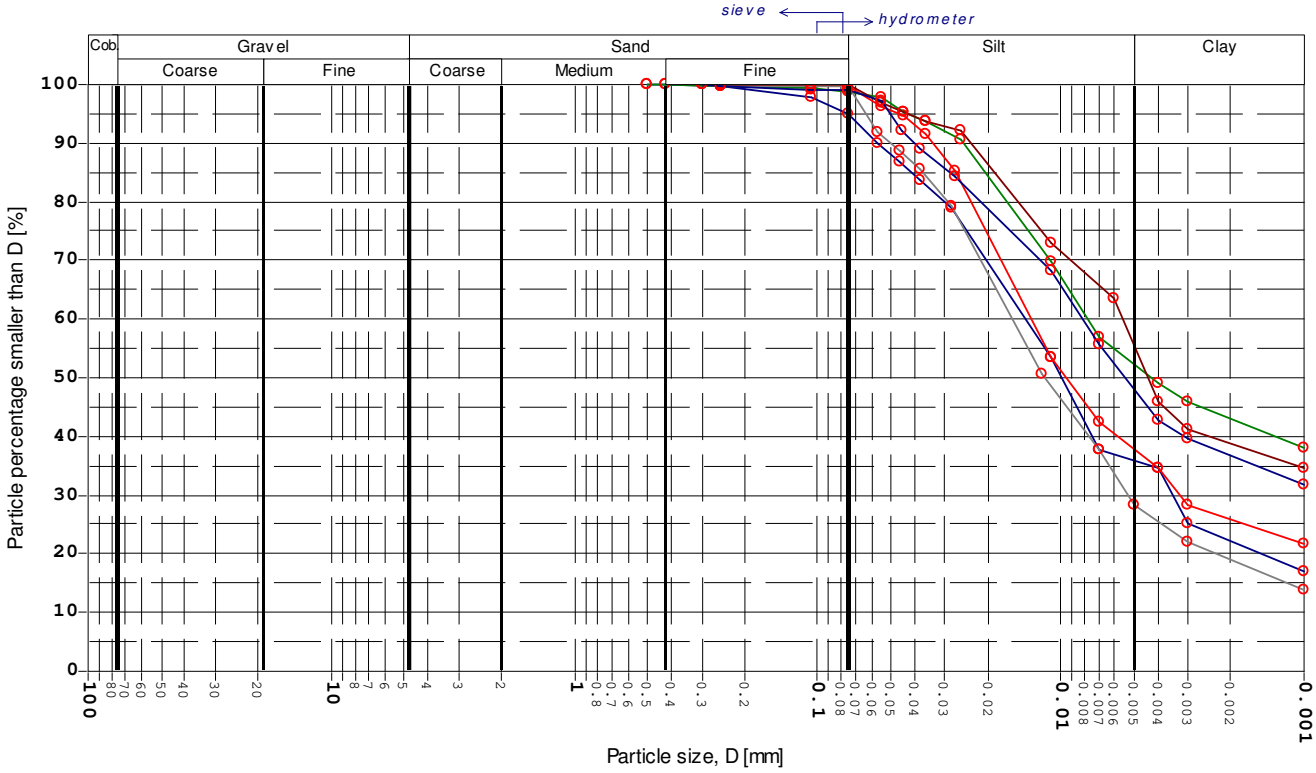
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 24.2.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-07-1-04 S-104-21-02-08-1-04 S-104-21-02-09-1-04
S-104-21-02-10-1-04 S-104-21-02-11-1-04 S-104-21-02-12-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-07-1-04	0,014	0,003	-	-	-	n/a	5,1	59,3	35,6
S-104-21-02-08-1-04	0,013	0,003	-	-	-	n/a	0,3	62,6	37,1
S-104-21-02-09-1-04	0,008	-	-	-	-	n/a	1,2	47,1	51,7
S-104-21-02-10-1-04	0,016	0,005	-	-	-	n/a	0,3	71,4	28,3
S-104-21-02-11-1-04	0,006	-	-	-	-	n/a	0,1	45,2	54,7
S-104-21-02-12-1-04	0,008	-	-	-	-	n/a	1,1	51,9	47,0

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-2	15,50-15,60	S-104-21-02-07-1-04	0,5	sharp	hard & solid	2,71	mixer	10
B-2	17,60-17,90	S-104-21-02-08-1-04	0,3	sharp	hard & solid	2,72	mixer	10
B-2	18,50-18,60	S-104-21-02-09-1-04	0,5	sharp	hard & solid	2,69	mixer	10
B-2	20,40-20,80	S-104-21-02-10-1-04	0,3	sharp	hard & solid	2,70	mixer	10
B-2	22,00-22,10	S-104-21-02-11-1-04	0,3	sharp	hard & solid	2,69	mixer	10
B-2	23,50-23,90	S-104-21-02-12-1-04	0,3	sharp	hard & solid	2,68	mixer	10

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA
1089
TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

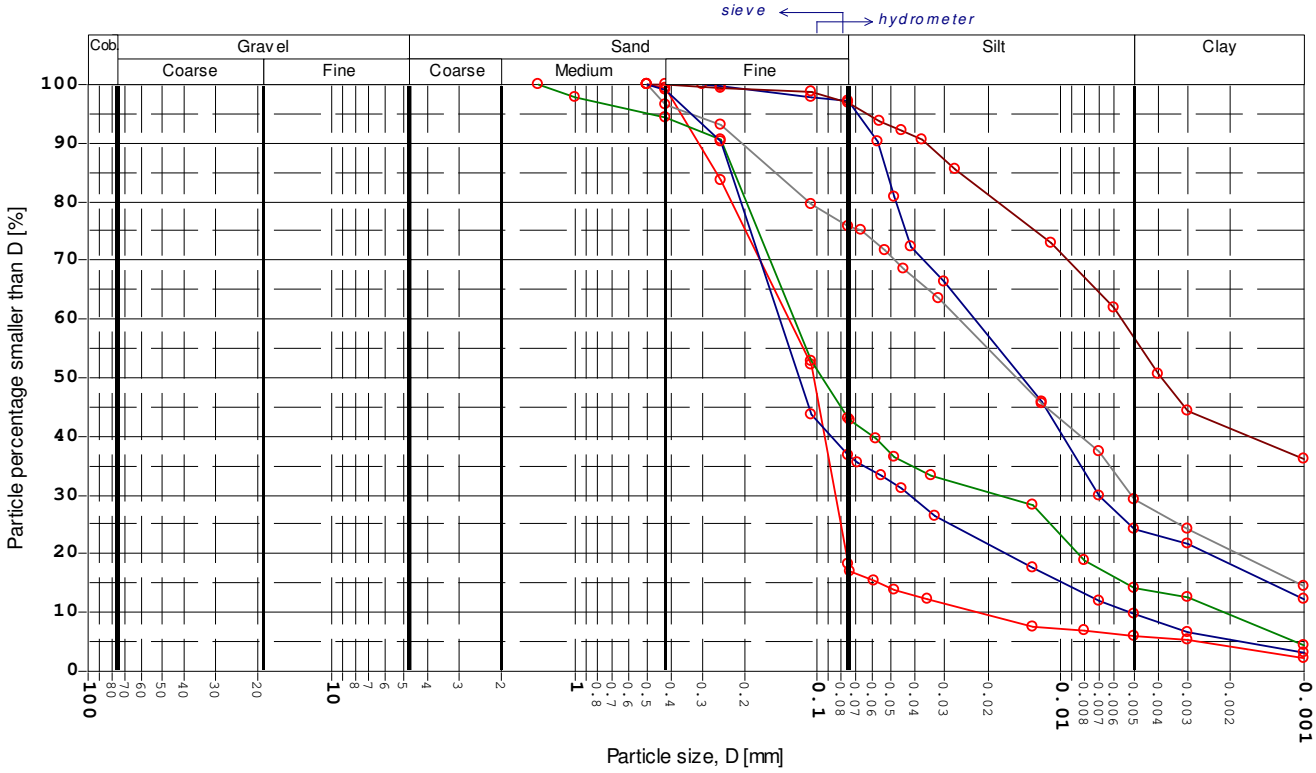
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 24.2.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-13-1-04 S-104-21-02-14-1-04 S-104-21-02-15-1-04
S-104-21-02-16-1-04 S-104-21-02-17-1-04 S-104-21-02-18-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-13-1-04	0,023	0,007	-	-	-	n/a	2,8	73,0	24,2
S-104-21-02-14-1-04	0,131	0,085	0,021	6,187	2,586	n/a	81,9	12,0	6,1
S-104-21-02-15-1-04	0,125	0,018	0,002	58,274	1,196	n/a	56,9	29,1	14,0
S-104-21-02-16-1-04	0,026	0,005	-	-	-	n/a	24,1	46,7	29,2
S-104-21-02-17-1-04	0,006	-	-	-	-	n/a	3,0	40,8	56,2
S-104-21-02-18-1-04	0,143	0,042	0,005	27,877	2,386	n/a	63,1	27,1	9,8

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-2	24,50-24,60	S-104-21-02-13-1-04	0,3	sharp	hard & solid	2,70	mixer	10
B-2	27,50-27,60	S-104-21-02-14-1-04	0,5	sharp	hard & solid	2,76	mixer	10
B-2	29,50-29,60	S-104-21-02-15-1-04	1,4	sharp	hard & solid	2,68	mixer	10
B-2	30,70-30,80	S-104-21-02-16-1-04	0,5	sharp	hard & solid	2,57	mixer	10
B-2	31,20-31,30	S-104-21-02-17-1-04	0,5	sharp	hard & solid	2,69	mixer	10
B-2	31,90-32,00	S-104-21-02-18-1-04	0,5	sharp	hard & solid	2,78	mixer	10

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

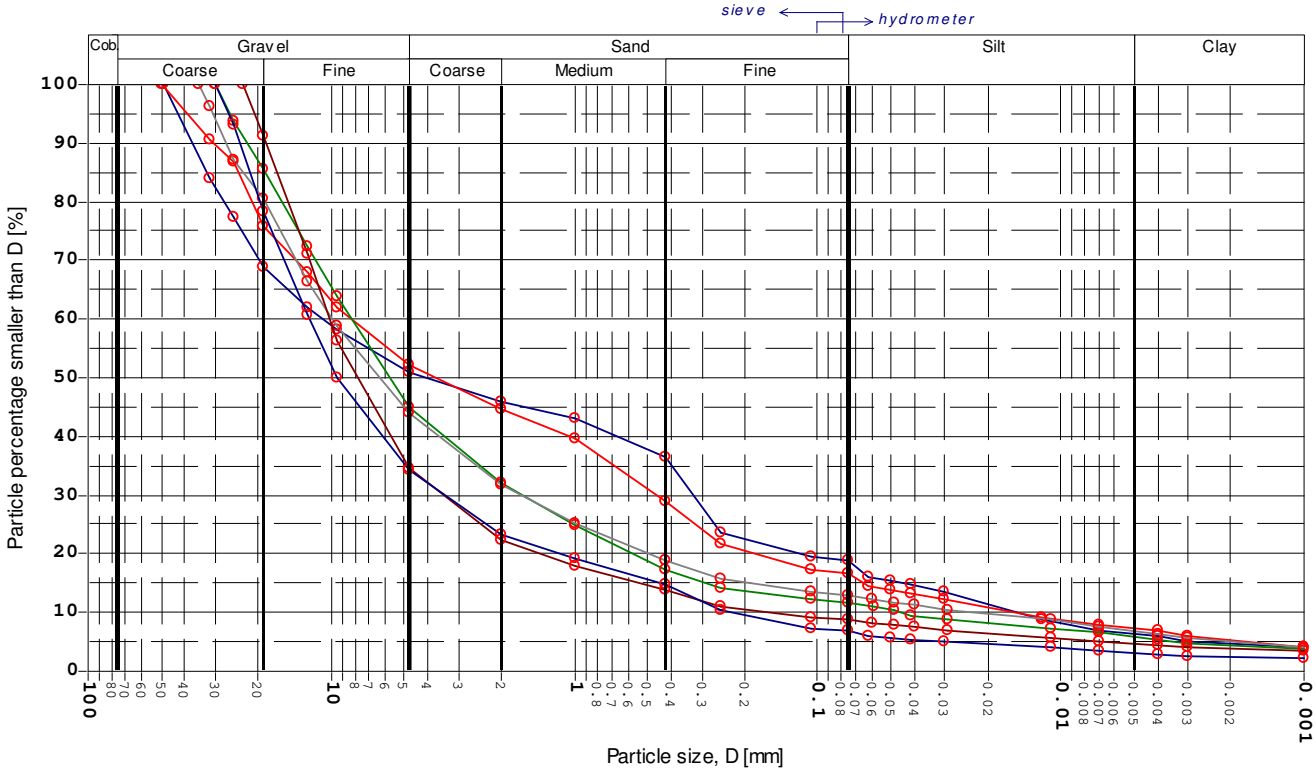
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 23.2.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-19-1-04 S-104-21-02-20-1-04 S-104-21-02-21-1-04
S-104-21-02-22-1-04 S-104-21-02-23-1-04 S-104-21-02-24-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-19-1-04	10,814	0,326	0,015	715,930	0,651	48,9	32,1	12,8	6,2
S-104-21-02-20-1-04	8,270	0,464	0,016	528,819	1,666	47,7	35,6	9,6	7,1
S-104-21-02-21-1-04	8,263	1,649	0,044	187,299	7,459	54,9	33,6	5,8	5,7
S-104-21-02-22-1-04	9,912	1,682	0,022	453,699	13,061	56,0	31,1	6,1	6,8
S-104-21-02-23-1-04	10,198	3,462	0,157	64,995	7,491	65,5	25,6	4,2	4,7
S-104-21-02-24-1-04	12,294	3,408	0,232	53,057	4,076	65,7	27,4	3,8	3,1

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-2	33,00-33,10	S-104-21-02-19-1-04	49,0	sharp	hard & solid	2,80		0
B-2	36,00-36,10	S-104-21-02-20-1-04	50,0	sharp	hard & solid	2,80		0
B-2	39,00-39,10	S-104-21-02-21-1-04	30,0	rounded	hard & solid	2,80		0
B-2	42,00-42,10	S-104-21-02-22-1-04	35,0	rounded	hard & solid	2,80		0
congl. removed from test sample	43,90-44,00	S-104-21-02-23-1-04	23,0	sharp	hard & solid	2,80		0
congl. removed from test sample	46,90-47,00	S-104-21-02-24-1-04	30,0	rounded	hard & solid	2,80		0

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

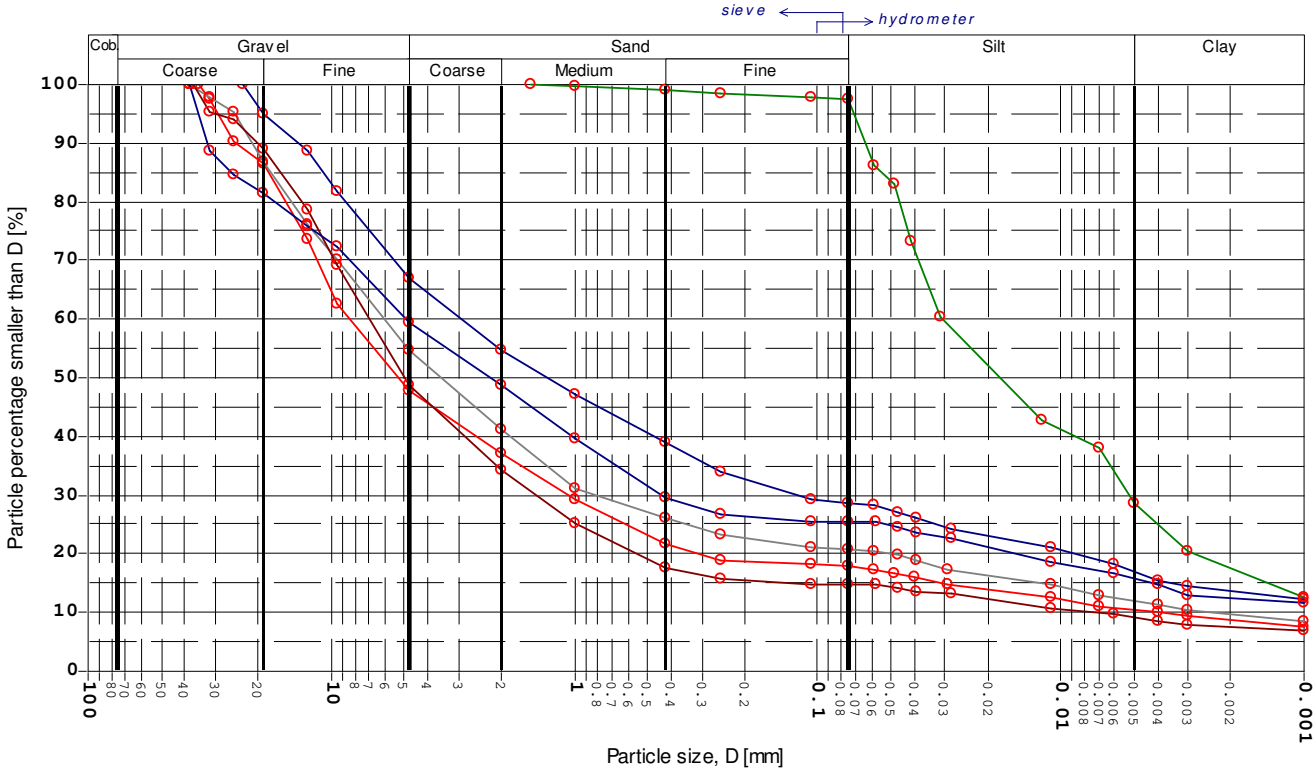
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 17.3.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-25-1-04 S-104-21-02-26-1-04 S-104-21-02-27-1-04
S-104-21-02-28-1-04 S-104-21-02-29-1-04 S-104-21-02-30-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-25-1-04	2,916	0,124	-	-	-	33,0	38,5	11,7	16,8
S-104-21-02-26-1-04	8,444	1,080	0,004	2184,241	35,721	52,2	29,8	7,6	10,4
S-104-21-02-27-1-04	0,030	0,005	-	-	-	n/a	2,6	68,9	28,5
S-104-21-02-28-1-04	5,993	0,836	0,002	2522,443	49,036	45,1	34,1	9,0	11,8
S-104-21-02-29-1-04	6,959	1,437	0,007	974,861	41,543	51,3	34,0	5,6	9,1
S-104-21-02-30-1-04	4,885	0,437	-	-	-	40,5	34,1	9,7	15,7

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
congl. removed from test sample	49,90-50,00	S-104-21-02-25-1-04	23,0	rounded	hard & solid	2,80		0
congl. removed from test sample	52,90-53,00	S-104-21-02-26-1-04	35,0	rounded	hard & solid	2,80		0
B-2	54,70-55,00	S-104-21-02-27-1-04	1,5	sharp	hard & solid	2,67	mixer	10
B-2	57,00-57,10	S-104-21-02-28-1-04	38,0	rounded	hard & solid	2,80		0
congl. removed from test sample	60,00-60,10	S-104-21-02-29-1-04	37,0	sharp	hard & solid	2,80		0
congl. removed from test sample	63,00-63,10	S-104-21-02-30-1-04	38,0	sharp	hard & solid	2,80		0

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA
1089
TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

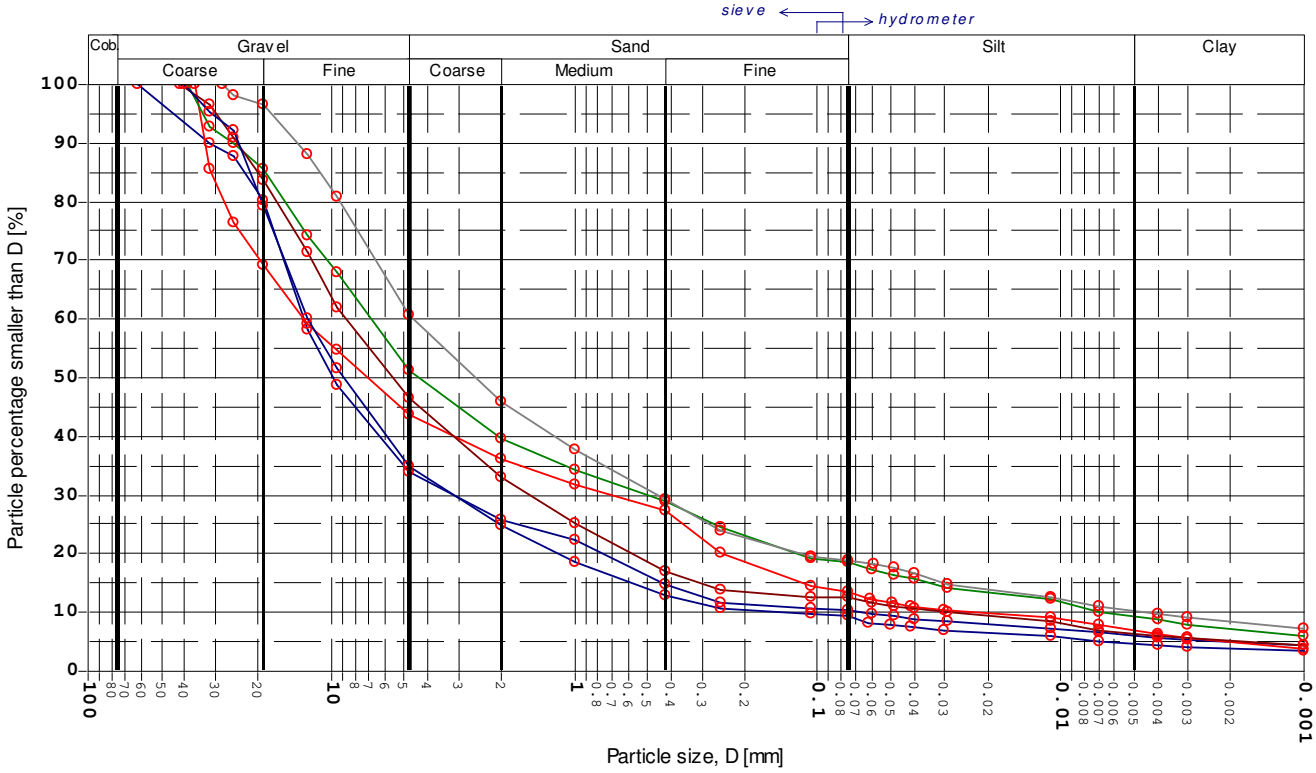
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 17.3.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-31-1-04 S-104-21-02-32-1-04 S-104-21-02-33-1-04
S-104-21-02-34-1-04 S-104-21-02-35-1-04 S-104-21-02-36-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-31-1-04	12,930	3,097	0,065	199,103	11,423	66,1	23,5	4,5	5,9
S-104-21-02-32-1-04	12,995	0,717	0,024	544,598	1,659	56,2	30,1	6,8	6,9
S-104-21-02-33-1-04	6,838	0,500	0,007	970,347	5,182	48,6	32,9	9,2	9,3
S-104-21-02-34-1-04	4,534	0,455	0,004	1016,630	10,248	39,2	42,0	8,6	10,2
S-104-21-02-35-1-04	8,699	1,523	0,030	288,281	8,840	53,6	34,0	6,1	6,3
S-104-21-02-36-1-04	12,523	3,112	0,146	85,889	5,303	64,9	25,5	4,9	4,7

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
congl. removed from test sample	66,00-66,10	S-104-21-02-31-1-04	62,0	sharp	hard & solid	2,80		0
B-2	34,90-35,00	S-104-21-02-32-1-04	36,0	rounded	hard & solid	2,80		0
B-2	37,90-38,00	S-104-21-02-33-1-04	39,0	rounded	hard & solid	2,80		0
B-2	40,00-40,10	S-104-21-02-34-1-04	28,0	rounded	hard & solid	2,80		0
B-2	41,50-41,60	S-104-21-02-35-1-04	42,0	rounded	hard & solid	2,80		0
B-2	43,00-43,10	S-104-21-02-36-1-04	40,0	rounded	hard & solid	2,80		0

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

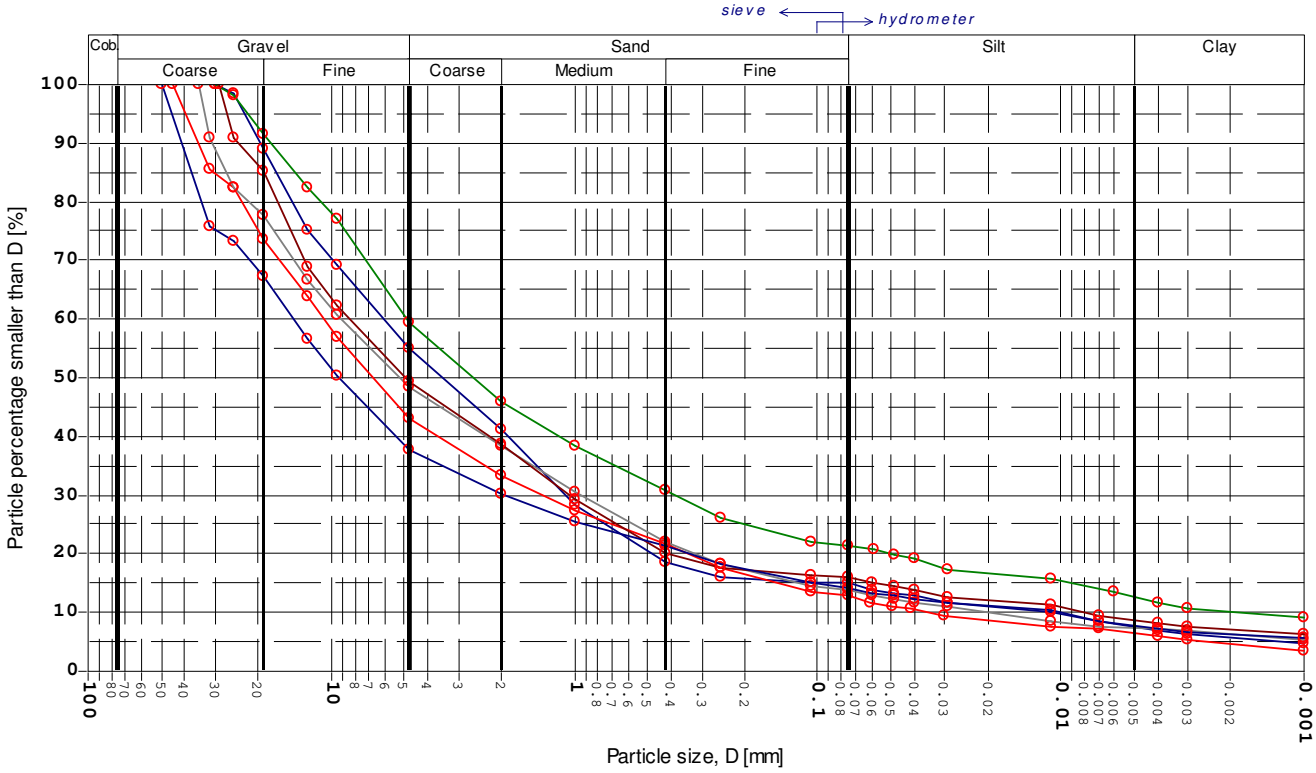
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 14.3.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-37-1-04 S-104-21-02-38-1-04 S-104-21-02-39-1-04
S-104-21-02-40-1-04 S-104-21-02-41-1-04 S-104-21-02-43-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-37-1-04	6,050	1,098	0,011	571,715	18,827	45,0	40,0	7,6	7,4
S-104-21-02-38-1-04	10,766	1,361	0,035	310,644	4,968	56,9	30,2	6,5	6,4
S-104-21-02-39-1-04	4,835	0,388	0,002	2626,312	16,929	40,4	38,2	8,8	12,6
S-104-21-02-40-1-04	9,138	0,950	0,020	460,072	4,970	51,5	34,7	6,5	7,3
S-104-21-02-41-1-04	8,451	1,052	0,008	1040,303	16,112	50,8	33,1	7,6	8,5
S-104-21-02-43-1-04	14,276	1,971	0,010	1384,551	26,381	62,3	23,4	6,7	7,6

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-2	45,00-45,10	S-104-21-02-37-1-04	30,0	rounded	hard & solid	2,80		0
congl. removed from test sample	47,90-48,00	S-104-21-02-38-1-04	45,0	rounded	hard & solid	2,80		0
B-2	48,90-49,00	S-104-21-02-39-1-04	30,0	rounded	hard & solid	2,80		0
B-2	50,90-51,00	S-104-21-02-40-1-04	35,0	rounded	hard & solid	2,80		0
congl. removed from test sample	51,90-52,00	S-104-21-02-41-1-04	29,0	rounded	hard & solid	2,80		0
B-2	53,90-54,00	S-104-21-02-43-1-04	50,0	rounded	hard & solid	2,80		0

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

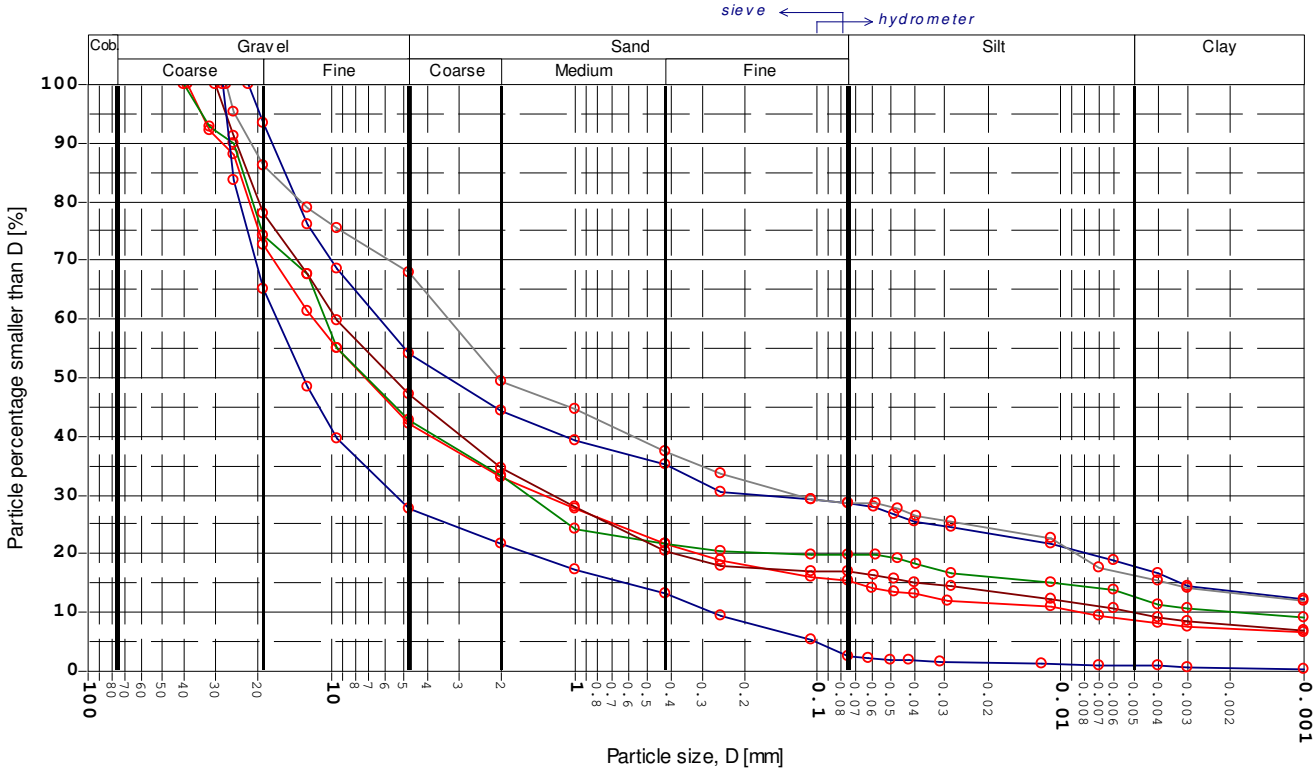
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 14.3.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-44-1-04 S-104-21-02-45-1-04 S-104-21-02-46-1-04
S-104-21-02-47-1-04 S-104-21-02-48-1-04 S-104-21-02-49-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-44-1-04	6,306	0,177	-	-	-	45,8	25,4	11,0	17,8
S-104-21-02-45-1-04	11,803	1,352	0,008	1444,293	18,957	58,0	26,7	6,6	8,7
S-104-21-02-46-1-04	10,599	1,558	0,002	5580,510	120,551	57,3	23,0	7,1	12,6
S-104-21-02-47-1-04	3,270	0,122	-	-	-	31,9	39,7	12,3	16,1
S-104-21-02-48-1-04	9,625	1,221	0,005	1932,628	31,102	52,8	30,4	6,9	9,9
S-104-21-02-49-1-04	16,748	5,465	0,266	62,849	6,692	72,5	25,1	1,5	0,9

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-2	56,00-56,10	S-104-21-02-44-1-04	22,0	rounded	hard & solid	2,80		0
B-2	58,00-58,10	S-104-21-02-45-1-04	39,0	rounded	hard & solid	2,80		0
B-2	59,00-59,10	S-104-21-02-46-1-04	40,0	rounded	hard & solid	2,80		0
congl. removed from test sample	61,00-61,10	S-104-21-02-47-1-04	27,0	rounded	hard & solid	2,80		0
B-2	62,00-62,10	S-104-21-02-48-1-04	30,0	rounded	hard & solid	2,80		0
B-2	63,90-64,00	S-104-21-02-49-1-04	28,0	rounded	hard & solid	2,80		0

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

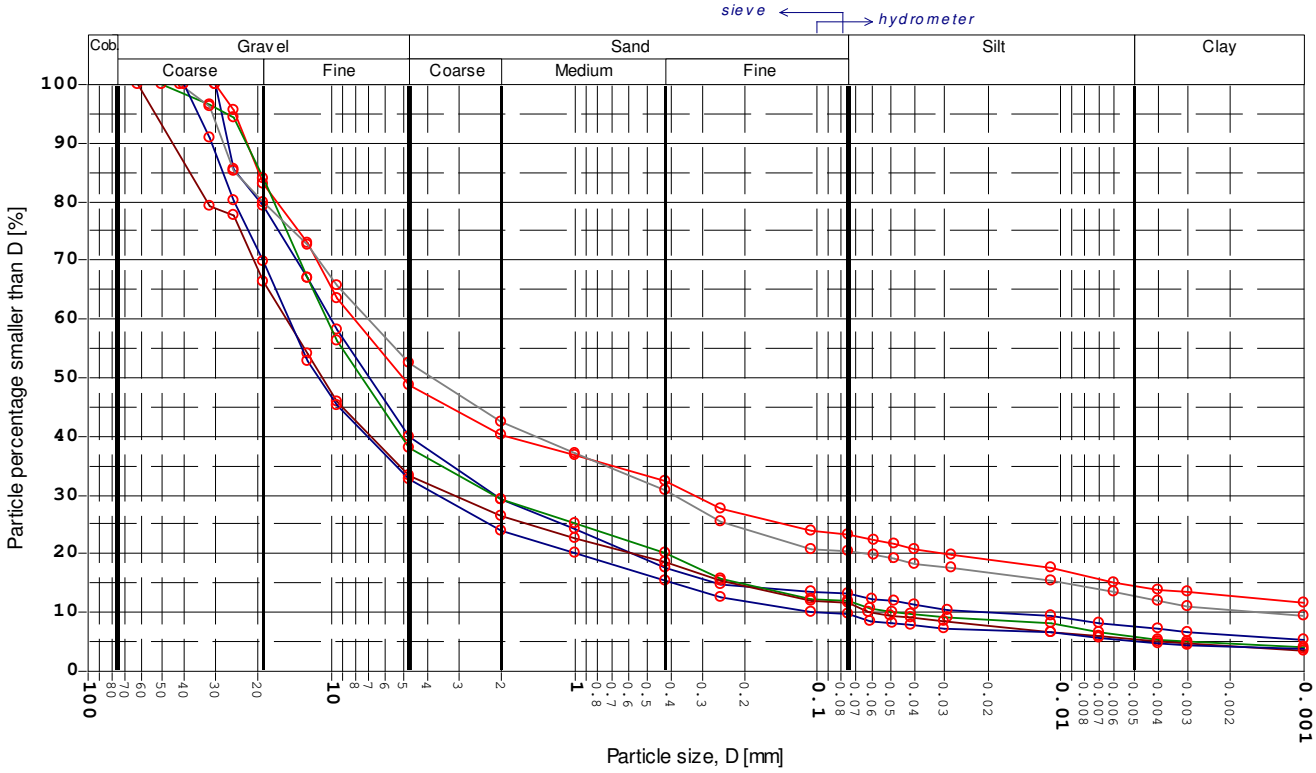
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 15.3.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-50-1-04 S-104-21-02-51-1-04 S-104-21-02-52-1-04
S-104-21-02-53-1-04 S-104-21-02-54-1-04 S-104-21-02-55-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-50-1-04	10,053	2,150	0,021	469,607	21,469	60,1	26,5	5,8	7,6
S-104-21-02-51-1-04	8,007	0,325	-	-	-	51,2	25,6	8,6	14,6
S-104-21-02-52-1-04	10,437	2,182	0,047	221,886	9,701	61,9	26,2	6,0	5,9
S-104-21-02-53-1-04	6,990	0,393	0,001	4897,832	15,486	47,3	32,2	7,8	12,7
S-104-21-02-54-1-04	15,335	3,106	0,063	245,106	10,056	66,7	21,7	6,2	5,4
S-104-21-02-55-1-04	14,918	3,678	0,108	137,810	8,375	67,4	23,0	4,5	5,1

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-2	64,50-64,60	S-104-21-02-50-1-04	30,0	rounded	hard & solid	2,80		0
congl. removed from test sample	65,50-65,60	S-104-21-02-51-1-04	30,0	rounded	hard & solid	2,80		0
B-2	67,50-67,60	S-104-21-02-52-1-04	50,0	rounded	hard & solid	2,80		0
B-2	68,50-68,60	S-104-21-02-53-1-04	42,0	rounded	hard & solid	2,80		0
B-2	69,50-69,60	S-104-21-02-54-1-04	62,0	rounded	hard & solid	2,80		0
B-2	70,50-70,60	S-104-21-02-55-1-04	40,0	rounded	hard & solid	2,80		0

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

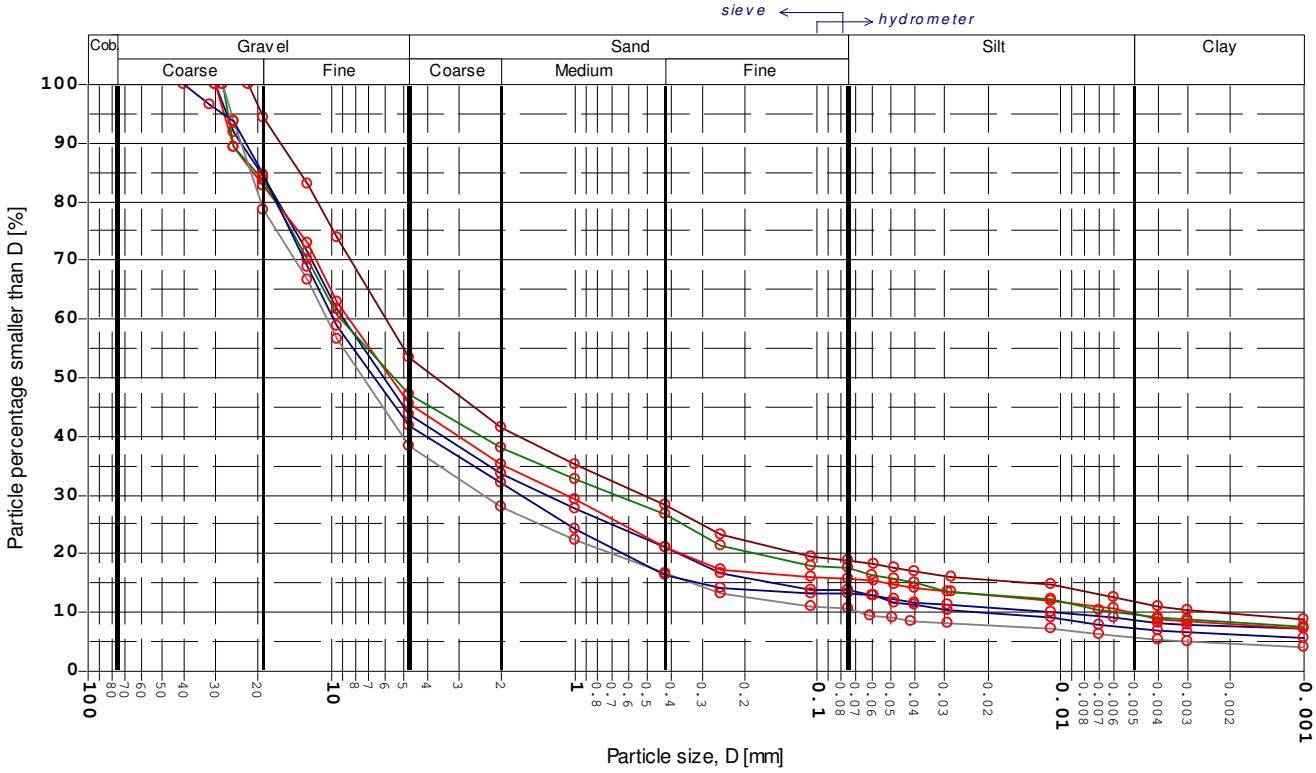
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 15.3.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-56-1-04 S-104-21-02-57-1-04 S-104-21-02-58-1-04
S-104-21-02-59-1-04 S-104-21-02-60-1-04 S-104-21-02-61-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-56-1-04	8,908	1,331	0,010	868,672	19,385	56,3	29,9	5,1	8,7
S-104-21-02-57-1-04	8,491	1,107	0,005	1640,639	27,899	54,4	29,8	6,0	9,8
S-104-21-02-58-1-04	9,117	0,675	0,006	1475,160	8,077	52,8	29,6	8,1	9,5
S-104-21-02-59-1-04	10,436	2,384	0,067	155,160	8,097	61,7	27,7	4,9	5,7
S-104-21-02-60-1-04	5,927	0,527	0,003	2362,943	18,697	46,5	34,6	7,2	11,7
S-104-21-02-61-1-04	9,824	1,658	0,020	493,434	14,054	58,4	28,4	6,0	7,2

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
congl. removed from test sample	71,50-71,60	S-104-21-02-56-1-04	30,0	rounded	hard & solid	2,80		0
B-2	72,50-72,60	S-104-21-02-57-1-04	30,0	sharp	hard & solid	2,80		0
congl. removed from test sample	73,50-73,60	S-104-21-02-58-1-04	28,0	rounded	hard & solid	2,80		0
B-2	74,90-75,00	S-104-21-02-59-1-04	28,0	sharp	hard & solid	2,80		0
congl. removed from test sample	75,90-76,00	S-104-21-02-60-1-04	22,0	rounded	hard & solid	2,80		0
B-2	76,90-77,00	S-104-21-02-61-1-04	40,0	rounded	hard & solid	2,80		0

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

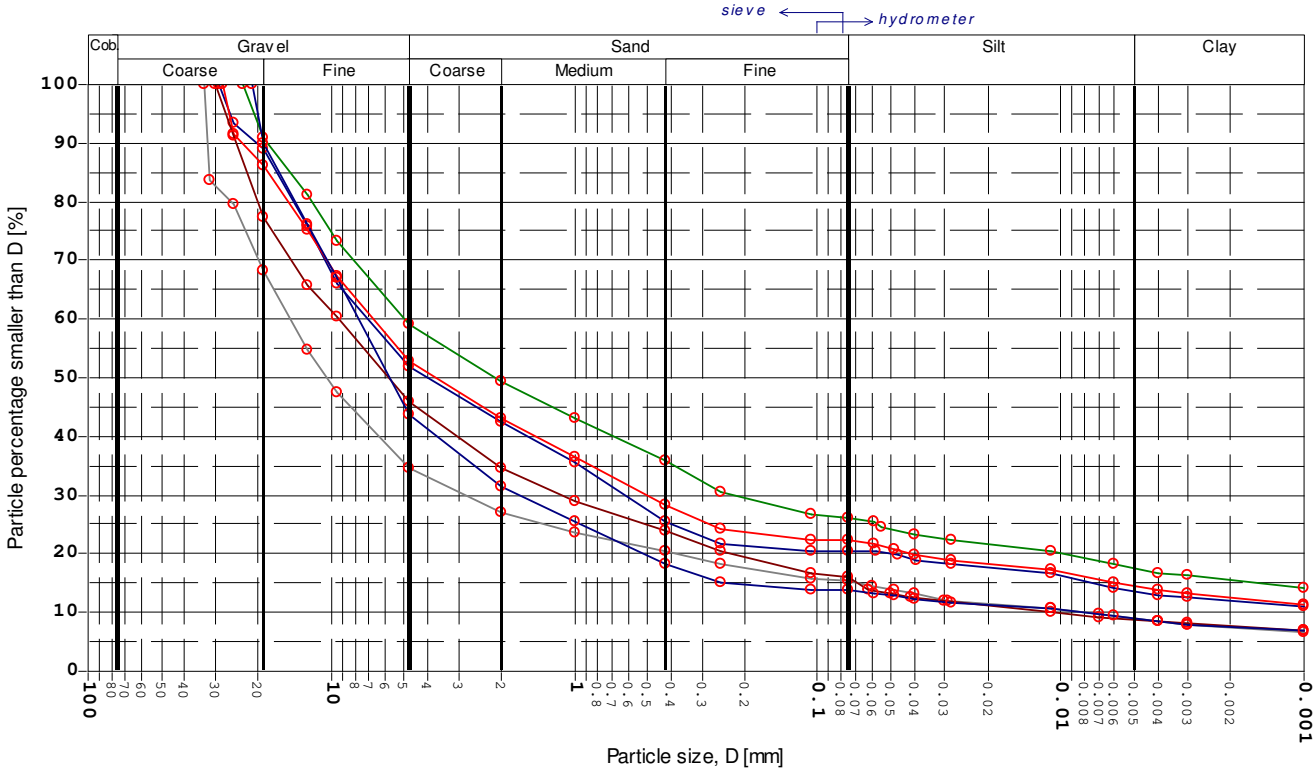
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 15.3.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-62-1-04 S-104-21-02-63-1-04 S-104-21-02-64-1-04
S-104-21-02-65-1-04 S-104-21-02-66-1-04 S-104-21-02-67-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-62-1-04	7,053	0,627	-	-	-	48,1	31,5	6,8	13,6
S-104-21-02-63-1-04	6,701	0,511	-	-	-	47,4	30,4	7,8	14,4
S-104-21-02-64-1-04	4,986	0,229	-	-	-	41,0	32,8	8,7	17,5
S-104-21-02-65-1-04	14,671	2,780	0,008	1822,092	65,416	65,3	19,2	6,7	8,8
S-104-21-02-66-1-04	9,375	1,123	0,011	836,035	11,994	54,1	29,8	7,5	8,6
S-104-21-02-67-1-04	7,693	1,675	0,008	1009,737	47,860	56,2	30,1	4,7	9,0

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-2	77,90-78,00	S-104-21-02-62-1-04	29,0	rounded	hard & solid	2,80		0
B-2	78,90-79,00	S-104-21-02-63-1-04	28,0	rounded	hard & solid	2,80		0
B-2	79,90-80,00	S-104-21-02-64-1-04	23,0	sharp	hard & solid	2,80		0
B-2	81,00-81,10	S-104-21-02-65-1-04	33,0	rounded	hard & solid	2,80		0
congl. removed from test sample	82,00-82,10	S-104-21-02-66-1-04	30,0	rounded	hard & solid	2,80		0
B-2	83,00-83,10	S-104-21-02-67-1-04	21,0	rounded	hard & solid	2,80		0

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

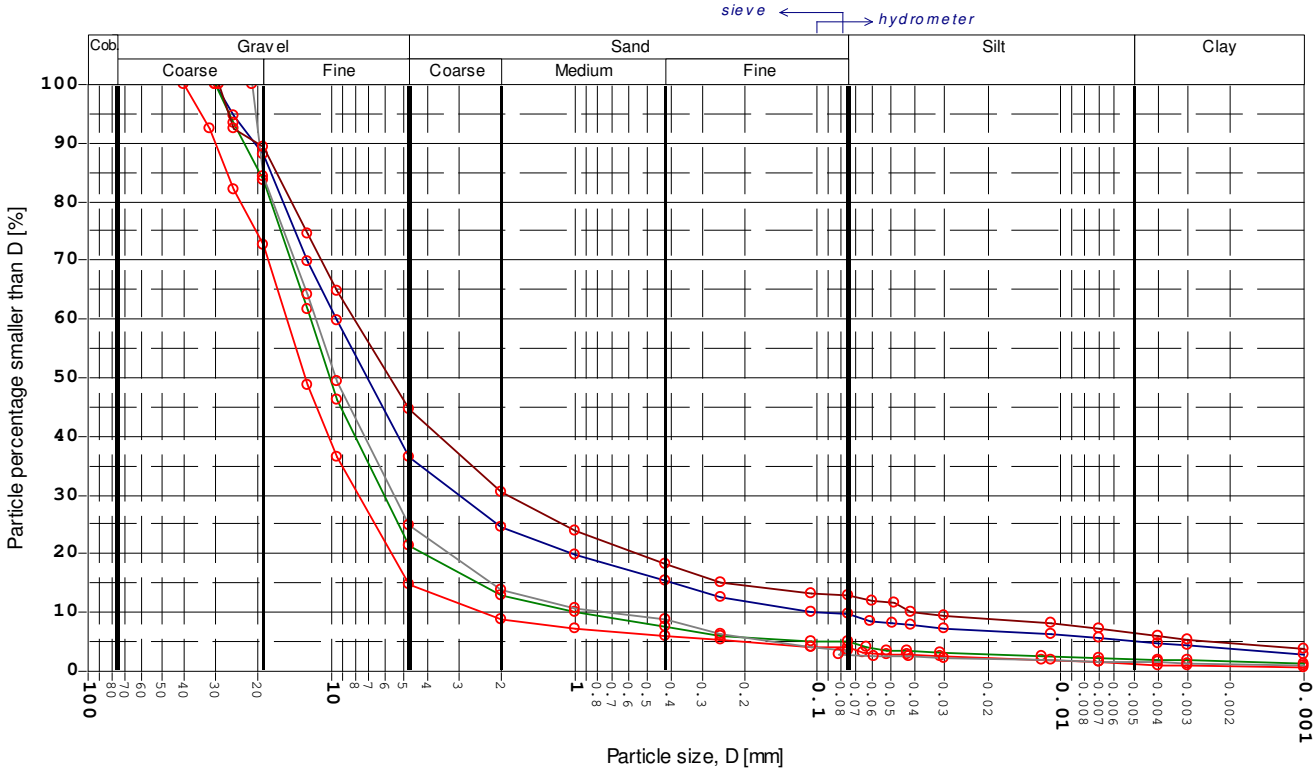
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 15.3.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-02-68-1-04 S-104-21-02-69-1-04 S-104-21-02-70-1-04
S-104-21-02-71-1-04 S-104-21-02-72-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-02-68-1-04	9,580	2,983	0,094	102,211	9,907	63,5	26,9	4,5	5,1
S-104-21-02-69-1-04	15,228	7,734	2,372	6,419	1,656	85,3	10,6	2,9	1,2
S-104-21-02-70-1-04	12,115	6,048	0,981	12,353	3,079	78,8	16,2	3,1	1,9
S-104-21-02-71-1-04	11,563	5,501	0,752	15,368	3,478	75,3	21,4	1,8	1,5
S-104-21-02-72-1-04	8,056	1,878	0,041	196,458	10,679	55,4	31,7	6,5	6,4

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-2	84,00-84,10	S-104-21-02-68-1-04	30,0	rounded	hard & solid	2,80		0
B-2	85,00-85,10	S-104-21-02-69-1-04	40,0	rounded	hard & solid	2,80		0
B-2	86,50-86,60	S-104-21-02-70-1-04	30,0	rounded	hard & solid	2,80		0
B-2	88,00-88,10	S-104-21-02-71-1-04	21,0	rounded	hard & solid	2,80		0
B-2	89,90-90,00	S-104-21-02-72-1-04	29,0	rounded	hard & solid	2,80		0

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 17.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

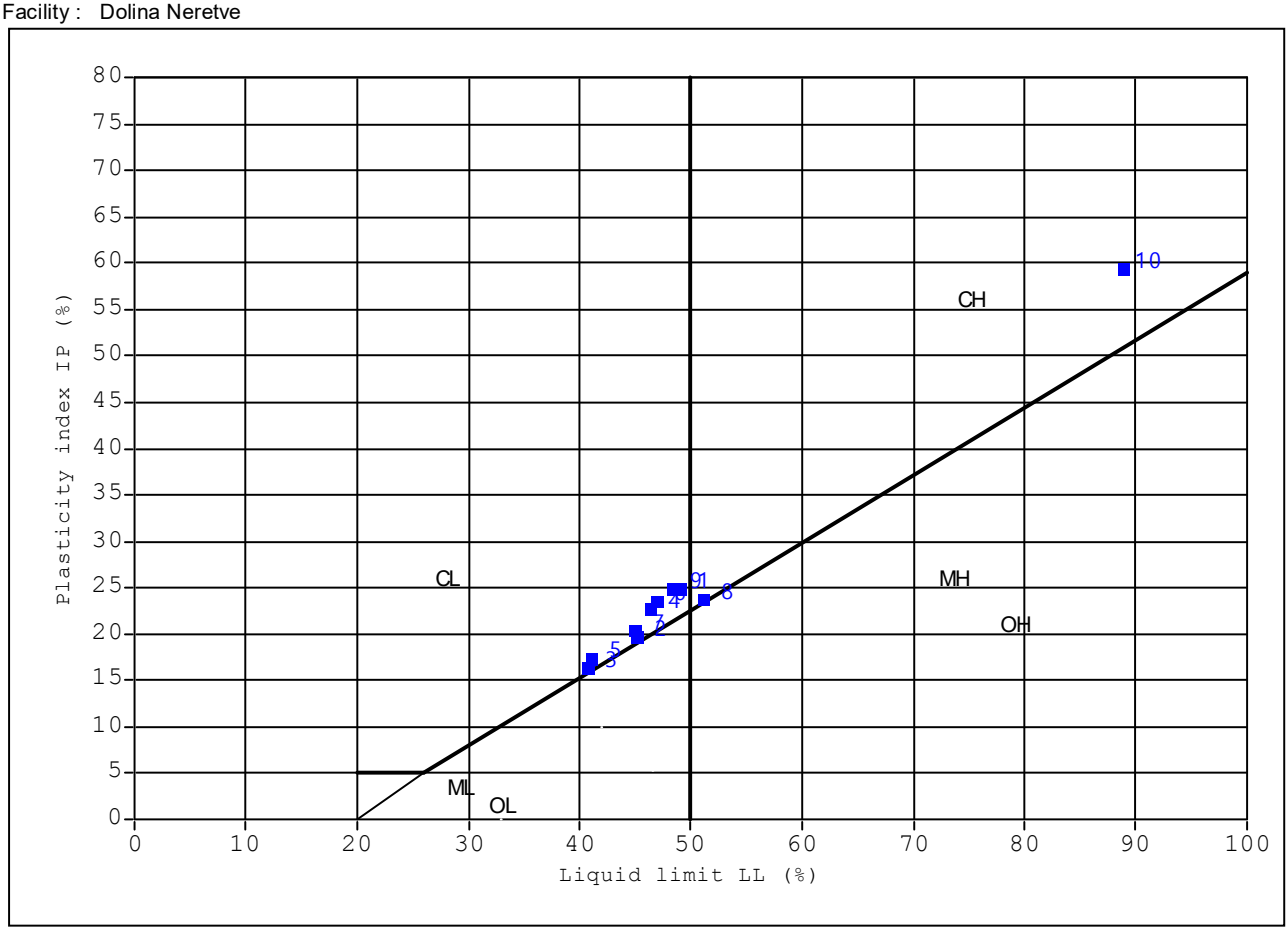
Consistency limits determination (Atterberg limits) according to ASTM D4318-17

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-05-01 v.1.2**

Location: Dolina Neretve

Report date: 22.2.2022.

Facility : Dolina Neretve



Nr.	Borehole ID	Depth (m)	Test ID	Sym-bol	wl (%)	wp (%)	IP (%)	LOS (%)	pv / ps
1	B-2	6,70-6,80	S-104-21-02-03-1-05	CL	48,96	24,09	24,87	0,00	pv
2	B-2	13,50-13,60	S-104-21-02-06-1-05	CL	45,17	25,36	19,80	0,00	pv
3	B-2	15,50-15,60	S-104-21-02-07-1-05	CL	40,75	24,35	16,40	0,00	pv
4	B-2	17,60-17,90	S-104-21-02-08-1-05	CL	46,36	23,56	22,80	0,00	pv
5	B-2	18,50-18,60	S-104-21-02-09-1-05	CL	41,15	23,76	17,39	0,00	pv
6	B-2	20,40-20,80	S-104-21-02-10-1-05	CL	46,94	23,48	23,46	0,00	pv
7	B-2	22,00-22,10	S-104-21-02-11-1-05	CL	44,97	24,62	20,34	0,00	pv
8	B-2	23,50-23,90	S-104-21-02-12-1-05	CH	51,17	27,35	23,82	0,00	pv
9	B-2	24,50-24,60	S-104-21-02-13-1-05	CL	48,38	23,57	24,81	0,00	pv
10	B-2	30,70-30,80	S-104-21-02-16-1-05	CH	88,88	29,54	59,33	0,00	pv

LEGEND:
CH - fat plasticity clay (inorganic) **MH** - fat plasticity silt **CL** - lean plasticity clay (inorganic) **ML** - lean plasticity silt
OH - fat plasticity clay (organic) **SM** - Silty sand **SC** - clayey sand **OL** - lean plasticity clay (organic)
LOS - left on sieve No.40 (0,425 mm) % **pv** - sample prepaired in naturally wet conditions **ps** - sample prepaired in dry conditions
L.L. - liquid limit **P.L.** - plastic limit **PI** - plasticity index

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 4.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

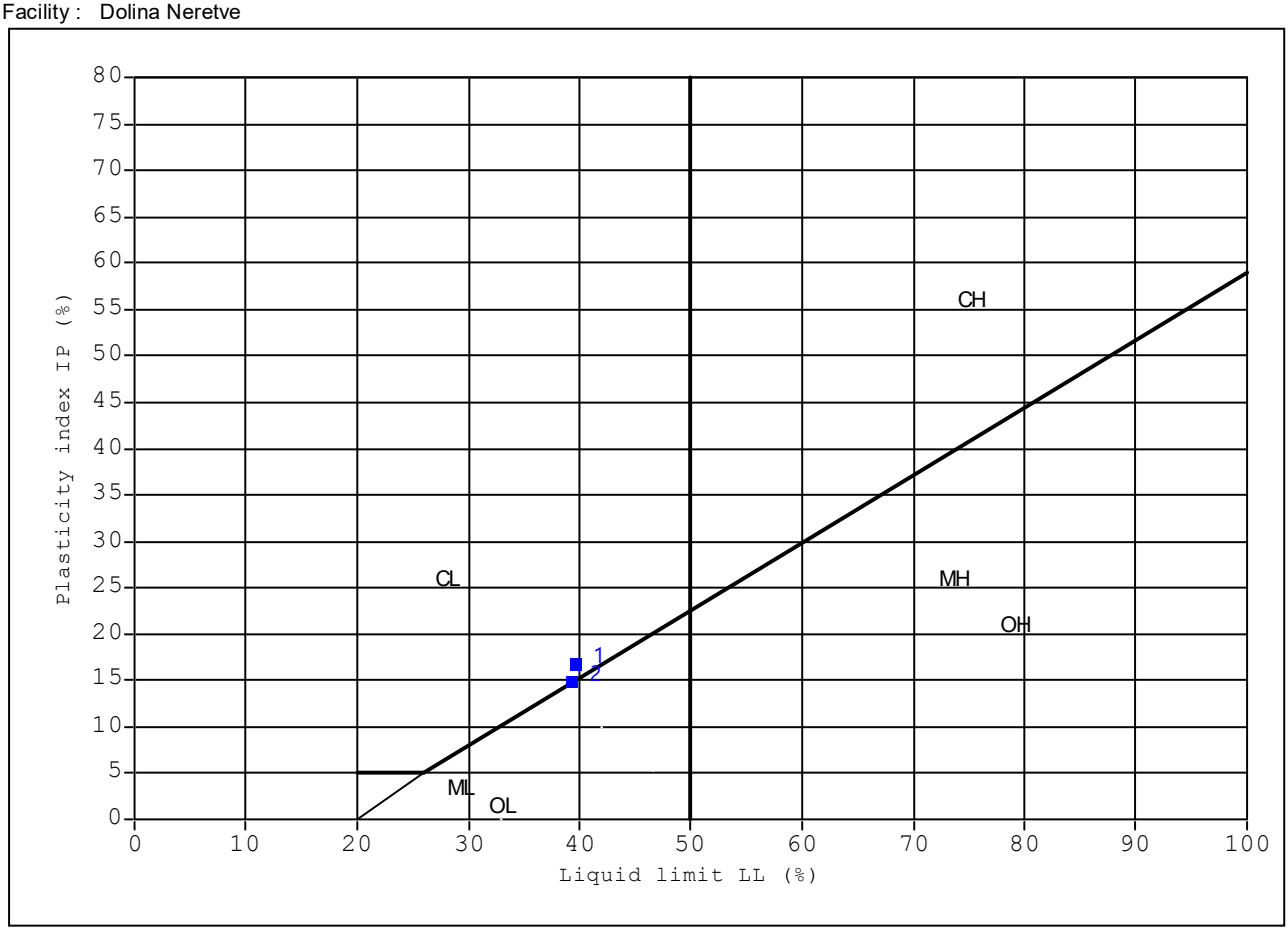
Consistency limits determination (Atterberg limits) according to ASTM D4318-17

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-05-01 v.1.2**

Location: Dolina Neretve

Report date: 22.2.2022.

Facility : Dolina Neretve



Nr.	Borehole ID	Depth (m)	Test ID	Sym-bol	wl (%)	wp (%)	IP (%)	LOS (%)	pv / ps
1	B-2	31,20-31,30	S-104-21-02-17-1-05	CL	39,69	22,91	16,78	0,00	pv
2	B-2	54,70-55,00	S-104-21-02-27-1-05	CL	39,21	24,28	14,93	0,00	pv

LEGEND:

CH - fat plasticity clay (inorganic) **MH** - fat plasticity silt **CL** - lean plasticity clay (inorganic) **ML** - lean plasticity silt
OH - fat plasticity clay (organic) **SM** - Silty sand **SC** - clayey sand **OL** - lean plasticity clay (organic)
LOS - left on sieve No.40 (0,425 mm) % **pv** - sample prepaired in naturally wet conditions **ps** - sample prepaired in dry conditions
L.L. - liquid limit **P.L.** - plastic limit **PI** - plasticity index

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 4.3.2022.

17025·HAA 1089 TEST

Determination of permeability coefficient using a Flexible Wall Permeamete by ASTM D 5084-97 - metoda: A

Client :
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i geodezije Ul. Matice hrvatske 15 21000, Split

Template id: OL-5.4-09_03 V1.1

Project ID: E-104-21-01
Location: Dolina Neretve
Structure: Dolina Neretve
Borehole ID: S-104-21-02 **Depth:** 17,60-17,90
Test ID: S-104-21-02-08-2-09 **Test date:** 17.3.2022
Test device: Produced by "ELE international" Tri-Flex 2
Sample type: Undisturbed sample **Spec. gravity, rs [g/cm3] =** 2,72
Sample description: gray color

Desc. of correction: n/a

	test condition
height [mm]	50,00
diameter [mm]	70,00
w [%]	39,2
ρ [g/cm^3]	1,81
ρ_d [g/cm^3]	1,30
e []	1,10
S_r [%]	97,19

σr [kPa]	u [kPa]	Δu [kPa]	e []	k [cm/s]
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
300,0	200	30	1,080	7,7E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
400,0	200	30	1,045	6,0E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
500,0	200	30	1,045	5,3E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Test report prepared by: Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 05.4.2022.

Determination of permeability coefficient using a Flexible Wall Permeamete by ASTM D 5084-97 - metoda: A

Client :
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i geodezije Ul. Matice hrvatske 15 21000, Split

Template id: OL-5.4-09_03 V1.1

Project ID: E-104-21-01
Location: Dolina Neretve
Structure: Dolina Neretve
Borehole ID: S-104-21-02 **Depth:** 20,40-20,80
Test ID: S-104-21-02-10-2-09 **Test date:** 17.3.2022
Test device: Produced by "ELE international" Tri-Flex 2
Sample type: Undisturbed sample **Spec. gravity, rs [g/cm3] =** 2,70
Sample description: gray color

Desc. of correction: n/a

	test condition
height [mm]	50,00
diameter [mm]	70,00
w [%]	38,6
ρ [g/cm^3]	1,81
ρ_d [g/cm^3]	1,30
e []	1,07
S_r [%]	97,15

σr [kPa]	u [kPa]	Δu [kPa]	e []	k [cm/s]
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
300,0	200	30	1,030	1,3E-07
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
400,0	200	30	1,039	6,5E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
500,0	200	30	1,049	3,4E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Test report prepared by: Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 05.4.2022.

Determination of permeability coefficient using a Flexible Wall Permeamete by ASTM D 5084-97 - metoda: A

Client :
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i geodezije Ul. Matice hrvatske 15 21000, Split

Template id: OL-5.4-09_03 V1.1

Project ID: E-104-21-01
Location: Dolina Neretve
Structure: Dolina Neretve
Borehole ID: S-104-21-02 **Depth:** 23,50-23,90
Test ID: S-104-21-02-12-2-09 **Test date:** 17.3.2022
Test device: Produced by "ELE international" Tri-Flex 2
Sample type: Undisturbed sample **Spec. gravity, rs [g/cm3] =** 2,68
Sample description: gray color

Desc. of correction: n/a

	test condition
height [mm]	50,00
diameter [mm]	70,00
w [%]	39,2
ρ [g/cm^3]	1,81
ρ_d [g/cm^3]	1,30
e []	1,07
S_r [%]	98,59

σr [kPa]	u [kPa]	Δu [kPa]	e []	k [cm/s]
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
300,0	200	30	1,089	2,9E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
400,0	200	30	1,078	2,7E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
500,0	200	30	1,053	1,4E-08
-	-	-	-	-

Test report prepared by: Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 05.4.2022.

LABORATORY
GEOKON
Storotrnjanska 16c / 10 000 Zagreb, Hrvatska

Standard Test Methods for determination of Combustible and Organic matter content according to HRN U.B1 024

Sveučilište u Splitu, Fakultet građevinarstva, arhitekture
Ul. Matice hrvatske 15
21000, Split

Template OL-5.4-11-01 v.1.3

Project ID:	S-104-21-01		Location:	Dolina Neretve	Structure:	Dolina Neretve	
Borehole ID:	**S-104-21-02**						
Test ID::	S-104-21-02-06-1-11	Depth:	13,50-13,60	Test date:	18.02.2022.	Test Method:	HRN U.B1 024 (1968)
Method of testing:	Combustible		Method of testing:	Hydrogen peroxide	The average value of the content of organic matter [%] (based on two test)		**4,19**
Test ID:	S-104-21-02-06-1-11		Test ID:	S-104-21-02-06-2-11	Test ID:		S-104-21-02-06-3-11
Test date:	21.02.2022.		Test date:	21.02.2022.	Test date:		21.02.2022.
Combustible matter content O_g, [%]	**13,93**		Organic matter content, O_o, [%]	4,30	Organic matter content, O_o, [%]		4,08
Remarks:			Remarks:				

Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 25.02.2022

17025 · HAA
1089
TEST

LABORATORY
GEOKON
Storotrnjanska 16c / 10 000 Zagreb, Hrvatska

Standard Test Methods for determination of Combustible and Organic matter content according to HRN U.B1 024

Sveučilište u Splitu, Fakultet građevinarstva, arhitekture
Ul. Matice hrvatske 15
21000, Split

Template OL-5.4-11-01 v.1.3

Project ID:	S-104-21-01		Location:	Dolina Neretve	Structure:	Dolina Neretve	
Borehole ID:	**S-104-21-02**						
Test ID::	S-104-21-02-07-1-11	Depth:	15,50-15,60	Test date:	18.02.2022.	Test Method:	HRN U.B1 024 (1968)
Method of testing:	Combustible		Method of testing:	Hydrogen peroxide	The average value of the content of organic matter [%] (based on two test)		**5,16**
Test ID:	S-104-21-02-07-1-11		Test ID:	S-104-21-02-07-2-11	Test ID:		S-104-21-02-07-3-11
Test date:	21.02.2022.		Test date:	21.02.2022.	Test date:		21.02.2022.
Combustible matter content O_g, [%]	**13,86**		Organic matter content, O_o, [%]	5,10	Organic matter content, O_o, [%]		5,21
Remarks:			Remarks:				

Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 25.02.2022

17025 · HAA
1089
TEST

LABORATORY
GEOKON
Storotrnjanska 16c / 10 000 Zagreb, Hrvatska

Standard Test Methods for determination of Combustible and Organic matter content according to HRN U.B1 024

Sveučilište u Splitu, Fakultet građevinarstva, arhitekture
Ul. Matice hrvatske 15
21000, Split

Template OL-5.4-11-01 v.1.3

Project ID:	S-104-21-01		Location:	Dolina Neretve	Structure:	Dolina Neretve	
Borehole ID:	**S-104-21-02**						
Test ID::	S-104-21-02-08-1-11	Depth:	17,60-17,90	Test date:	18.02.2022.	Test Method:	HRN U.B1 024 (1968)
Method of testing:	Combustible		Method of testing:	Hydrogen peroxide	The average value of the content of organic matter [%] (based on two test)		**2,67**
Test ID:	S-104-21-02-08-1-11		Test ID:	S-104-21-02-08-2-11	Test ID:		S-104-21-02-08-3-11
Test date:	21.02.2022.		Test date:	21.02.2022.	Test date:		21.02.2022.
Combustible matter content O_g, [%]	**11,11**		Organic matter content, O_o, [%]	2,58	Organic matter content, O_o, [%]		2,77
Remarks:			Remarks:				

Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 25.02.2022

17025 · HAA
1089
TEST

LABORATORY
GEOKON
Storotrnjanska 16c / 10 000 Zagreb, Hrvatska

Standard Test Methods for determination of Combustible and Organic matter content according to HRN U.B1 024

Sveučilište u Splitu, Fakultet građevinarstva, arhitekture
Ul. Matice hrvatske 15
21000, Split

Template OL-5.4-11-01 v.1.3

Project ID:	S-104-21-01		Location:	Dolina Neretve	Structure:	Dolina Neretve	
Borehole ID:	**S-104-21-02**						
Test ID::	S-104-21-02-10-1-11	Depth:	20,40-20,80	Test date:	18.02.2022.	Test Method:	HRN U.B1 024 (1968)
Method of testing:	Combustible		Method of testing:	Hydrogen peroxide	The average value of the content of organic matter [%] (based on two test)		**2,22**
Test ID:	S-104-21-02-10-1-11		Test ID:	S-104-21-02-10-2-11	Test ID:		S-104-21-02-10-3-11
Test date:	21.02.2022.		Test date:	21.02.2022.	Test date:		21.02.2022.
Combustible matter content O_g, [%]	**9,30**		Organic matter content, O_o, [%]	2,45	Organic matter content, O_o, [%]		1,99
Remarks:			Remarks:				

Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 25.02.2022

17025 · HAA
1089
TEST

Standard Test Methods for determination of Combustible and Organic matter content according to HRN U.B1 024

Sveučilište u Splitu, Fakultet građevinarstva, arhitekture
Ul. Matice hrvatske 15
21000, Split

Project ID:	S-104-21-01		Location:	Dolina Neretve	Structure:	Dolina Neretve	
Borehole ID:	**S-104-21-02**						
Test ID::	S-104-21-02-16-1-11	Depth:	30,70-30,80	Test date:	18.02.2022.	Test Method:	HRN U.B1 024 (1968)
Method of testing:	Combustible		Method of testing:	Hydrogen peroxide	The average value of the content of organic matter [%] (based on two test)		**35,12**
Test ID:	S-104-21-02-16-1-11		Test ID:	S-104-21-02-16-2-11	Test ID:		S-104-21-02-16-3-11
Test date:	21.02.2022.		Test date:	21.02.2022.	Test date:		21.02.2022.
Combustible matter content O_g, [%]	**12,52**		Organic matter content, O_o, [%]	35,11	Organic matter content, O_o, [%]		35,12
Remarks:			Remarks:				

Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 25.02.2022

Test report for the borehole S-104-21-03 (B-3)

Kind of test	**Name of the test report**	Number of pages
01	Test report of water content determination– S-104-21-03	1
02	Test report of specific gravity – S-104-21-03	2
03	Test report of bulk density determination – S-104-21-03	1
04	Test report of particle size analysis of solis – S-104-21-03	2
05	Test report of consistency limits determination (Atterberg limits) – S-104-21-03	1
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-03-08 / 15,00-15,30	1
09	Test report of determination of permealibity coefficient in the triaxial cell (ASTM) – S-104-21-03-08 / 15,00-15,30	1
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-03-09 / 17,00-17,30	1
09	Test report of determination of permealibity coefficient in the triaxial cell (ASTM) – S-104-21-03-09 / 17,00-17,30	1
09	Test report of determination of permealibity coefficient (HRN) – S-104-21-03-10 / 19,70-20,00	1
09	Test report of determination of permealibity coefficient in the triaxial cell (ASTM) – S-104-21-03-10 / 19,70-20,00	1
11	Test report for determination of combustible and organic matter content – S-104-21-03-07 / 13,50-13,60	1

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Water content determination

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-01-01 v.1.3**

Project: 104-21
Location: Dolina Neretve

Facility: Dolina Neretve

Borehole ID: S-104-21-03 (B-3)

Test ID: **S-104-21-03-07-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 13,50-13,60 Starting test date: 14.3.2022. Test date: 16.3.2022.
Tare weight (g): 55,29 Wet mass (g): 254,49 Dry mass (g): 203,58 **Water content (%): 34,33**
Remark:

Test ID: **S-104-21-03-08-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 15,00-15,30 Starting test date: 14.3.2022. Test date: 16.3.2022.
Tare weight (g): 33,72 Wet mass (g): 178,07 Dry mass (g): 138,05 **Water content (%): 38,36**
Remark:

Test ID: **S-104-21-03-09-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 17,00-17,30 Starting test date: 14.3.2022. Test date: 16.3.2022.
Tare weight (g): 35,92 Wet mass (g): 182,17 Dry mass (g): 141,57 **Water content (%): 38,43**
Remark:

Test ID: **S-104-21-03-10-1-01** Norm/Standard: ASTM D 2216-10
Depth (m): 19,70-20,00 Starting test date: 14.3.2022. Test date: 16.3.2022.
Tare weight (g): 62,19 Wet mass (g): 215,68 Dry mass (g): 173,34 **Water content (%): 38,09**
Remark:

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.
Test report date: 16.3.2022.

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Specific gravity

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-02-01 v.1.3**

Subject: 104-21
Facility: Dolina Neretve

Structuret: Dolina Neretve

Borehole ID: S-104-21-03 (B-3)

Test ID: **S-104-21-03-01-1-02** Standard: ASTM D 854-14
Depth (m): 0,50-0,60 Starting test date: 16.3.2022. Test date: 17.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,75**
Remarks:

Test ID: **S-104-21-03-02-1-02** Standard: ASTM D 854-14
Depth (m): 1,50-1,60 Starting test date: 16.3.2022. Test date: 17.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,78**
Remarks:

Test ID: **S-104-21-03-03-1-02** Standard: ASTM D 854-14
Depth (m): 4,50-4,60 Starting test date: 16.3.2022. Test date: 17.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,78**
Remarks:

Test ID: **S-104-21-03-04-1-02** Standard: ASTM D 854-14
Depth (m): 7,50-7,60 Starting test date: 16.3.2022. Test date: 17.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,78**
Remarks:

Test ID: **S-104-21-03-05-1-02** Standard: ASTM D 854-14
Depth (m): 10,00-10,10 Starting test date: 16.3.2022. Test date: 17.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,78**
Remarks:

Test ID: **S-104-21-03-06-1-02** Standard: ASTM D 854-14
Depth (m): 12,50-12,60 Starting test date: 16.3.2022. Test date: 17.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,78**
Remarks:

Test ID: **S-104-21-03-07-1-02** Standard: ASTM D 854-14
Depth (m): 13,50-13,60 Starting test date: 16.3.2022. Test date: 17.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,78**
Remarks:

Test ID: **S-104-21-03-08-1-02** Standard: ASTM D 854-14
Depth (m): 15,00-15,30 Starting test date: 16.3.2022. Test date: 17.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,69**
Remarks:

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Specific gravity

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-02-01 v.1.3**

Subject: 104-21
Facility: Dolina Neretve

Test ID: **S-104-21-03-09-1-02** Standard: ASTM D 854-14
Depth (m): 17,00-17,30 Starting test date: 16.3.2022. Test date: 17.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,69**
Remarks:

Test ID: **S-104-21-03-10-1-02** Standard: ASTM D 854-14
Depth (m): 19,70-20,00 Starting test date: 16.3.2022. Test date: 17.3.2022.
Dmax (mm): **Specific gravity (g/cm^3): 2,69**
Remarks:

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.
Print date: 28.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

BULK DENSITY DETERMINATION

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-03-01 v.1.3**

Subject: 104-21
Location: Dolina Neretve

Facility: Dolina Neretve

Borehole ID: S-104-21-03 (B-3)

Test ID: **S-104-21-03-08-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 15,00-15,30 Starting test date: 16.3.2022. Test date: 28.3.2022.

Moist density (g/cm^3): 1,88 **Dry density (g/cm^3): 1,41**

Remark:

Test ID: **S-104-21-03-09-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 17,00-17,30 Starting test date: 16.3.2022. Test date: 28.3.2022.

Moist density (g/cm^3): 1,85 **Dry density (g/cm^3): 1,36**

Remark:

Test ID: **S-104-21-03-10-1-03** Standard: HRN U.B1 016 (1968)
Depth (m): 19,70-20,00 Starting test date: 16.3.2022. Test date: 28.3.2022.

Moist density (g/cm^3): 1,83 **Dry density (g/cm^3): 1,34**

Remark:

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 28.3.2022.

17025 · HAA
1089
TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

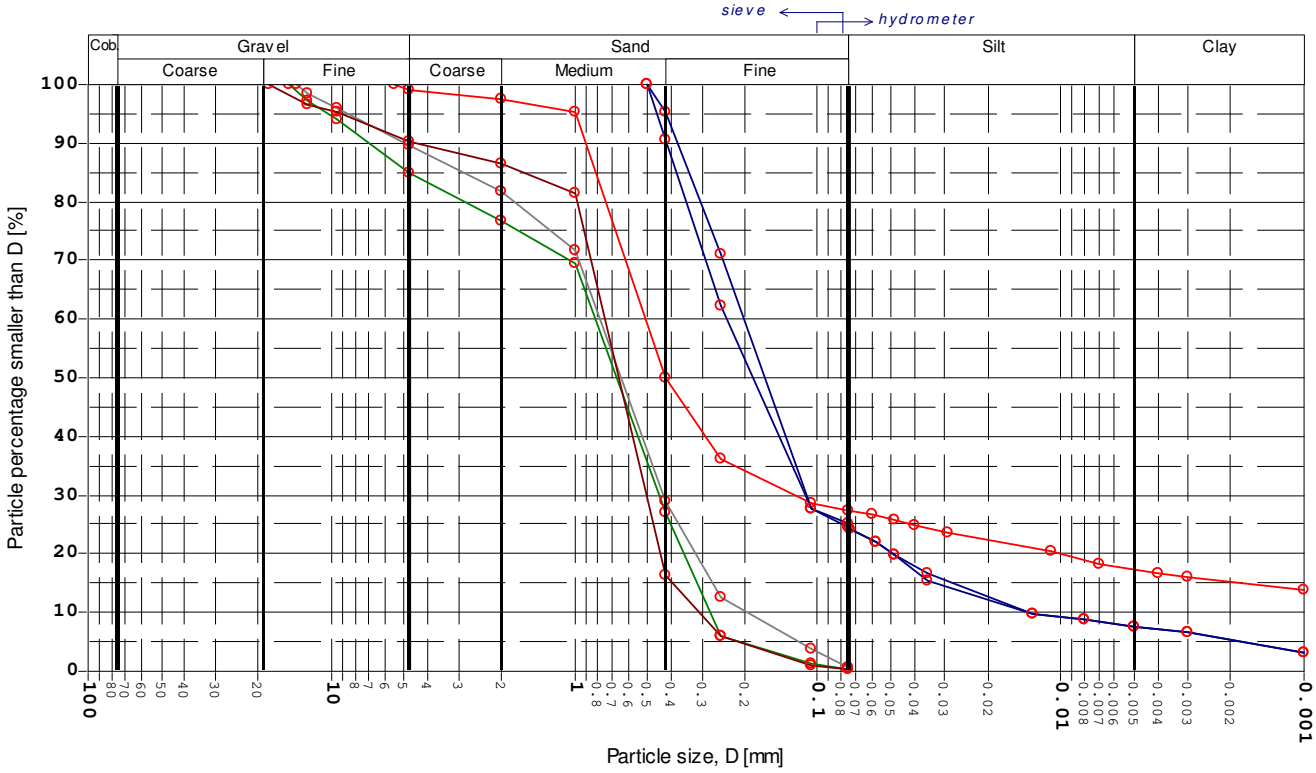
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 17.3.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-03-01-1-04 S-104-21-03-02-1-04 S-104-21-03-03-1-04
S-104-21-03-04-1-04 S-104-21-03-05-1-04 S-104-21-03-06-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-03-01-1-04	0,514	0,124	-	-	-	0,9	71,6	10,3	17,2
S-104-21-03-02-1-04	0,826	0,452	0,277	2,980	0,891	15,2	84,6	M(%) + C(%)= 0,2	
S-104-21-03-03-1-04	0,792	0,434	0,193	4,093	1,232	10,4	89,0	M(%) + C(%)= 0,6	
S-104-21-03-04-1-04	0,754	0,508	0,306	2,463	1,120	9,9	89,9	M(%) + C(%)= 0,2	
S-104-21-03-05-1-04	0,236	0,112	0,013	17,651	4,011	n/a	74,9	17,5	7,6
S-104-21-03-06-1-04	0,201	0,111	0,013	14,971	4,565	n/a	75,4	17,0	7,6

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-3	0,50-0,60	S-104-21-03-01-1-04	5,5	sharp	hard & solid	2,75		0
B-3	1,50-1,60	S-104-21-03-02-1-04	15,0	sharp	hard & solid	2,78		0
B-3	4,50-4,60	S-104-21-03-03-1-04	14,0	sharp	hard & solid	2,78		0
B-3	7,50-7,60	S-104-21-03-04-1-04	18,0	sharp	hard & solid	2,78		0
B-3	10,00-10,10	S-104-21-03-05-1-04	0,5	sharp	hard & solid	2,78	mixer	10
B-3	12,50-12,60	S-104-21-03-06-1-04	0,5	sharp	hard & solid	2,78	mixer	10

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 28.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

Particle size analysis of solis

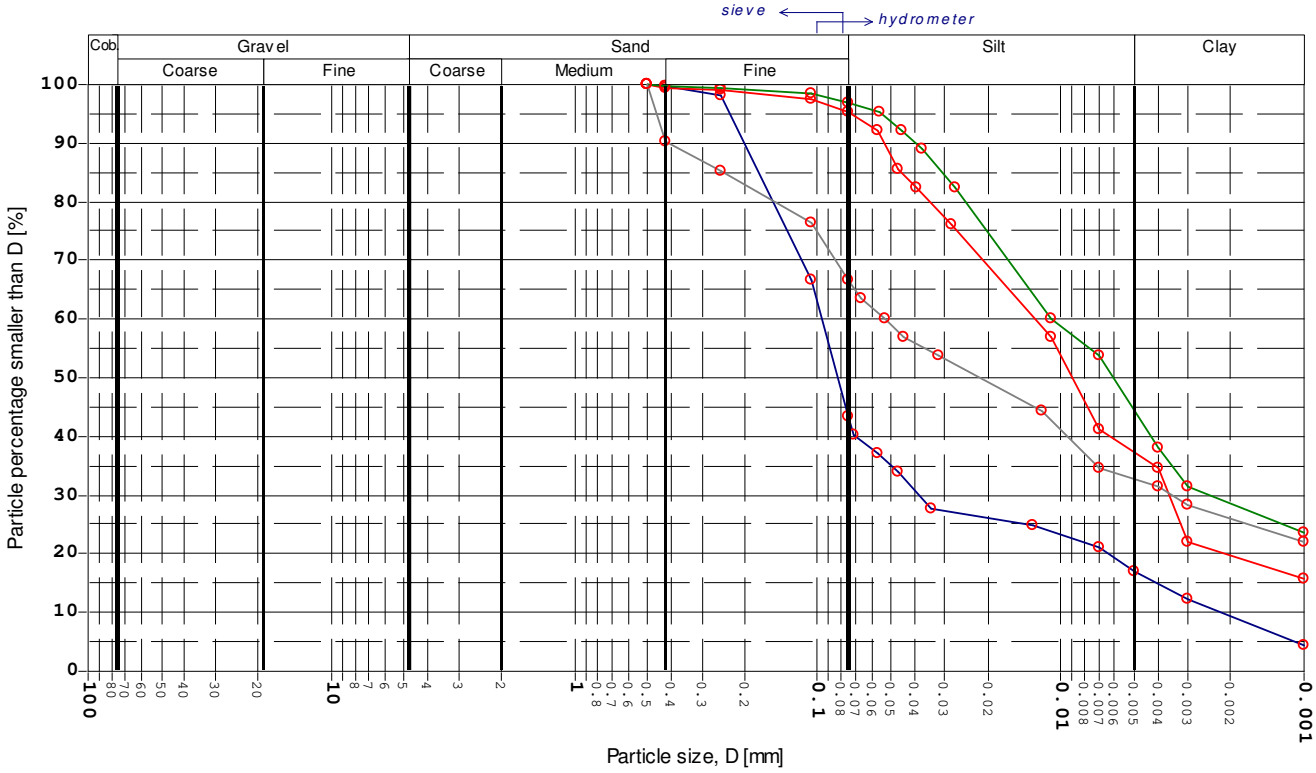
ASTM D 422-63

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-04-01 v.1.1**

Location Dolina Neretve

Report date: 18.3.2022.

Facility : Dolina Neretve



Remarks

Measured points in the diagram are indicated by the corresponding symbol shown in the legend

S-104-21-03-07-1-04 S-104-21-03-08-1-04 S-104-21-03-09-1-04 S-104-21-03-10-1-04

Test ID	D60	D30	D10	Cu	Cc	G(%)	S(%)	M(%)	C(%)
S-104-21-03-07-1-04	0,096	0,038	0,002	43,530	6,842	n/a	56,5	26,6	16,9
S-104-21-03-08-1-04	0,013	0,004	-	-	-	n/a	4,8	58,4	36,8
S-104-21-03-09-1-04	0,011	0,002	-	-	-	n/a	3,1	53,7	43,2
S-104-21-03-10-1-04	0,052	0,003	-	-	-	n/a	33,2	34,2	32,6

Borehole ID	Depth (m)	Unique lab. ID	Dmax (mm)	Particle shape/form	Description of particles	Particle density	Dispersion device	Mixing duration (min)
B-3	13,50-13,60	S-104-21-03-07-1-04	0,5	sharp	hard & solid	2,78	mixer	10
B-3	15,00-15,30	S-104-21-03-08-1-04	0,5	n/a	soft	2,69	mixer	10
B-3	17,00-17,30	S-104-21-03-09-1-04	0,5	n/a	soft	2,69	mixer	10
B-3	19,70-20,00	S-104-21-03-10-1-04	0,5	n/a	soft	2,69	mixer	10

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 28.3.2022.

17025·HAA 1089 TEST

LABORATORY
GEOKON
Starotrnjanska 16a / 10 000 Zagreb, Hrvatska

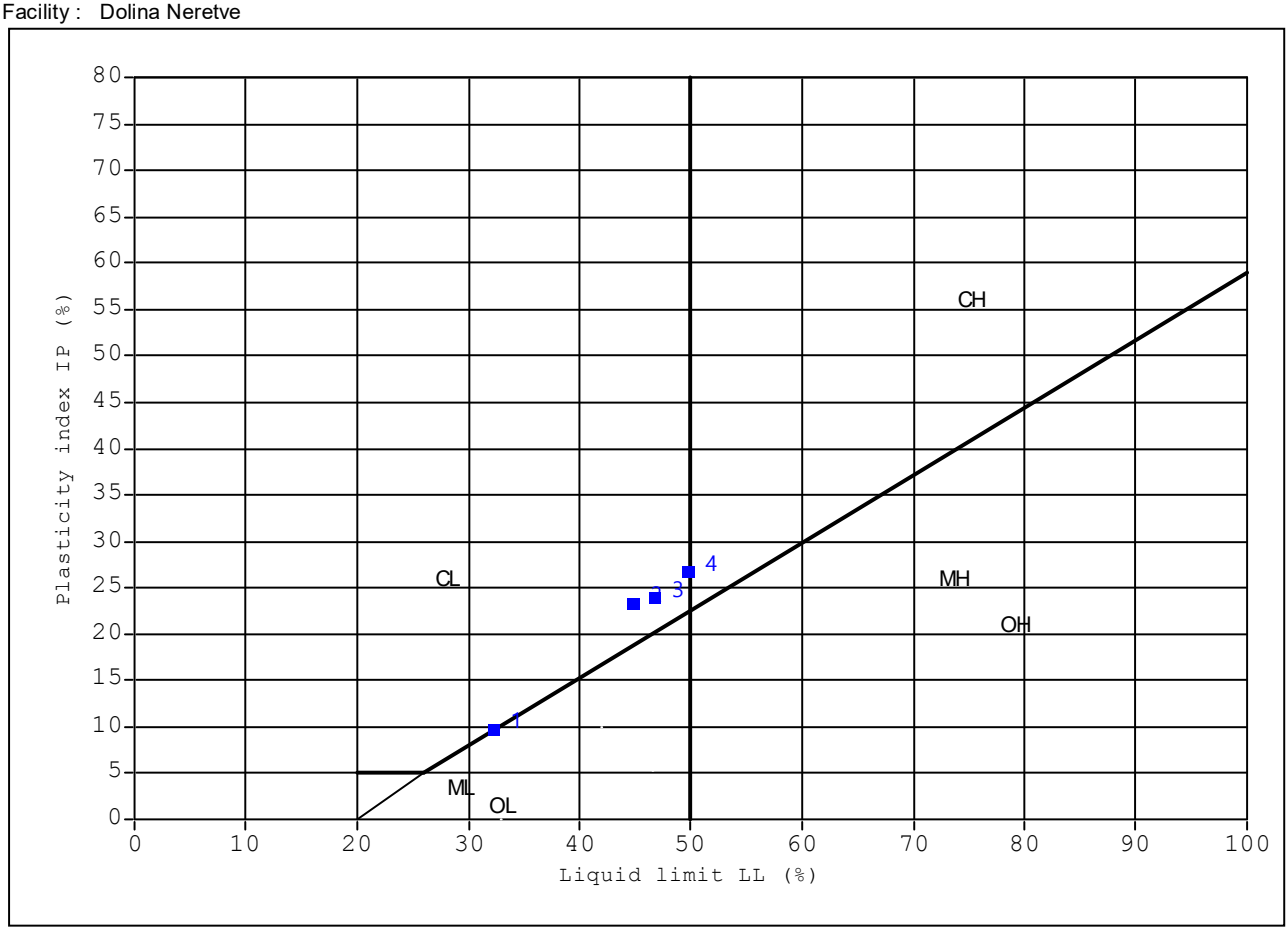
Consistency limits determination (Atterberg limits) according to ASTM D4318-17

Client:
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i
Ul. Matice hrvatske 15
21000, Split
Template ID: **OL-5.4-05-01 v.1.2**

Location: Dolina Neretve

Report date: 24.3.2022.

Facility : Dolina Neretve



Nr.	Borehole ID	Depth (m)	Test ID	Sym-bol	wl (%)	wp (%)	IP (%)	LOS (%)	pv / ps
1	B-3	13,50-13,60	S-104-21-03-07-1-05	CL	32,23	22,41	9,82	0,00	pv
2	B-3	15,00-15,30	S-104-21-03-08-1-05	CL	44,84	21,48	23,37	0,00	pv
3	B-3	17,00-17,30	S-104-21-03-09-1-05	CL	46,75	22,70	24,05	0,00	pv
4	B-3	19,70-20,00	S-104-21-03-10-1-05	CL	49,79	23,13	26,66	0,00	pv

LEGEND:
CH - fat plasticity clay (inorganic) **MH** - fat plasticity silt **CL** - lean plasticity clay (inorganic) **ML** - lean plasticity silt
OH - fat plasticity clay (organic) **SM** - Silty sand **SC** - clayey sand **OL** - lean plasticity clay (organic)
LOS - left on sieve No.40 (0,425 mm) % **pv** - sample prepaired in naturally wet conditions **ps** - sample prepaired in dry conditions
L.L. - liquid limit **P.L.** - plastic limit **PI** - plasticity index

Test prepared by: Head of laboratory Branimir Veličković, M.sc.Min.

Print date: 24.3.2022.

17025·HAA 1089 TEST

Determination of permeability coefficient using a Flexible Wall Permeamete by ASTM D 5084-97 - metoda: A

Client :
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i geodezije Ul. Matice hrvatske 15 21000, Split

Template id: OL-5.4-09_03 V1.1

Project ID: E-104-21-01
Location: Dolina Neretve
Structure: Dolina Neretve
Borehole ID: S-104-21-03 **Depth:** 15,00-15,30
Test ID: S-104-21-03-08-2-09 **Test date:** 5.4.2022
Test device: Produced by "ELE international" Tri-Flex 2
Sample type: Undisturbed sample **Spec. gravity, rs [g/cm3] =** 2,69
Sample description: gray color

Desc. of correction: n/a

	test condition
height [mm]	50,00
diameter [mm]	70,00
w [%]	32,6
ρ [g/cm^3]	1,88
ρ_d [g/cm^3]	1,42
e []	0,90
S_r [%]	97,32

σr [kPa]	u [kPa]	Δu [kPa]	e []	k [cm/s]
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
300,0	200	30	0,849	4,1E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
400,0	200	30	0,841	2,1E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
500,0	200	30	1,093	1,3E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Test report prepared by: Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 25.4.2022.

Determination of permeability coefficient using a Flexible Wall Permeamete by ASTM D 5084-97 - metoda: A

Client :
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i geodezije Ul. Matice hrvatske 15 21000, Split

Template id: OL-5.4-09_03 V1.1

Project ID: E-104-21-01
Location: Dolina Neretve
Structure: Dolina Neretve
Borehole ID: S-104-21-03 **Depth:** 17,00-17,30
Test ID: S-104-21-03-09-2-09 **Test date:** 4.4.2022
Test device: Produced by "ELE international" Tri-Flex 2
Sample type: Undisturbed sample **Spec. gravity, rs [g/cm3] =** 2,69
Sample description: gray color

Desc. of correction: n/a

	test condition
height [mm]	50,00
diameter [mm]	70,00
w [%]	36,4
ρ [g/cm^3]	1,84
ρ_d [g/cm^3]	1,35
e []	1,00
S_r [%]	98,08

σr [kPa]	u [kPa]	Δu [kPa]	e []	k [cm/s]
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
300,0	200	30	0,991	3,7E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
400,0	200	30	0,992	2,6E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
500,0	200	30	0,996	2,2E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Test report prepared by: Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 27.4.2022.

Determination of permeability coefficient using a Flexible Wall Permeamete by ASTM D 5084-97 - metoda: A

Client :
Sveučilište u Splitu, Fakultet građevinarstva, arhitekture i geodezije Ul. Matice hrvatske 15 21000, Split

Template id: OL-5.4-09_03 V1.1

Project ID: E-104-21-01
Location: Dolina Neretve
Structure: Dolina Neretve
Borehole ID: S-104-21-03 **Depth:** 19,70-20,00
Test ID: S-104-21-03-10-2-09 **Test date:** 17.3.2022
Test device: Produced by "ELE international" Tri-Flex 2
Sample type: Undisturbed sample **Spec. gravity, rs [g/cm3] =** 2,69
Sample description: gray color

Desc. of correction: n/a

	test condition
height [mm]	50,00
diameter [mm]	70,00
w [%]	38,2
ρ [g/cm^3]	1,83
ρ_d [g/cm^3]	1,33
e []	1,03
S_r [%]	99,75

σr [kPa]	u [kPa]	Δu [kPa]	e []	k [cm/s]
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
300,0	200	30	1,008	2,6E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
400,0	200	30	0,974	2,2E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
500,0	200	30	0,979	2,1E-08
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Test report prepared by: Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 27.4.2022.

LABORATORY
GEOKON
Storotrnjanska 16c / 10 000 Zagreb, Hrvatska

Standard Test Methods for determination of Combustible and Organic matter content according to HRN U.B1 024

Sveučilište u Splitu, Fakultet građevinarstva, arhitekture
Ul. Matice hrvatske 15
21000, Split

Project ID:	S-104-21-01		Location:	Dolina Neretve	Structure:	Dolina Neretve	
Borehole ID:	**S-104-21-03**						
Test ID::	S-104-21-03-07-1-11	Depth:	13,50-13,60	Test date:	18.03.2022.	Test Method:	HRN U.B1 024 (1968)
Method of testing:	Combustible		Method of testing:	Hydrogen peroxide	The average value of the content of organic matter [%] (based on two test)		**1,76**
Test ID:	S-104-21-03-07-1-11		Test ID:	S-104-21-03-07-2-11	Test ID:		S-104-21-03-07-3-11
Test date:	23.03.2022.		Test date:	23.03.2022.	Test date:		23.03.2022.
Combustible matter content O_g, [%]	**9,12**		Organic matter content, O_o, [%]	1,86	Organic matter content, O_o, [%]		1,67
Remarks:			Remarks:				

Head of Laboratory Branimir Veličković, .M.sc.Min.
Report date: 25.03.2022

17025 · HAA
1089
TEST

GEOKON - ZAGREB d.d.

PHYSICAL PROPERTIES TABLE

SAMPLE ID	DEPTH	WATER CONTENT	PARTICLE DENSITY	BULK DENSITY		PARTICLE SIZE DISTRIBUTION						PLASTICITY LIMITS		PLASTICITY INDEKS	CONSISTENCY INDEKS	COMBUSTIBLE CONTENT	ORGANIC CONTENT	SYMBOL
	m	w [%]	ρ_s [g/cm^3]	ρ_d [g/cm^3]	ρ [g/cm^3]	G [%]	S [%]	M [%]	C [%]	M + C [%]	VDP USBR k [cm/s]	wL [%]	wP [%]	IP [%]	IC	[%]	[%]	
BOREHOLE		**B-1 (S-104-21-01)**																
S-104-21-01-01	1,00-1,10	23,58	2,72				11,00	64,00	25,00		3,16E-07	37,32	21,78	15,54	0,88			CL
S-104-21-01-02	2,00-2,30	48,74	2,69	1,28	1,80		11,50	66,50	22,00		8,86E-07	56,37	24,02	32,34	0,24			CH
S-104-21-01-03	3,40-3,50	32,60	2,73				53,40	28,00	18,60		2,57E-06	35,06	22,42	12,64	0,19			SC/CL
S-104-21-01-04	4,50-4,60	38,96	2,76				77,70	13,60	8,70		5,43E-04							SC
S-104-21-01-05	6,80-6,90	41,86	2,68				30,10	49,50	20,40		1,34E-06							CL
S-104-21-01-06	8,90-9,00					2,20	96,60			1,20	2,09E-02							SP
S-104-21-01-07	10,50-10,60	37,92	2,71				27,20	54,10	18,70		2,27E-06	36,64	21,79	14,86		10,79	5,96	CL
S-104-21-01-08	13,30-13,60	35,38	2,67	1,42	1,64		15,80	65,30	18,90		2,69E-06	38,63	22,98	15,65	0,21	15,17	6,23	CL
S-104-21-01-09	15,50-15,80	36,46	2,68	1,43	1,89		18,80	62,40	18,80		2,73E-06	37,56	21,34	16,22	0,07			CL
S-104-21-01-10	17,50-17,60	35,96	2,67				10,60	70,50	18,90		2,37E-06	37,73	23,59	14,14	0,13			CL
S-104-21-01-11	18,50-18,80	39,17	2,69	1,33	1,83		2,80	60,40	36,80			39,90	22,02	17,88	0,04			CL
S-104-21-01-12	20,50-20,80	38,89	2,73	1,37	1,86		6,40	75,00	18,60		2,17E-06	40,20	23,24	16,96	0,08			CL
S-104-21-01-13	22,50-22,60	37,43	2,73				4,70	76,70	18,60		2,30E-06	41,14	23,28	17,86	0,21			CL
S-104-21-01-14	24,70-25,00	35,79	2,74	1,42	1,90		3,00	75,20	21,80		1,18E-06	37,31	22,49	14,83	0,10			CL
S-104-21-01-15	25,50-25,60	53,18	2,58				5,50	76,90	17,60		5,88E-06	94,01	26,80	67,20	0,61	17,85	15,47	OH
S-104-21-01-16	26,10-26,20	20,48	2,76				71,40	16,50	12,10		1,52E-04							SC
S-104-21-01-17	26,90-27,00	50,58	2,70				26,90	51,20	21,90		9,00E-07	44,00	21,89	22,11		17,57	11,27	CL
S-104-21-01-18	27,80-27,90	29,78	2,71				2,50	53,40	44,10			35,91	22,95	12,96	1,25			CL
S-104-21-01-19	29,40-29,50	28,69	2,75				62,90	25,00	12,10		2,83E-05	27,91	20,87	7,04				SC
S-104-21-01-20	31,20-31,30	31,49	2,70				5,50	51,40	43,10			37,20	22,17	15,04	0,38			CL
S-104-21-01-21	32,50-32,60	19,46	2,77				70,00	20,20	9,80		1,54E-04							SC
S-104-21-01-22	33,50-33,60	27,17	2,72				5,10	29,50	65,40			53,86	24,19	29,67	0,90			CH

GEOKON - ZAGREB d.d.

PHYSICAL PROPERTIES TABLE

SAMPLE ID	DEPTH	WATER CONTENT	PARTICLE DENSITY	BULK DENSITY		PARTICLE SIZE DISTRIBUTION						PLASTICITY LIMITS		PLASTICITY INDEKS	CONSISTENCY INDEKS	COMBUSTIBLE CONTENT	ORGANIC CONTENT	SYMBOL
	m	w [%]	ρ_s [g/cm^3]	ρ_d [g/cm^3]	ρ [g/cm^3]	G [%]	S [%]	M [%]	C [%]	M + C [%]	VDP USBR k [cm/s]	wL [%]	wP [%]	IP [%]	IC	[%]	[%]	
BOREHOLE		**B-2 (S-104-21-02)**																
S-104-21-02-01	1,00-1,10					3,60	95,40			1,00	1,51E-02							SP
S-104-21-02-02	4,20-4,30		2,75				71,00	18,00	11,00		3,98E-04							SC
S-104-21-02-03	6,70-6,80	53,81	2,74				46,90	34,50	18,60		3,67E-06	48,96	24,09	24,87				CL/SC
S-104-21-02-04	8,50-8,60		2,76				70,80	17,10	12,10		8,90E-05							SC
S-104-21-02-05	11,50-11,60		2,76				77,30	14,00	8,70		4,68E-04							SC
S-104-21-02-06	13,50-13,60	34,17	2,68				16,50	61,50	22,00		5,06E-07	45,17	25,36	19,80	0,56	13,93	4,19	CL
S-104-21-02-07	15,50-15,60	34,16	2,71				5,10	59,30	35,60		1,13E-07	40,75	24,35	16,40	0,40	13,86	5,16	CL
S-104-21-02-08	17,60-17,90	39,81	2,72	1,37	1,86		0,30	62,60	37,10			46,36	23,56	22,80	0,29	11,11	2,67	CL
S-104-21-02-09	18,50-18,60	37,32	2,69				1,20	47,10	51,70			41,15	23,76	17,39	0,22			CL
S-104-21-02-10	20,40-20,80	39,25	2,70	1,40	1,88		0,30	71,40	28,30		3,07E-07	46,94	23,48	23,46	0,33	9,30	2,22	CL
S-104-21-02-11	22,00-22,10	38,07	2,69				0,10	45,20	54,70			44,97	24,62	20,34	0,34			CL
S-104-21-02-12	23,50-23,90	39,35	2,68	1,42	1,85		1,10	51,90	47,00			51,17	27,35	23,82	0,50			CH
S-104-21-02-13	24,50-24,60	41,87	2,70				2,80	73,00	24,20		3,65E-07	48,38	23,57	24,81	0,26			CL
S-104-21-02-14	27,50-27,60		2,76				81,90	12,00	6,10		9,73E-04							SC
S-104-21-02-15	29,50-29,60		2,68				56,90	29,10	14,00		6,20E-06							SC/CL
S-104-21-02-16	30,70-30,80	54,46	2,57				24,10	46,70	29,20		1,91E-07	88,88	29,54	59,33	0,58	12,52	35,12	OH
S-104-21-02-17	31,20-31,30	26,66	2,69				3,00	40,80	56,20			39,69	22,91	16,78	0,78			CL
S-104-21-02-18	31,90-32,00	16,89	2,78				63,10	27,10	9,80		2,92E-05							SC
S-104-21-02-19	33,00-33,10					48,90	32,10	12,80	6,20		2,73E-03							GC
S-104-21-02-32	34,90-35,00					56,20	30,10	6,80	6,90		1,40E-02							GC
S-104-21-02-20	36,00-36,10					47,70	35,60	9,60	7,10		7,02E-03							GC
S-104-21-02-33	37,90-38,00					48,60	32,90	9,20	9,30		2,71E-03							GC
S-104-21-02-21	39,00-39,10					54,90	33,60	5,80	5,70		1,03E-01							GP-GC
S-104-21-02-34	40,00-40,10					39,20	42,00	8,60	10,20		2,73E-03							SC/GC

GEOKON - ZAGREB d.d.

PHYSICAL PROPERTIES TABLE

SAMPLE ID	DEPTH	WATER CONTENT	PARTICLE DENSITY	BULK DENSITY		PARTICLE SIZE DISTRIBUTION						PLASTICITY LIMITS		PLASTICITY INDEKS	CONSISTENCY INDEKS	COMBUSTIBLE CONTENT	ORGANIC CONTENT	SYMBOL
	m	w [%]	ρ_s [g/cm^3]	ρ_d [g/cm^3]	ρ [g/cm^3]	G [%]	S [%]	M [%]	C [%]	M + C [%]	VDP USBR k [cm/s]	wL [%]	wP [%]	IP [%]	IC	[%]	[%]	
S-104-21-02-35	41,50-41,60					53,60	34,00	6,10	6,30		1,05E-01							GC
S-104-21-02-22	42,00-42,10					56,00	31,10	6,10	6,80		7,51E-02							GC
S-104-21-02-36	43,00-43,10					64,90	25,50	4,90	4,70		5,21E-01							GP-GC
S-104-21-02-23	43,90-44,00					65,50	25,60	4,20	4,70		7,91E-01							GP-GC
S-104-21-02-37	45,00-45,10					45,00	40,00	7,60	7,40		6,72E-02							GC/SC
S-104-21-02-24	46,90-47,00					65,70	27,40	3,80	3,10		5,08E-01							GP-GC
S-104-21-02-38	47,90-48,00					56,90	30,20	6,50	6,40		3,01E-02							GC
S-104-21-02-39	48,90-49,00					40,40	38,20	8,80	12,60		3,53E-04							GC
S-104-21-02-25	49,90-50,00					33,00	38,50	11,70	16,80		6,82E-06							SC/GC
S-104-21-02-42	50,00-53,00																	Kon
S-104-21-02-40	50,90-51,00					51,50	34,70	6,50	7,30		2,65E-02							GC
S-104-21-02-41	51,90-52,00					50,80	33,10	7,60	8,50		4,89E-02							GC
S-104-21-02-26	52,90-53,00					52,20	29,80	7,60	10,40		2,41E-02							GC
S-104-21-02-43	53,90-54,00					62,30	23,40	6,70	7,60		2,97E-02							GC
S-104-21-02-27	54,70-55,00	30,04	2,67	1,46	1,91		2,60	68,90	28,50		4,88E-07	39,21	24,28	14,93	0,61			CL
S-104-21-02-44	56,00-56,10					45,80	25,40	11,00	17,80		4,81E-06							GC
S-104-21-02-28	57,00-57,10					45,10	34,10	9,00	11,80		3,79E-04							GC
S-104-21-02-45	58,00-58,10					58,00	26,70	6,60	8,70		2,27E-02							GC
S-104-21-02-46	59,00-59,10					57,30	23,00	7,10	12,60		3,61E-03							GC
S-104-21-02-29	60,00-60,10					51,30	34,00	5,60	9,10		9,31E-02							GC
S-104-21-02-47	61,00-61,10					31,90	39,70	12,30	16,10		6,54E-06							SC
S-104-21-02-48	62,00-62,10					52,80	30,40	6,90	9,90		4,19E-02							GC
S-104-21-02-30	63,00-63,10					40,50	34,10	9,70	15,70		2,29E-05							GC
S-104-21-02-49	63,90-64,00					72,50	25,10	1,50	0,90		9,48E-01							GP

GEOKON - ZAGREB d.d.

PHYSICAL PROPERTIES TABLE

SAMPLE ID	DEPTH	WATER CONTENT	PARTICLE DENSITY	BULK DENSITY		PARTICLE SIZE DISTRIBUTION						PLASTICITY LIMITS		PLASTICITY INDEKS	CONSISTENCY INDEKS	COMBUSTIBLE CONTENT	ORGANIC CONTENT	SYMBOL
	m	w [%]	ρ_s [g/cm^3]	ρ_d [g/cm^3]	ρ [g/cm^3]	G [%]	S [%]	M [%]	C [%]	M + C [%]	VDP USBR k [cm/s]	wL [%]	wP [%]	IP [%]	IC	[%]	[%]	
S-104-21-02-50	64,50-64,60					60,10	26,50	5,80	7,60		1,01E-01							GC
S-104-21-02-51	65,50-65,60					51,20	25,60	8,60	14,60		1,21E-04							GC
S-104-21-02-31	66,00-66,10					66,10	23,50	4,50	5,90		1,90E-01							GP-GC
S-104-21-02-52	67,50-67,60					61,90	26,20	6,00	5,90		4,99E-02							GP-GC
S-104-21-02-53	68,50-68,60					47,30	32,20	7,80	12,70		6,13E-04							GC
S-104-21-02-54	69,50-69,60					66,70	21,70	6,20	5,40		1,00E-01							GP-GC
S-104-21-02-55	70,50-70,60					67,40	23,00	4,50	5,10		3,50E-01							GP-GC
S-104-21-02-56	71,50-71,60					56,30	29,90	5,10	8,70		3,77E-02							GC
S-104-21-02-57	72,50-72,60					54,40	29,80	6,00	9,80		3,60E-02							GC
S-104-21-02-58	73,50-73,60					52,80	29,60	8,10	9,50		6,74E-03							GC
S-104-21-02-59	74,90-75,00					61,70	27,70	4,90	5,70		1,60E-01							GP-GC
S-104-21-02-60	75,90-76,00					46,50	34,60	7,20	11,70		2,60E-03							GC
S-104-21-02-61	76,90-77,00					58,40	28,40	6,00	7,20		1,26E-01							GC
S-104-21-02-62	77,90-78,00					48,10	31,50	6,80	13,60		3,69E-04							GC
S-104-21-02-63	78,90-79,00					47,40	30,40	7,80	14,40		2,35E-04							GC
S-104-21-02-64	79,90-80,00					41,00	32,80	8,70	17,50		9,07E-06							GC
S-104-21-02-65	81,00-81,10					65,30	19,20	6,70	8,80		3,84E-02							GC
S-104-21-02-66	82,00-82,10					54,10	29,80	7,50	8,60		1,19E-02							GC
S-104-21-02-67	83,00-83,10					56,20	30,10	4,70	9,00		7,84E-02							GC
S-104-21-02-68	84,00-84,10					63,50	26,90	4,50	5,10		3,90E-01							GP-GC
S-104-21-02-69	85,00-85,10					85,30	10,60	2,90	1,20		1,91E+01							GW
S-104-21-02-70	86,50-86,60					78,80	16,20	3,10	1,90		9,65E+00							GP-GC
S-104-21-02-71	88,00-88,10					75,30	21,40	1,80	1,50		5,45E+00							GP
S-104-21-02-72	89,90-90,00					55,40	31,70	6,50	6,40		9,20E-02							GC

GEOKON - ZAGREB d.d.

PHYSICAL PROPERTIES TABLE

SAMPLE ID	DEPTH	WATER CONTENT	PARTICLE DENSITY	BULK DENSITY		PARTICLE SIZE DISTRIBUTION						PLASTICITY LIMITS		PLASTICITY INDEKS	CONSISTENCY INDEKS	COMBUSTIBLE CONTENT	ORGANIC CONTENT	SYMBOL
	m	w [%]	ρ_s [g/cm^3]	ρ_d [g/cm^3]	ρ [g/cm^3]	G [%]	S [%]	M [%]	C [%]	M + C [%]	VDP USBR k [cm/s]	wL [%]	wP [%]	IP [%]	IC	[%]	[%]	
BOREHOLE		**B-3 (S-104-21-03)**																
S-104-21-03-01	0,50-0,60		2,75			0,90	71,60	10,30	17,20		9,32E-06							SC
S-104-21-03-02	1,50-1,60		2,78			15,20	84,60			0,20	3,36E-02							SP
S-104-21-03-03	4,50-4,60		2,78			10,40	89,00			0,60	2,58E-02							SP
S-104-21-03-04	7,50-7,60		2,78			9,90	89,90			0,20	5,61E-02							SP
S-104-21-03-05	10,00-10,10		2,78				74,90	17,50	7,60		3,42E-04							SC
S-104-21-03-06	12,50-12,60		2,78				75,40	17,00	7,60		3,42E-04							SC
S-104-21-03-07	13,50-13,60	34,33	2,78				56,50	26,60	16,90		3,33E-06	32,23	22,41	9,82		9,12	1,76	SC/CL
S-104-21-03-08	15,00-15,30	38,36	2,69	1,41	1,88		4,80	58,40	36,80		2,59E-07	44,84	21,48	23,37	0,28			CL
S-104-21-03-09	17,00-17,30	38,43	2,69	1,36	1,85		3,10	53,70	43,20			46,75	22,70	24,05	0,35			CL
S-104-21-03-10	19,70-20,00	38,09	2,69	1,34	1,83		33,20	34,20	32,60			49,79	23,13	26,66	0,44			CL

GEOKON - ZAGREB d.d.

MECHANICAL PROPERTIES TABLE

SAMPLE ID	DEPTH	PERMEABILLITY COEFFICIENT			SYMBOL
		σ_{300}	σ_{400}	σ_{500}	
	m	k [cm/s]			
BOREHOLE		**B-1 (S-104-21-01)**			
S-104-21-01-02	2,00-2,30	6,30E-08	4,60E-08	2,50E-08	CH
S-104-21-01-08	13,30-13,60	8,70E-08	5,90E-08	3,90E-08	CL
S-104-21-01-11	18,50-18,80	6,90E-08	4,00E-08	3,60E-08	CL
S-104-21-01-14	24,70-25,00	2,50E-07	1,20E-07	3,60E-08	CL
BOREHOLE		**B-2 (S-104-21-02)**			
S-104-21-02-08	17,60-17,90	7,70E-08	6,00E-08	5,30E-08	CL
S-104-21-02-10	20,40-20,80	1,30E-07	6,50E-08	3,40E-08	CL
S-104-21-02-12	23,50-23,90	2,90E-08	2,70E-08	1,40E-08	CH
BOREHOLE		**B-3 (S-104-21-03)**			
S-104-21-03-08	15,00-15,30	4,10E-08	2,10E-08	1,30E-08	CL
S-104-21-03-09	17,00-17,30	3,70E-08	2,60E-08	2,20E-08	CL
S-104-21-03-10	19,70-20,00	2,60E-08	2,20E-08	2,10E-08	CL