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FOR METALLURGICAL WORKS DESIGN

UKRDIPROMEZ SE

Plant **EuroCape Ukraine I LLC**

Project **Sites for Wind Power Plant Units in Pryazovske Rayon of Zaporizhzhia Oblast (First-Priority Operations)**

Part **Building Site Survey**

Project stage **Urban Planning Verification**

ДТ 349653
identification

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Dnipropetrovsk
2009

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Building Site Survey Finding for Wind Power Plant Units in Pryazovske Rayon of Zaporizhzhia Oblast (First-Priority Operations)

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1. Introduction

In September of 2009 the Geological and Topographical Department of Ukrdipromez SE carried out a site exploration under the agreement with EuroCape Ukraine I LLC according to the requirements of Diproprom Institute at eight points where WPP units are to be deployed in Pryazovske Rayon of Zaporizhzhia Oblast.

The locations of the WPP units are shown on Diproprom SE Drawing (Annex to the Requirements Specification) # M 2300-ГТ of 8 August 2009. As the drawing does not include an altimetric survey, the holehead heights are shown as 0.00 (ground surface) and the soil layer depth data are shown on the strip logs from the ground surface, which has been agreed upon (see Annex 1, Letter from Mr. L.I. Klymenko, Head of Geological and Topographical Department, to Mr. P. O'Brien).

The exploration holes were drilled by a mechanical percussive-rotary method with ПБУ-2-119 A drilling rig by a team of I.I. Martynenko. L.S. Yaroshchuk, V.T. Golovko and V.L. Paravenkov took part in the organization of work. G.A. Shtepa, Task Team Leader, was in charge of integrated field operations. The in-situ soil tests and description were carried out by T.V. Lysa and V.L. Paravenkov.

The laboratory tests of soil and groundwater were made by T.I. Zemliana, Head of Ukrdipromez SE Soil Laboratory, and Y.I. Ogiychenko, Laboratory Engineer.

All the geological staff of the Department was involved in the desk study of the field data and laboratory tests and in the preparation of the Building Site Survey Finding.

II. General

The study area is located in the Azov Seaside Geomorphologic Region. This is a territory limited by Donetsky Ridge in the north, the Azov Sea in the south, the Molochna River with the estuary in the west and the Mius River in the east. In terms of origin it is a secondary plain. In hypsometric terms it is a plateau. Its surface is undulating, slightly graded towards the Azov Sea. The river valleys (the Molochna – the Estuary) in the southern part of the Azov Seaside Plateau have a complicated structure. Being deeply cut in and very expanded, they do not correspond to the contemporary river sizes.

The actual survey area abuts on the Azov Sea in the south and is limited with the Molochny Estuary in the west. In geomorphologic terms it is a flat plain (peneplain) with the heights of land varying from 10 to 20. The survey points are scattered across the site with the approximate area 15 x 9 km. The area includes the Villages of Dunayivka, Victorivka, Oleksandrivka, Stepanivka Persha and their neighbouring lands. In terms of administrative division the area belongs to Pryazovske Rayon of Zaporizhzhia Oblast.

In climatic terms this is a subhumid area with the groundwater mainly fed by year-round precipitation. The average annual precipitation does not exceed 300 mm. The average annual air temperature is $+8^{o}$ C.

The region of the survey used to be a geological exploration target for natural gas (Ukrvostokneftegazrazvedka) and potable water supply (Pivdenukrgeologia and Zaporozhvodstroy). The materials of these organizations are summarized and published. The publications are used in the parts of this Survey Finding which cover the general issues of geotectonics, stratigraphy, groundwater hydrology and geotechnical characteristics of the deposits in the surveyed area.

The detailed data on each of the eight drilling points are specified in the columns of the drilling holes and the physical and mechanical properties of the soils in each layer.

The Building Site Survey Finding also includes the columns of Zaporozhvodstroy drilling holes located in the region of survey and the schematic geological cross-sections.

III. Geology of the surveyed area

1) The plots for deployment of the wind power plants are located within the northern slope (margin) of the Black Seaside Depression, which is a monocline. The Precambrian granite-gneissic crystalline basement is inclined southward and deeply sunk. The embedding is benched. The northern border of the Precambrian abrupt sinking goes along Perekop-Berdiansk-Mariupol line. The crystalline basement faults and sinking occurred in the Jurassic period. After that the sediment accumulation processes prevailed until the early Pleistocene (beginning of the Anthropogene – Quaternary). The sediment accumulation process was complicated with oscillatory motions related to the continuing tectonic genesis.

2) On the Precambrian crystalline basement in the range of depths 1.2 – 0.5 km there are upper cretaceous deposits (Gr_2) consisting mainly of glauconitic sandstones.

3) Tertiary deposits.

Drilling of deep holes (Ukrvostokneftegazrazvedka) revealed a thick mass of Paleogene deposits (Pg_1, Pg_2, and Pg_3) above the top of Mesozoic (Cetaceous) deposits. These layers are studied in the most detail in the Molochna River basin in Pryazovske Rayon (the neighbourhood of Stepanivka, Dunayivka and Oleksandrivka Villages).

Here, the Paleogene deposits include carboniferous terrestrial formations of Buchak stage and marine sandy-argillaceous deposits of Kyiv and Kharkiv stages. The terrestrial carboniferous deposits (Pg_1) include a series of alternate grey and black coaly sandy clays with lentils of brown coal and sandy secondary kaolins (terrigenous stratum). These deposits overlap the Cretaceous (or Precambrian) strata transgressively. The thickness of carboniferous deposits varies in a wide range and reaches 20 – 50 m in the lowest sections of the Pretertiary relief.

The carboniferous deposits are increasingly inclined southward, i. e. along the sinking of the crystalline basement. The coal-bearing series, like the whole series of Paleogene deposits, deepens steeply following the basement relief.

The marine deposits of Kyiv stage (stratigraphically overlaying the terrestrial carboniferous deposits) consist of marls.

In the region of Stepanivka, Dunayivka, Oleksandrivka and Prymorsky Posad Villages the lower part of Kyiv stage consists of glauconitic sands and brownish grey and greenish grey coarse sands with quartz gravel. In the Village of Stepanivka the marls of Kyiv stage occur on the Middle Eocene limestones.

A series of greenish glauconitic noncalcareous sandy and clay strata of Kharkiv Stage overlays the marl clays stratigraphically. The aggregate thickness of such strata is 62 – 150 m.

A thick series of Neogene deposits occurs above the top of Paleogene deposits. Within the surveyed area the thickness of such strata varies from 100 to 250 m.

Clays with bands of marl and fine sand are revealed in the neighbourhood of Stepanivka Village at a depth of 250 m. There are also pyrite nodules (Pliocene). In the Sivash neighbourhood and the plots adjacent to the valley of the Molochna River, the Neogene includes sandy strata with silicon pebble (lower Sarmatian stage) and narrow bands of limestones and sandy marls.

4) The Quaternary deposits (Anthropogene) consist mainly of terrestrial sediments. The estuary and marine deposits are only limited to the narrow band along the Azov Sea and the Sivash.

The terrestrial beds include the mass of Aeolian soils and loess loams.

In the large drainless soles the mass of Aeolian soil and loess loams is transformed into greenish grey bottom loams and clays by gleization.

At the shore of the Azov Sea, the Sivash and the Molochny Estuary the stratum of Aeolian soil and loess loams sinks below the sea level in some places. Such sinking is caused by epeirogenic foundering of the seafloor section of the mainland in the Quaternary time.

This study focuses on the use of natural Quaternary (Q) and Tertiary (N_{II}^{2-3}) strata (soils) as bases of foundations.

The geology of the surveyed sites (bottom-up) to the depth of drilled holes includes middle to upper Pliocene deposits consisting of clays (N_2kl).

Marine sandy-argillaceous Cimmerian-Kuyalnik deposits (N_2k-kl) occur above the clays. Above such deposits there are red brown clays of late Pliocene and early Pleistocene ($N_2 – Q_1$). The Pleistocene loess soils (L_{II-III}) cover the area as a continuous blanket essentially in all places except for erosion valleys and gullies.

The detailed data on the strata occurring on the building sites are shown in the strip logs and the engineering-geological passports of Sites 1-8.

IV. Groundwater conditions

The surveyed area is located in the Dnipro-Molochna hydrogeological region (Index 4.4.6.A – II' (B)-27).

The free aquifer is pervasive in the Anthropogene blanket terrestrial (recent) marine, estuary-marine and lacustrine-marine deposits. The level of the Azov Sea, the Sivash Bay and the Molochny Estuary is the hydrological basis of drainage for this aquifer. Upper and middle Pliocene loams and clays underlay water-bearing silica inequigranular argillaceous sands and less frequent loamy sands.

The phreatic aquifer in the region of Molochny Estuary is limited to the buried high-water bed.

The alluvial water-bearing deposits, which make up terraces I-III above the flood-plain of the Molochna River (Hydrogeological Landscape Systems (HGLS) 6a $(II)^{I}$), consist mainly of argillaceous sands, 1 – 18 m thick. The depth of the level occurrence is 0.2 – 10 m. The water-bearing sedimentary alluvia are covered with aeoline-diluvial loams. The confining layer is Pliocene clay loams and clays, which make the first stable regional confining layer from the ground surface.

As a whole, sodium sulphate-chloride water with the salinity from 2-3 to 13 g/dm^3 prevails in the Azov Seaside Geomorphologic Region. Total hardness of the water varies from 20.4 to 70.7 mg-eq., pH = 7.4 – 7.8. The flow rate of the drilling holes is 0.2 to 1-2 l/sec. The daily water intake from the wells does not exceed 2 m^3, more often being 0.2 – 0.4 m^3. The permeability is 1.0 – 7.2 m/day.

The survey carried out directly at the sites resulted in the data shown below, in Table 1:

Table 1

Hole No. – Lab. No.	Degree of groundwater sulphate aggressiveness to the grades of concrete as per SNiP 2.03.11-85:		
	W_4	W_6	W_8
Portland cement GOST 10178-76			
1-16	Non-aggressive	Non-aggressive	Non-aggressive
1-17	Strongly aggressive	Strongly aggressive	Strongly aggressive
2-10	Medium-aggressive	Mildly aggressive	Mildly aggressive
2-9	Strongly aggressive	Strongly aggressive	Strongly aggressive
3-12	Mildly aggressive	Non-aggressive	Non-aggressive
3-11	Medium-aggressive	Mildly aggressive	Non-aggressive
4-24	Mildly aggressive	Non-aggressive	Non-aggressive
5-18	Strongly aggressive	Medium-aggressive	Non-aggressive
5-19	Non-aggressive	Non-aggressive	Non-aggressive
6-25	Mildly aggressive	Non-aggressive	Non-aggressive
7-21	Non-aggressive	Non-aggressive	Non-aggressive
8-22	Strongly aggressive	Strongly aggressive	Mildly aggressive
8-23	Non-aggressive	Non-aggressive	Non-aggressive
Well (78 Frunze St.,	Strongly aggressive	Medium-aggressive	Mildly aggressive

Dunayivka Village)			
Drilling hole (34 Kotovskogo St., Dunayivka Village)	Medium-aggressive	Mildly aggressive	Non-aggressive
Well (84 Frunze St., Dunayivka Village)	Strongly aggressive	Strongly aggressive	Medium-aggressive
Slag portland cement			
1-16	Non-aggressive	Non-aggressive	Non-aggressive
1-17	Mildly aggressive	Non-aggressive	Non-aggressive
2-10	Non-aggressive	Non-aggressive	Non-aggressive
2-9	Non-aggressive	Non-aggressive	Non-aggressive
3-12	Non-aggressive	Non-aggressive	Non-aggressive
3-11	Non-aggressive	Non-aggressive	Non-aggressive
4-24	Non-aggressive	Non-aggressive	Non-aggressive
5-18	Non-aggressive	Non-aggressive	Non-aggressive
5-19	Non-aggressive	Non-aggressive	Non-aggressive
6-25	Non-aggressive	Non-aggressive	Non-aggressive
7-21	Non-aggressive	Non-aggressive	Non-aggressive
8-22	Non-aggressive	Non-aggressive	Non-aggressive
8-23	Non-aggressive	Non-aggressive	Non-aggressive
Well (78 Frunze St., Dunayivka Village)	Non-aggressive	Non-aggressive	Non-aggressive
Drilling hole (34 Kotovskogo St., Dunayivka Village)	Non-aggressive	Non-aggressive	Non-aggressive
Well (84 Frunze St., Dunayivka Village)	Non-aggressive	Non-aggressive	Non-aggressive
Sulphate-resistant cements GOST 22266-76			
1-16	Non-aggressive	Non-aggressive	Non-aggressive
1-17	Non-aggressive	Non-aggressive	Non-aggressive
2-10	Non-aggressive	Non-aggressive	Non-aggressive
2-9	Non-aggressive	Non-aggressive	Non-aggressive
3-12	Non-aggressive	Non-aggressive	Non-aggressive
3-11	Non-aggressive	Non-aggressive	Non-aggressive
4-24	Non-aggressive	Non-aggressive	Non-aggressive
5-18	Non-aggressive	Non-aggressive	Non-aggressive
5-19	Non-aggressive	Non-aggressive	Non-aggressive
6-25	Non-aggressive	Non-aggressive	Non-aggressive
7-21	Non-aggressive	Non-aggressive	Non-aggressive
8-22	Non-aggressive	Non-aggressive	Non-aggressive
8-23	Non-aggressive	Non-aggressive	Non-aggressive
Well (78 Frunze St., Dunayivka Village)	Non-aggressive	Non-aggressive	Non-aggressive
Drilling hole (34 Kotovskogo St., Dunayivka Village)	Non-aggressive	Non-aggressive	Non-aggressive
Well (84 Frunze St., Dunayivka Village)	Non-aggressive	Non-aggressive	Non-aggressive

The degree of groundwater attack in terms of chloride content (Cl^- - 883.50-14,202.50 mg/dm^3) against concrete reinforcement varies from non-aggressive to mildly aggressive for permanently immersed structures and from medium- to strongly aggressive for regularly wetted structures. The estimation of groundwater aggressiveness in terms of other indices and the water test data are provided in Text Annex 6.

The fluctuations of water levels in the wells of the villages neighbouring the estuary are negligible. Only in spring the level rises by 1.0 – 1.5 m. As a whole, for the period of 30 – 40 years the level has fallen by 1.2 – 1.5 m. The reason is that the Molochny Estuary as the base level of drainage is blocked by surfy alluvium and the connection with the sea is disrupted and, therefore, the estuary is not being replenished. This leads to shoaling of the estuary, i. e. lowering of the hydrological base level of drainage. The result is general recession of water level in the wells. The groundwater is recharged only at the expense of precipitation, which does not exceed 300 mm a year. The stable thickness and essentially general occurrence of Kuyalnik clays limit the possibility for the aquifer to be replenished at the expense of the underlying Paleogene aquifer systems.

In drilling hole 5 (the closest to the estuary) the perched groundwater was observed at a depth of 0.9 m, which is caused by the influence of surface water body. The piezometric level of the confined aquifer limited to silica sands (N_2k-kl) is observed at a depth of 2.20 m in this drilling hole.

In drilling holes 1, 2, 3, 4, 6 and 7 the heights of the free phreatic aquifer (perched groundwater) coincide with the heights of the confined aquifer limited to the sands. It is the evidence of the hydraulic connection between these aquifers within the study area. The analysis of the built schematic geological cross-sections (III-III' – IV-IV') does not contradict to the aforesaid.

The abnormally high salinity of 20,204 mg/dm^3 is observed in drilling hole 2.

In the other drilling holes the values vary from 2,700 to 11,720 mg/dm^3 and in each hole the salinity increases with the increase of sampling depth: hole 1 (2,702 to 10,894 mg/dm^3), hole 5 (2,912 to 7,816 mg/dm^3), hole 3 (2,466 to 5,236 mg/dm^3).

Three water samples from wells:
78 Frunze St. – 4,660 mg/dm^3;
34 Kotovskogo St. – 4,280 mg/dm^3;
84 Frunze St. – 5,722 mg/dm^3.

Therefore, the groundwater analyses do not disprove the hydraulic connection between the aquifers, though the degree of stagnation increases with the depth despite the fact that the permeability of aquifers also increases with the depth.

Such state indicates that precipitation is the main source of feed for the aquifer of perched groundwater. Its desalinating effect is the most intensive during the period of snow melting in winter and spring. As during the recent decades the precipitation is 200-300 mm/year, their impact on the desalination has slowed down.

As no water loss is expected to be caused by any industrial or engineering factors, there will be no changes in the mode of levels and hydrochemistry. The nature of the changes will be only seasonal. Judging from the fluctuations of water levels in the wells, the actual fluctuations do not exceed ± 1.00 m vs. those observed at the time of drilling (low water: July, flood: March).

V. Geotechnical conditions of the area

In accordance with its objectives, the survey paid a special attention to the Quaternary and the upper part of Tertiary (Neogene) deposits as bases of foundations. The points of survey cover the approximate area of 15 x 9 km. All this area is covered with Quaternary deposits down from the top. Loess, which was formed during all the period of Pleistocene, prevails among the Quaternary deposits. It covers the interfluvial plains and the buried river valleys and terraces like a blanket. Such deposits are absent only in the gullies, the river high-water beds where the sandy alluvium occurs down from the top, and in the denudation uplands. In most of the area the thickness of the loess cover reaches 20 m.

The loess includes aeoline-diluvial, residual and talus, and alluvial Quaternary types. The alluvial type is observed in drilling hole 2. As a whole, the loess series is made up of three (less frequent four) rhythms, each including fossil soil, subhorizon of loess and subhorizon of loess loams (Krayev 1971, Veklich 1968). Within the surveyed area no full rhythm of lithogenesis is observed because of the long erosion process following the aeoline-diluvial sediment accumulation.

The sand and pulverescent fractions of the loess include more than 50 minerals. The rock-forming minerals are quartz (70-95%) and feldspars (5-30%), as well as carbonates (1-10%), mica, gypsum and glauconite. The fine fraction of the loess includes montmorillonite and hydromica. The largest amount of humus is in the fossil soils (0.32 – 1.24%), which is 3-9 times as much as it is in the modern chernozem. The largest content of water-soluble salts is observed in the lower part of the loess stratum and the smallest one is in the upper well-flushed (degraded) horizons of bottom loams (<0.34%). The content of sand fractions decreases and the content of pulverescent and clay fractions increases with the depth. The subsidence of loess soils in the zone of suspended water (above the groundwater table) depends on their age. The subsidence and compressibility decreases and the strength increases with the age of strata.

Characteristics of the marine Neogene clays (depth interval 12 – 40 m)

Moisture at the plastic limit W_p, fractions	0.28 – 0.35
Index of plasticity I_p, fractions	0.33 – 0.43
Density γ, g/cm^3	1.83 – 1.87
Porosity factor e, fractions	0.47 – 0.82
Angle of internal friction, degrees	14-18
Cohesion c, Pa	$0.63 \times 10^5 – 1.50 \times 10^5$
Natural moisture W, fractions	0.205 – 0.245

Characteristics of the terrestrial red brown clays (depth interval 0.5 - 9.0 m)

Moisture at the plastic limit W_p, fractions	0.26 - 0.28
Index of plasticity I_p, fractions	0.18 – 0.24
Density γ, g/cm^3	1.96
Dry density γ_s, g/cm^3	1.58
Porosity factor e, fractions	0.67 – 0.72

Angle of internal friction, degrees	14-17
Cohesion c, Pa	$0.45 \times 10^5 – 0.54 \times 10^5$

The red brown clays make the first stable regional confining layer from the ground surface.

Characteristics of the loess in the Azov Seaside Subregion of the Ukrainian Crystalline Core-Area

Ground particle number density γ_d	2.63 – 2.81 g/cm^3, 2.73 g/cm^3 on average
Density γ	1.35 – 2.05 g/cm^3, 1.71 g/cm^3 on average
Dry density γ_s	1.24 – 1.67 g/cm^3, 1.48 g/cm^3 on average
Porosity n	31.20 – 54.00 %, 41.60 % on average
Natural moisture W	0.088 – 0.321 fractions
Moisture at the liquid limit W_l	0.250 – 0.667 fractions, 0.412 fractions on average
Moisture at the plastic limit W_p	0.117 – 0.396 fractions, 0.237 fractions on average
Index of plasticity I_p	0.08 – 0.20 fractions, 0.175 fractions on average
Coefficient of relative subsidence at a pressure of 3 kg/cm^2 – 0.014	
Angle of internal friction φ	22 – 25°, 25° on average
Cohesion c	$0.09 \times 10^5 – 0.60 \times 10^5$, 0.23×10^5 Pa on average

In accordance with par. 2.17 and 2.18 of Ukrainian Building Code (DBN) A.2.2-1-2003 (Environmental Impact Assessment during Design and Construction), the preliminary data on the engineering data of the designed facilities and the geological conditions of the soil environment for the foundations indicate the following:

- no negative impact of the projects on the sustainability of geological environment is expected;
- no negative impact of the geological environment on the facilities is expected.

A pattern was revealed in the process of drilling: the time of the casing pipes in the soil environment is directly proportional to the force of soil sticking to the pipes. Such process is called a silica gel skinning effect at the soil – casing pipe interface.

The aforesaid indicates that in the event of piling such processes will increase the friction against the side face of piles. The study of analogues in the similar geological conditions show that the pile capacity may increase by a factor of 1.5 with time as compared with the data from the tests held 1 – 1.5 month after the palification.

Characteristics of the seismic conditions

The relative proximity to the Crimean Mountain Ridge, which is a geosynclinal belt, makes it necessary to consider the seismicity conditions in the surveyed area.

In accordance with DBN B.1.1-12: 2006 (Protection against Hazardous Geological Processes and Harmful Impacts. Kyiv, 2006), this area has the following characteristics:

- probability of 1% increase in MSK-64 seismic intensity within 50 years (the seismic gap is 5,000 years) is 7 points on a 1-10 scale;
- probability of 5% increase in MSK-64 seismic intensity within 50 years (the seismic gap is 1,000 years) is 6 points on a 1-10 scale;
- probability of 10% increase in MSK-64 seismic intensity within 50 years (the seismic gap is 500 years) is 6 points on a 1-10 scale.

VI. Geotechnical conditions of the sites for the designed projects and foundation recommendations

In the surveyed sites the loess limons are not collapsible. But during the construction the foundation pits must not get wet with precipitation because the loess soils change their consistency if saturated with water, which leads to reduction of the specific cohesion and the modulus of deformation. If a foundation pit has large horizontal dimensions, saturation with water inside the pit will not always be equal and by the time of concrete casting the characteristics of the same layer of loess soils may be different in different ends of the pit, which is not allowable. Therefore, the wetting of pits must be strongly prevented.

Given the structural embedment of the foundations to a depth of 4.00 m and that the future grade levels will slightly exceed the existing ground levels (up to 1.5 m), at seven of the sites (except for Site 2) the bottom of the foundation pits will be in the Quaternary limons, mainly in loess soils.

These grounds are quite different at different sites (E is 10 to 23 MPa). Consequently, the structural concepts of the foundation will not be standard. The Requirements Specification does not include the expected vertical and horizontal foundation loads. But the horizontal loads will be determinative for the foundation design, given the height of the structures (about 100 m) and the wind loads against the wind power plant units. It appears that the horizontal loads may be reacted properly by means of piling. The piles of 350 x 350 mm, 10 m long (abutting against the Tertiary clays or sands) will have a capacity of about 80 t. And the pile capacity will increase with time (0.5 – 1 year) up to 90-100 t because of silica gel skinning at the pile – soil interface. The horizontal pile loads are 5-7 t. The pulling load is 12 t. At the site of hole 2 the greenish grey clay may serve as the natural bed, but the horizontal load accommodation with the varying vector of wind load application may necessitate piling.

Where the 4-meter bottom of the foundation pit comes upon plastic loess loams, it may be advisable to lay a bed under the foundations or under the caps of pile field. Such bed should be made of crushed magmatic silicate rocks (granite, gneiss, migmatite) or of cast blast-furnace slag of stable structure not susceptible to ferrous and silicate decomposition.

The detailed characteristics of soils at the surveyed sites and the detailed recommendations on foundation are described in the engineering-geological passports of the sites.

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4 September 2009

To: Mr. Peter Justin O'Brien
Director
EuroCape Ukraine I LLC

Dear Mr. O'Brien,

In response to your request, please see attached the standard sample of a strip log.

Attachment: 1 copy.

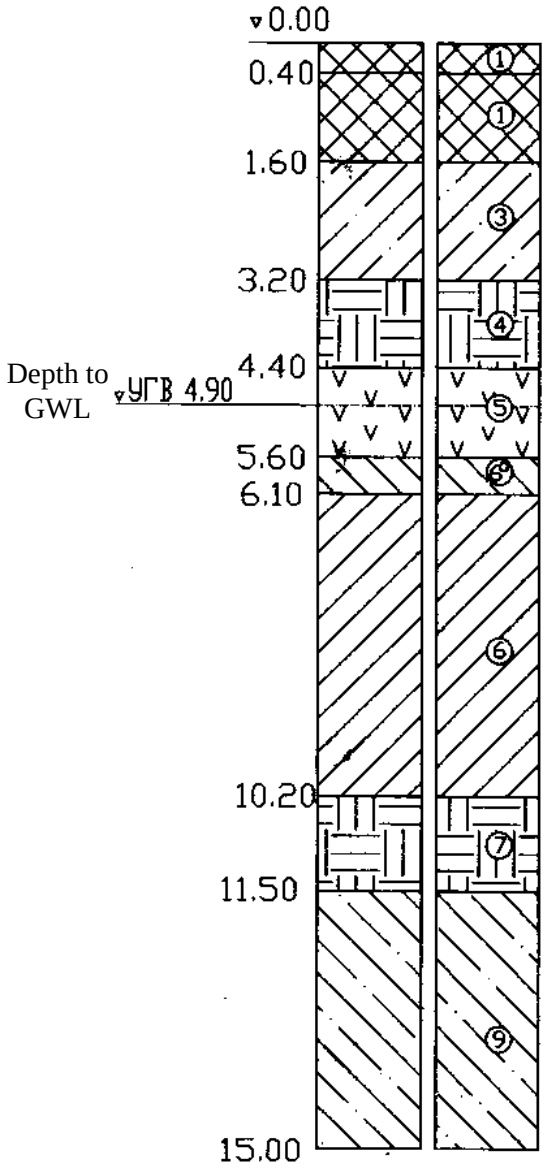
Sincerely,

//signed//

L.I. Klymenko
Head of Geological and Topographical Department,
Ukrdipromez SE

Drilling Hole 6202
Scale 1:100

Date of drilling: July 2009



Filled-up layer: asphalt

Filled-up layer: concrete, greyish brown loam, brick

Pale yellowish brown loess loam, calcareous, with plant roots, medium-hard and hard

Buried soil of I horizon (dark grayish brown loam, humus, low plasticity)
Light pale yellow loess loam, high plasticity, from the depth of 4.90 – of wet consistency
Brown loess loam, with calcareous inclusions, low plasticity

Brown loess loam, with calcareous inclusions, medium-hard to hard

Buried soil of II horizon (dark grayish brown loam, slightly humus, low plasticity)

Brown loam, with medium-hard and hard calcareous inclusions

As instructed by the Customer, we present to your attention a strip log of a drilling hole (drilled in Krivoy Rog) as a template for logging data from the drilling holes at the sites of the wind power plant units in Pryazovske Rayon of Zaporizhzhia Oblast. 'GWL' abbreviation means 'groundwater level'. Since no altimetric survey is being carried out at the moment, the holehead height is defined as ▽0.00.

Prepared by: //signed// A.A. Kononenko
Checked by: //signed// G.A. Shtepa

Д 51075-110	Sheet
	2

Paper size A4 (0.125)

STATE ENTERPRISE "STATE INSTITUTE FOR INDUSTRIAL DESIGNS"
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Acct.: 26005050790001 in Industrialbank JSCB, Zaporizhzia,
MFO 313849, EDRPOU 32343302

August 19, 2009

Ref. # 02/174

To: Mr. L.I. Klymenko
Head of Geological and Topographical Department
Dipromez SE
E-mail: postmaster@gipromez.dp.ua

RE: DESIGNING THE 450 MW WIND POWER PLANT IN PRYAZOVSKE RAYON

Dear Mr. Klymenko,

Please see attached the Requirements Specification for the Soil Survey at the Building Sites of Wind Power Plant Units in Pryazovske Rayon of Zaporizhzhia Oblast.

Attachment: Requirements Specification, Drawing M 2300-ГТ.

With kind regards,

//signed//

I.Y. Brodsky
Head of Thermotechnical Department

REQUIREMENTS SPECIFICATION
for the Building Site Survey for Wind Power Plant Units
in Pryazovske Rayon of Zaporizhzhia Oblast
(First-Priority Operations)

1. A separate site for the designed construction shall be located under each tower supporting a wind energy-generating unit.
2. In accordance with this specification the priority is to drill 10 holes: eight under the wind-power units and two under 100 m high wind monitoring towers.
   The depth of 9 holes shall be 20 m but not less than the thickness of the collapsible layer.
   One drilling hole for the tower shall be 30 m deep.
3. The Building Site Survey Finding based on this specification shall include all the data necessary to determine the structure and the cost of the foundations in the urban planning verification (par. 3.48 of USSR Building Code and Regulations (SNiP) 1.02.07-87).
4. The groundwater survey shall be carried out in accordance with par. 3.81 of SNiP 1.02.07-87 and par. 3.113 of the Guidelines to SNiP 2.02-83, M. 1986, developed by I.M. Gersevanov NIIOSP.
5. The building site survey shall be performed in accordance with the guidelines of Ukrainian Building Code (DBN) A 2.1-1-2008 subject to the concretely defining paragraphs of the above guidelines developed earlier by a main Research and Development Institute of the sector (PNIIIS, NIIOSP and others).
6. In terms of general technical characteristics of the facilities in the sector, all the design objects belong to Responsibility Class I (Higher) in accordance with State Standard of the USSR (GOST) 27751-88 (*Reliability of Building Structures and Foundations*).
7. The Building Site Survey Finding shall include data on any potential adverse conditions of the natural and geological environment (seismicity, landslides, declining level of seashores, karst, subsidence, heaving, swelling, etc.)
8. The finding shall correspond to all the requirements of DBN 2.1-1-2008 and other guidelines.
9. The coordinates of the drilling holes under the wind-power units and the location site plan are attached. The coordinates of the towers will be provided additionally by the customer.
10. Specification of the structures:

a. Height: 100 m;
b. Structural embedment: 4 m;
c. Estimated area of the tower: 17 m x 17 m.

Attachment: Drawing M 2300-ГТ.

//signed//

I.Y. Brodsky
Project Engineer

Annex 2

PROGRAM
OF BUILDING SITE SURVEY OPERATIONS

I. GENERAL

1. Name of plant or office: EuroCape Ukraine I LLC.
2. Requirements Specification No.: no number.
3. Customer (department issuing the Requirements): Diproprom Institute.
4. Topographic basis with master plan (or with plot boundaries): Arrangement of Drilling Points.
5. Official responsible for occupational safety in the department: L.I. Klymenko, Head of Geological and Topographical Department.

II. ESTIMATED SCOPE OF WORK

6. Number of drilling holes (open test pits): 8.
7. Depth of drilling holes (open test pits): 20 m.
8. Total meterage: 160 m.
9. Number of static penetration test points: -.
10. Static penetration depth: - m.
11. Total meterage: - m.

III. WORKING PROCEDURE

12. The drilling shall be carried out by means of cable tool percussion and rotary method.
13. Before the operations the points of drilling shall be approved by the Heads of Dunayivka and Oleksandrivka Village Councils.
14. From 100% of holes (open test pits) 97 monolith samples shall be taken with testing.
15. From 30% of holes 8 samples of groundwater shall be taken.
16. Horizontal and vertical positioning of 8 drilling holes shall be arranged.
17. Additional operations: -.

IV. ORGANIZATION OF WORK

18. Assumed seasonal period of operations (due to adverse weather conditions): in accordance with the master plan.
19. The samples of soils and groundwater shall be brought to the laboratory by midget car.

V. DELIVERABLES

20. The input geological data for design shall be provided to the customer.
21. The Building Site Survey Finding shall be sent to the customer, archived for office use.

The Program of Operations was prepared by *//signed//* G.A. Shtepa.

Annex 3

INSPECTION DOCUMENT

Acceptance inspection of Building Site Survey "Sites for Wind Power Plant Units in Pryazovske Rayon of Zaporizhzhia Oblast (First-Priority Operations)" of September – October 2009. This Inspection Document is prepared by Mr. G.A. Shtepa at the site of EuroCape Ukraine I LLC to certify inspection and acceptance of the building site soil and groundwater survey carried out in accordance with the requirements specification without number issued by Diproprom Institute.

The inspection revealed the following:

1. Program (requirements specification) for field work: available.
2. Approval of the drilling holes location by the leading underground service line enterprises: approved.
3. The number and depth of the drilling holes location correspond to the program (requirements specification).
4. No development work was carried out.
5. The number of samples of soil monoliths, soils, disturbed structure and groundwater corresponds to the program (requirements specification).
6. The packing, transportation and storage of the soil and groundwater sampling materials correspond to the regulations.
7. The technical documentation was prepared on the site.
8. Defects revealed during the acceptance were corrected by the contractor, Mr. G.A. Shtepa, Task Team Leader.
9. The field work on the building site soil and groundwater survey is accepted as satisfactory.

Task Team Leader *//signed//* G.A. Shtepa

10. Technical documentation delivered:

1/ Drill logs	3 ea.
2/ Field geological cross-sections	No
3/ Development work logs	No
4/ Groundwater unloading logs	No.

Comments on the site: No.

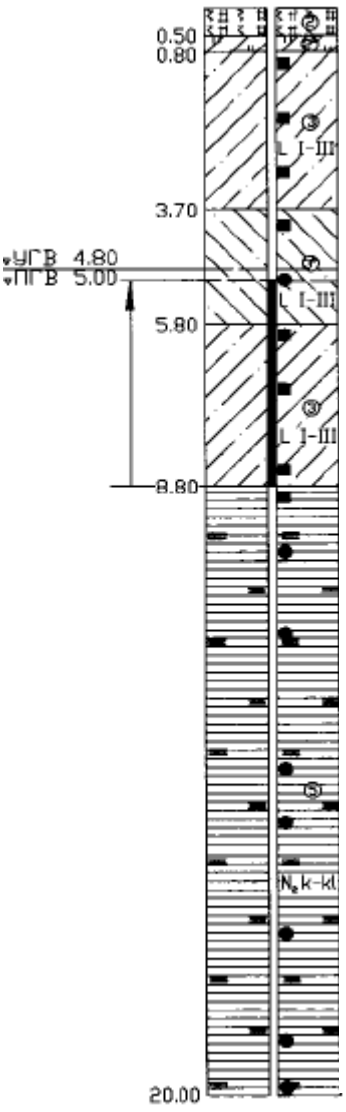
Task Team Leader *//signed//* G.A. Shtepa
Comments on the site: No.
Final evaluation of the deliverable: satisfactory.

Head of Department *//signed//* L.I. Klymenko

Date: 20 October 2009

Drilling Hole 1

Scale 1:100 Date of drilling: September 2009



Soil-vegetable layer

Dark greyish brown loam, humus, saline, hard, with plant roots

Pale yellowish brown loess loam, saline, with calcareous inclusions, dorbeetle holes, hard

Pale yellowish brown loess loam with calcareous inclusions and ochreous wedges, high plasticity, in the top – low plasticity

Pale yellowish brown loess loam with calcareous inclusions and ochreous wedges, medium-hard

Greenish grey and grey clay with ochreous wedges, oolitic inclusions of carbonates, Fe-Mn compounds, bands of pulverescent, in some places fine, greenish grey silica sand, hard

						Д 80206-337			
Measure	Q-ty	Sheet	Doc. No.	Signature	Date	EuroCape Ukraine I LLC			
Proj. Eng.		Klymenko		Signed	**Oct. 2009**				
Head of Dpt.		Klymenko		Signed	**Oct. 2009**	Sites for Wind Power Plant Units in Pryazovske Rayon of Zaporizhzhia Oblast (First-Priority Operations)	Stage	Sheet No.	Number of Sheets
Chief Geologist		Golovko		Signed	**Oct. 2009**		Feasibility Study	1	9
TTL		Shtepa		Signed	**Oct. 2009**				
Geologist		Kononenko		Signed	**Oct. 2009**	Strip logs	© Ukrdipromez SE 2009 GTD		
Geologist		Lysa		Signed	**Oct. 2009**				
Reg. Control		Volkov		Signed	**Oct. 2009**				

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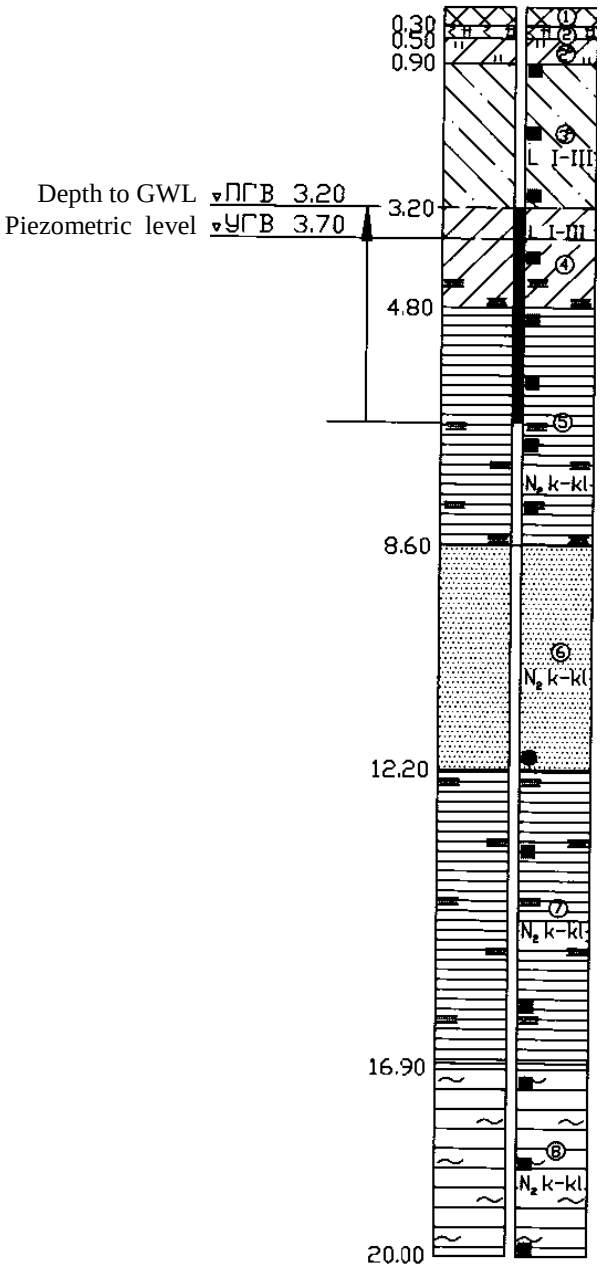
Engineering-Geological Passport, Site #1

Soil Characteristics	EGE-3	EGE-3[a]	EGE-5
Standard Values			
Natural moisture W, fractions	0.182	0.238	0.198
Density γ, g/cm^3	2.02	1.94	2.07
Dry density γ_s, g/cm^3	1.71	1.59	1.72
Ground particle number density γ_d, g/cm^3	2.69	2.69	2.70
Porosity n, %	36.35	40.09	36.30
Porosity factor e, fractions	0.577	0.692	0.570
Degree of saturation S_r, fractions	0.860	0.844	0.952
Moisture at full saturation W_{sat}, fractions	0.215	0.257	0.211
Moisture at the liquid limit W_L, fractions	0.320	0.300	0.289
Moisture at the plastic limit W_p, fractions	0.190	0.175	0.166
Index of plasticity I_p, fractions	0.13	0.126	0.124
Index of consistency I_L, fractions	<0	0.500	0.384
Loose density, g/cm^3	-	-	-
Packed density, g/cm^3	-	-	-
Angle of repose, air-dry, degrees	-	-	-
Angle of repose, under water, degrees	-	-	-
Modulus of deformation E, MPa	22	11	30
Angle of internal friction φ, degrees	25	22	20
Specific cohesion, kPa	36.00	25.00	37.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.9			
Density γ, g/cm^3	1.98	1.90	2.03
Angle of internal friction φ, degrees	22	19	17
Specific cohesion c, kPa	24	17.00	25.00
Estimated Values of Deflections, Confidence Factor α=0.85			
Density γ, g/cm^3	2.02	1.94	2.07
Angle of internal friction φ, degrees	25	22	20
Specific cohesion c, kPa	36	25.00	37.00

At the structural embedment to a depth of 4 m the bottom of the foundation pit should be deepened by 0.5 m and the turn-over layer should be replaced with crushed granite or cast blast-furnace slag of stable structure (which will serve the bed for piling caps). The piles cut through layer 3, with the foot of the pile cutting into clay of layer 5.

Drilling Hole 2
Scale 1:100

Date of drilling: September 2009



Filled-up layer: greyish brown and dark greyish brown loam, hard

Soil-vegetable layer
Dark greyish brown loam, humus, saline, hard, with plant roots

Pale yellowish brown loess loam, saline, low plasticity

Brown and dark grey loam with calcareous inclusions, low plasticity, from the depth of 4.30 – with bands of pulverescent sand

Greenish grey and grey clay with inclusions of Fe-Mn compounds, from the depth of 6.50 – with bands of pulverescent silica sand, hard to medium-hard

Light grey and yellowish grey silica sand, pulverescent, in some places fine, with shell fragments, water-saturated

Greenish grey and grey clay with ochreous wedges, oolitic inclusions of carbonates, Fe-Mn compounds, bands of pulverescent, in some places fine, greenish-grey silica sand, hard to medium-hard

Dark grey silty clay, medium-hard

Prepared by: //signed// T.V. Lysa
Checked by: //signed// V.T. Golovko

Д 80206-337	Sheet 2

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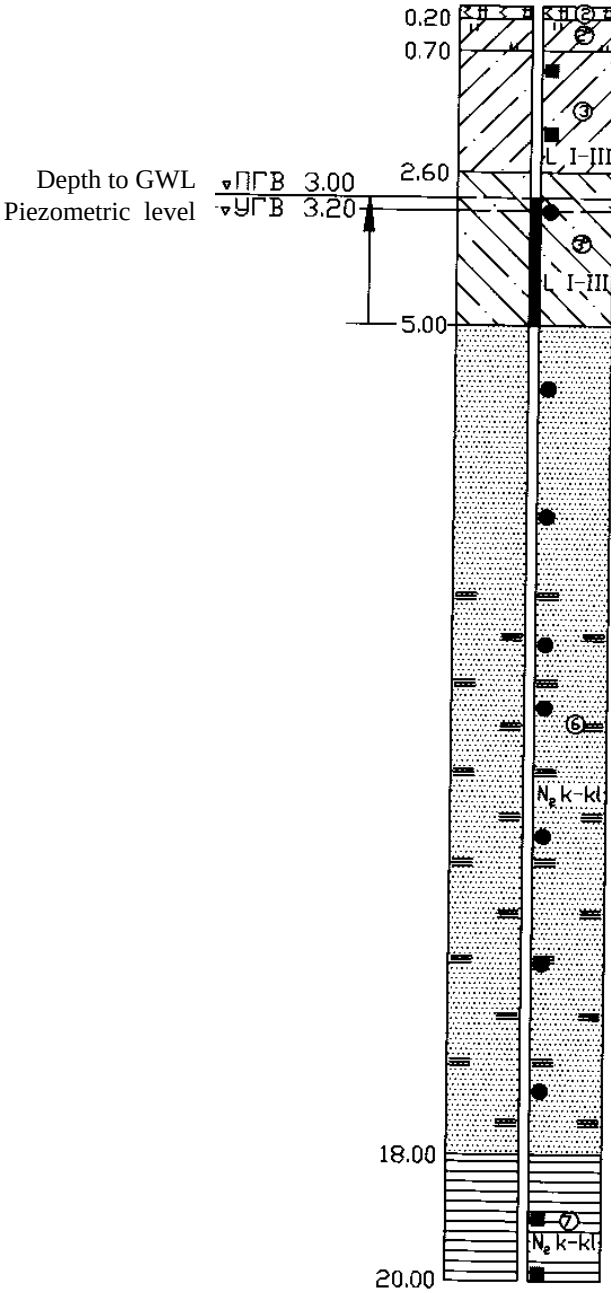
Engineering-Geological Passport, Site #2

Soil Characteristics	EGE-3[a]	EGE-4	EGE-5	EGE-6	EGE-7	EGE-8
Standard Values						
Natural moisture W, fractions	0.240	0.203	0.209		0.302	0.407
Density γ, g/cm^3	1.93	2.08	2.05		1.95	1.81
Dry density γ_s, g/cm^3	1.56	1.73	1.70		1.51	1.29
Ground particle number density γ_d, g/cm^3	2.69	2.69	2.69		2.71	2.68
Porosity n, %	42.47	35.69	36.91		44.28	52.05
Porosity factor e, fractions	0.739	0.555	0.592		0.815	1.086
Degree of saturation S_r, fractions	0.890	0.980	0.950		1.002	1.01
Moisture at full saturation W_{sat}, fractions	0.270	0.210	0.220		0.301	0.400
Moisture at the liquid limit W_L, fractions	0.330	0.290	0.360		0.498	0.630
Moisture at the plastic limit W_p, fractions	0.190	0.170	0.200		0.263	0.360
Index of plasticity I_p, fractions	0.13	0.12	0.16		0.235	0.270
Index of consistency I_L, fractions	0.360	0.280	0.08		0.152	0.170
Loose density, g/cm^3	-	-	-	1.33	-	-
Packed density, g/cm^3	-	-	-	1.66	-	-
Angle of repose, air-dry, degrees	-	-	-	37	-	-
Angle of repose, under water, degrees	-	-	-	33	-	-
Modulus of deformation E, MPa	11	19	29	11	23	10
Angle of internal friction φ, degrees	22	24	22	30	17	15
Specific cohesion, kPa	25.00	30.00	53.95	4.0	31.70	31.70
Estimated Values of Bearing Capacity, Confidence Factor α=0.9						
Density γ, g/cm^3	1.89	2.04	2.01	1.94	1.91	1.78
Angle of internal friction φ, degrees	20	21	19	27	15	13
Specific cohesion c, kPa	17.00	20	35.97	3.00	21.13	21.13
Estimated Values of Deflections, Confidence Factor α=0.85						
Density γ, g/cm^3	1.93	2.08	2.05	1.98	1.95	1.81
Angle of internal friction φ, degrees	22	24	22	30	17	15
Specific cohesion c, kPa	25.00	30.00	53.95	4.00	31.70	31.70

At the structural embedment to a depth of 4 m it seems expedient to excavate the pit down to the top clay of layer 5.

Drilling Hole 3
Scale 1:100

Date of drilling: September 2009



Soil-vegetable layer
Dark greyish brown loam, humus, saline, hard, with plant roots

Pale yellowish brown loess loam, saline, hard to medium-hard

Pale yellowish brown loess loam, saline, low plasticity to high plasticity

Light grey and yellowish grey silica sand, fine, in some places pulverescent, water-saturated, from the depth of 9.00 – with thin bands of clay

Greenish grey and grey clay with ochreous wedges, oolitic inclusions of carbonates, Fe-Mn compounds, hard to medium-hard

Prepared by: //signed// T.V. Lysa
Checked by: //signed// V.T. Golovko

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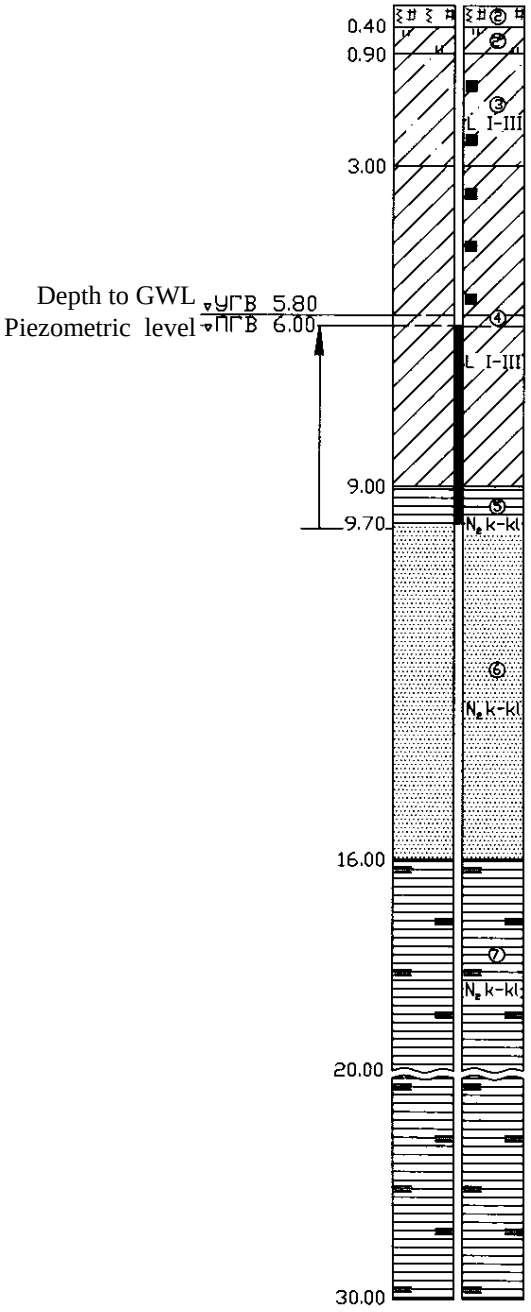
Engineering-Geological Passport, Site #3

Soil Characteristics	EGE-3	EGE-3[a]	EGE-6	EGE-7
Standard Values				
Natural moisture W, fractions	0.200	0.249		0.283
Density γ, g/cm^3	1.99	1.95		1.97
Dry density γ_s, g/cm^3	1.66	1.57		1.54
Ground particle number density γ_d, g/cm^3	2.70	2.69		2.71
Porosity n, %	38.41	4.25		43.36
Porosity factor e, fractions	0.624	0.709		0.769
Degree of saturation S_r, fractions	0.870	0.911		1.000
Moisture at full saturation W_{sat}, fractions	0.230	0.264		0.280
Moisture at the liquid limit W_L, fractions	0.320	0.293		0.520
Moisture at the plastic limit W_p, fractions	0.180	0.163		0.270
Index of plasticity I_p, fractions	0.14	0.130		0.25
Index of consistency I_L, fractions	0.15	0.662		0.05
Loose density, g/cm^3	-		1.25	-
Packed density, g/cm^3	-		1.59	-
Angle of repose, air-dry, degrees	-		38	-
Angle of repose, under water, degrees	-		34	-
Modulus of deformation E, MPa	22	11	11	23
Angle of internal friction φ, degrees	24	22	30	20
Specific cohesion, kPa	25.00	25.00	4.00	47.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.9				
Density γ, g/cm^3	1.95	1.91	1.94	1.93
Angle of internal friction φ, degrees	21	19	27	17
Specific cohesion c, kPa	17.00	17.00	3.00	31.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.85				
Density γ, g/cm^3	1.99	1.95	1.98	1.97
Angle of internal friction φ, degrees	24	22	30	20
Specific cohesion c, kPa	25.00	25.00	4.00	47.00

At the structural embedment to a depth of 4 m the bottom of the foundation pit comes upon high plasticity loess loam. This loam layer (1 m) should be excavated and replaced with crushed granite or cast blast-furnace slag of stable structure (which will serve the bed for foundation or caps of pile field). Surface drainage should be provided while the work is carried out.

Drilling Hole 4

Scale 1:100 Date of drilling: September 2009



Soil-vegetable layer
Dark greyish brown loam, humus, saline, hard, with plant roots
Pale yellowish brown loess loam, saline, hard to medium-hard

Brown loam with calcareous inclusions, hard to medium-hard

Greenish grey and greyish brown clay with inclusions of Fe-Mn compounds, big size inclusions of carbonates, ochreous wedges, hard

Light grey and greenish grey silica sand, fine, in some places pulverescent, with ochreous wedges

Greenish grey and grey clay with ochreous wedges, inclusions of Fe-Mn compounds, bands of pulverescent greenish grey silica sand, hard

Prepared by: //signed// T.V. Lysa
Checked by: //signed// V.T. Golovko

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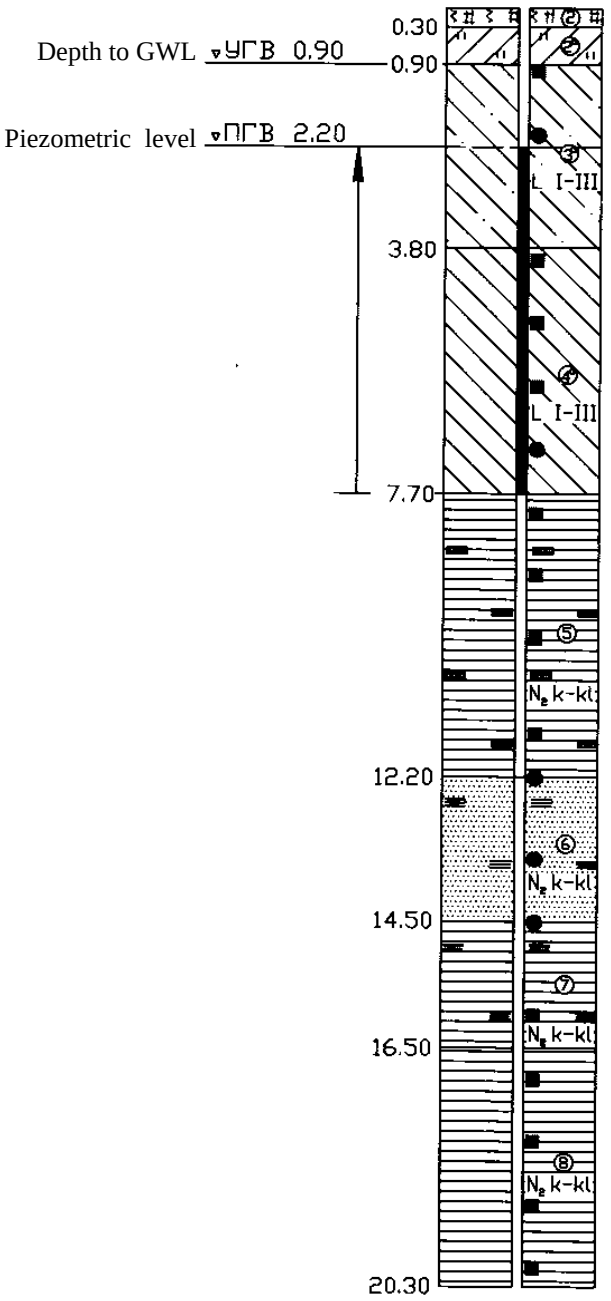
Engineering-Geological Passport, Site #4

Soil Characteristics	EGE-3	EGE-4	EGE-5	EGE-6	EGE-7
Standard Values					
Natural moisture W, fractions	0.173	0.208	0.205		0.288
Density γ, g/cm^3	1.84	1.97	2.06		1.94
Dry density γ_s, g/cm^3	1.57	1.63	1.71		1.51
Ground particle number density γ_d, g/cm^3	2.69	2.69	2.69		2.70
Porosity n, %	41.64	39.41	36.61		44.25
Porosity factor e, fractions	0.714	0.650	0.581		0.809
Degree of saturation S_r, fractions	0.649	0.860	0.951		0.994
Moisture at full saturation W_{sat}, fractions	0.265	0.241	0.216		0.299
Moisture at the liquid limit W_L, fractions	0.360	0.326	0.360		0.500
Moisture at the plastic limit W_p, fractions	0.213	0.202	0.193		0.256
Index of plasticity I_p, fractions	0.148	0.124	0.168		0.226
Index of consistency I_L, fractions	<0	0.067	0.083		0.147
Loose density, g/cm^3	-	-	-	1.29	-
Packed density, g/cm^3	-	-	-	1.63	-
Angle of repose, air-dry, degrees	-	-	-	37	-
Angle of repose, under water, degrees	-	-	-	33	-
Modulus of deformation E, MPa	20	23	30	11	23
Angle of internal friction φ, degrees	24	24	22	30	20
Specific cohesion, kPa	25.00	30.0	37.00	4.00	47.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.9					
Density γ, g/cm^3	1.80	1.93	2.02	1.94	1.90
Angle of internal friction φ, degrees	21	21	19	27	17
Specific cohesion c, kPa	16.70	20	24.70	3.00	31.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.85					
Density γ, g/cm^3	1.84	1.97	2.06	1.98	1.94
Angle of internal friction φ, degrees	24	24	22	30	20
Specific cohesion c, kPa	25.00	30.0	37.00	4.00	47.00

At the structural embedment to a depth of 4 m hard high-density brown loams will serve the base for foundations or piling.

Drilling Hole 5
Scale 1:100 Date of drilling: September 2009



Soil-vegetable layer
Dark greyish brown loam, humus, saline, hard, with plant roots

Pale yellowish brown loess loam, saline, with calcareous inclusions, dorbeetle holes, humus wedges, in the top of the layer – low plasticity, below – high plasticity

Brown loess loam with calcareous inclusions, in the top – medium-hard, below – low plasticity to high plasticity

Greenish grey and grey clay with ochreous wedges, oolitic inclusions of carbonates, Fe-Mn compounds, bands of greenish grey pulverescent, in some places fine, silica sand, medium-hard to high plasticity

Light grey and greenish grey silica sand, fine, in some places pulverescent, with bands of carbonates, Fe-Mn compounds, ochreous wedges and bands of greenish grey clay

Greenish grey and grey clay with ochreous wedges, oolitic inclusions of carbonates, Fe-Mn compounds, bands of pulverescent greenish grey silica sand, medium-hard

Dark grey silty clay, medium-hard

Prepared by: //signed// T.V. Lysa
Checked by: //signed// V.T. Golovko

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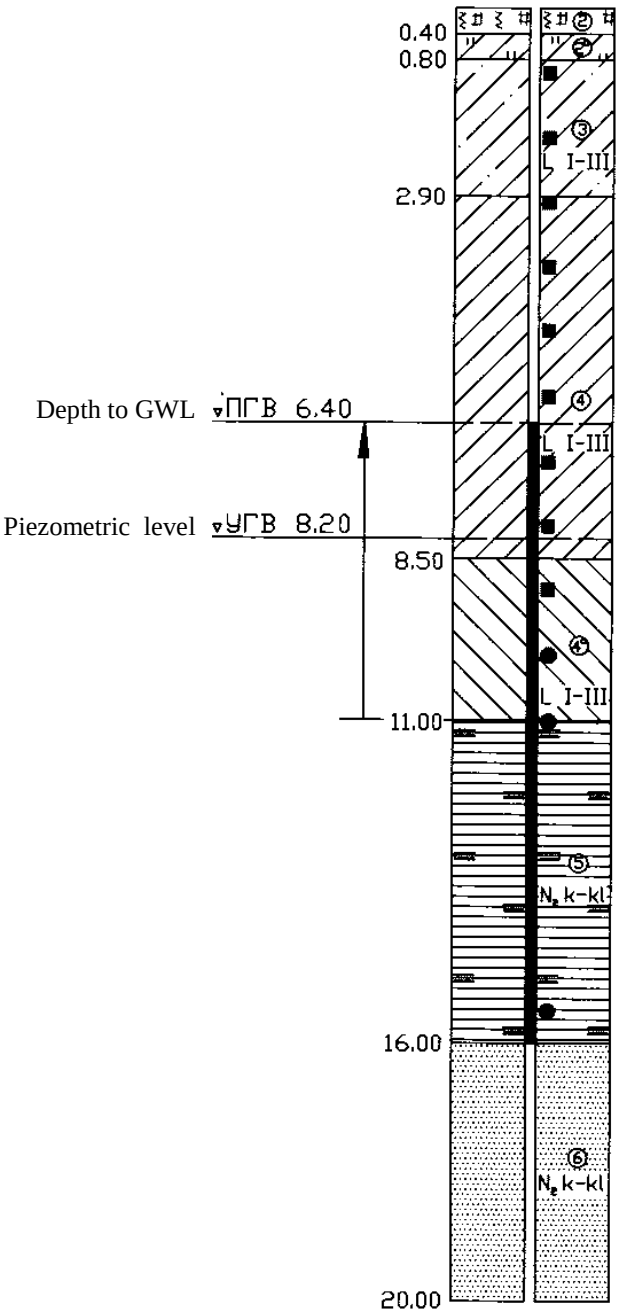
Engineering-Geological Passport, Site #5

Soil Characteristics	EGE-3[a]	EGE-4[a]	EGE-5	EGE-6	EGE-7	EGE-8
Standard Values						
Natural moisture W, fractions	0.267	0.193	0.203		0.293	0.352
Density γ, g/cm^3	1.94	2.04	2.10		1.97	1.88
Dry density γ_s, g/cm^3	1.57	1.71	1.75		1.52	1.40
Ground particle number density γ_d, g/cm^3	2.69	2.69	2.68		2.71	2.69
Porosity n, %	41.64	36.23	34.86		43.91	48.24
Porosity factor e, fractions	0.713	0.591	0.550		0.793	0.942
Degree of saturation S_r, fractions	0.894	0.880	0.990		1.001	1.013
Moisture at full saturation W_{sat}, fractions	0.265	0.220	0.204		0.293	0.296
Moisture at the liquid limit W_L, fractions	0.344	0.259	0.286		0.470	0.555
Moisture at the plastic limit W_p, fractions	0.192	0.154	0.160		0.255	0.309
Index of plasticity I_p, fractions	0.152	0.106	0.125		0.215	0.246
Index of consistency I_L, fractions	0.490	0.393	0.342		0.176	0.179
Loose density, g/cm^3	-	-	-	1.18	-	-
Packed density, g/cm^3	-	-	-	1.57	-	-
Angle of repose, air-dry, degrees	-	-	-	43	-	-
Angle of repose, under water, degrees	-	-	-	34	-	-
Modulus of deformation E, MPa	16	16	30	11	21	8.04
Angle of internal friction φ, degrees	23	23	20	30	20	15
Specific cohesion, kPa	26.70	28.30	36.70	4.0	47.00	47.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.9						
Density γ, g/cm^3	1.91	2.00	2.06	1.94	1.93	1.86
Angle of internal friction φ, degrees	20	20	17	27	17	13
Specific cohesion c, kPa	17.80	18.87	24.47	3.0	31.00	31.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.85						
Density γ, g/cm^3	1.94	2.04	2.10	1.98	1.97	1.89
Angle of internal friction φ, degrees	23	23	20	30	20	15
Specific cohesion c, kPa	26.70	28.30	36.70	4.0	47.00	47.00

At the structural embedment to a depth of 4 m the bottom of the foundation pit comes upon high plasticity brown loam. We believe it is necessary to deepen the pit down to 4.5 m and replace the high plasticity soil with crushed stone (which will serve the base for foundation or caps of pile field).

Drilling Hole 6

Scale 1:100 Date of drilling: October 2009



Soil-vegetable layer

Dark greyish brown loam, humus, saline, hard, with plant roots

Pale yellowish brown loess loam, saline, hard to medium-hard

Brown loam with inclusions of Fe-Mn compounds, medium-hard to low plasticity

Light grey loam, with ample inclusions of carbonates, high plasticity to wet consistency

Greenish grey and grey clay with ochreous wedges, inclusions of Fe-Mn compounds, bands of greenish grey pulverescent silica sand, hard

Yellowish grey silica sand, pulverescent

Prepared by: //signed// T.V. Lysa

Checked by: //signed// V.T. Golovko

Д 80206-337	Sheet
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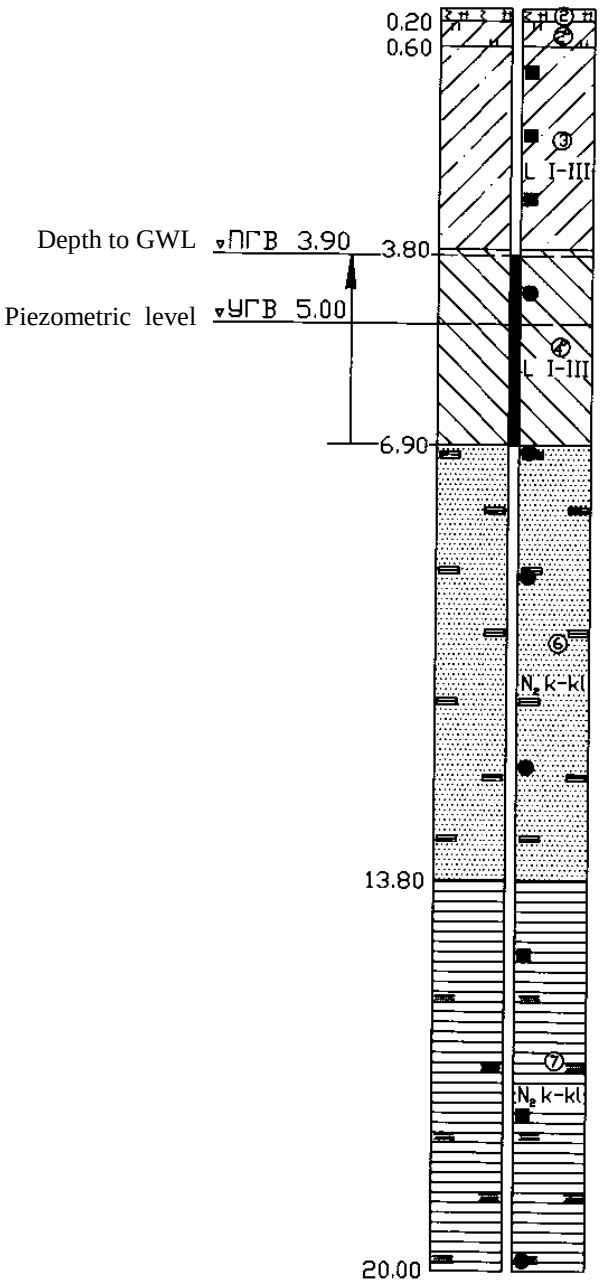
Paper size A4 (0.125)

Engineering-Geological Passport, Site #6

Soil Characteristics	EGE-3[a]	EGE-4	EGE-4[a]	EGE-5	EGE-6
Standard Values					
Natural moisture W, fractions	0.164	0.218	0.228	0.219	
Density γ, g/cm^3	1.94	1.99	2.00	2.10	
Dry density γ_s, g/cm^3	1.67	1.64	1.62	1.75	
Ground particle number density γ_d, g/cm^3	2.69	2.69	2.69	2.68	
Porosity n, %	38.11	39.10	39.78	34.86	
Porosity factor e, fractions	0.618	0.643	0.660	0.550	
Degree of saturation S_r, fractions	0.714	0.913	0.962	0.990	
Moisture at full saturation W_{sat}, fractions	0.229	0.241	0.245	0.204	
Moisture at the liquid limit W_L, fractions	0.364	0.337	0.289	0.285	
Moisture at the plastic limit W_p, fractions	0.217	0.207	0.175	0.167	
Index of plasticity I_p, fractions	0.293	0.130	0.114	0.118	
Index of consistency I_L, fractions	<0	0.084	0.535	0.441	
Loose density, g/cm^3	-	-	-	-	1.29
Packed density, g/cm^3	-	-	-	-	1.63
Angle of repose, air-dry, degrees	-	-	-	-	37
Angle of repose, under water, degrees	-	-	-	-	33
Modulus of deformation E, MPa	16	19	12	30	11
Angle of internal friction φ, degrees	23	23	23	20	30
Specific cohesion, kPa	26.00	31.70	23.30	37.00	4.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.9					
Density γ, g/cm^3	1.91	1.95	1.96	2.06	1.94
Angle of internal friction φ, degrees	20	20	20	17	27
Specific cohesion c, kPa	17.30	21.13	15.53	25.00	3.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.85					
Density γ, g/cm^3	1.94	1.99	2.00	2.10	1.98
Angle of internal friction φ, degrees	23	23	23	20	30
Specific cohesion c, kPa	26.00	31.70	23.30	37.00	4.00

At the structural embedment to a depth of 4 m high-density water-free brown loams will serve the base for foundations or piling.

Drilling Hole 7
Scale 1:100 Date of drilling: September 2009



Soil-vegetable layer
Dark greyish brown loam, humus, saline, hard, with plant roots
Pale yellowish brown loess loam, saline, with calcareous inclusions, dorbeetle holes, medium-hard to low plasticity

Brown loam with calcareous inclusions, high plasticity to wet consistency

Yellowish grey silica sand, fine, in some places pulverescent, with ample bands of greenish grey clay

Greenish grey and grey clay with ochreous wedges, oolitic inclusions of carbonates, Fe-Mn compounds, from the depth of 15.60 – with bands of greenish grey pulverescent, in some places fine, silica sand, hard

Prepared by: //signed// T.V. Lysa
Checked by: //signed// V.T. Golovko

Д 80206-337	Sheet
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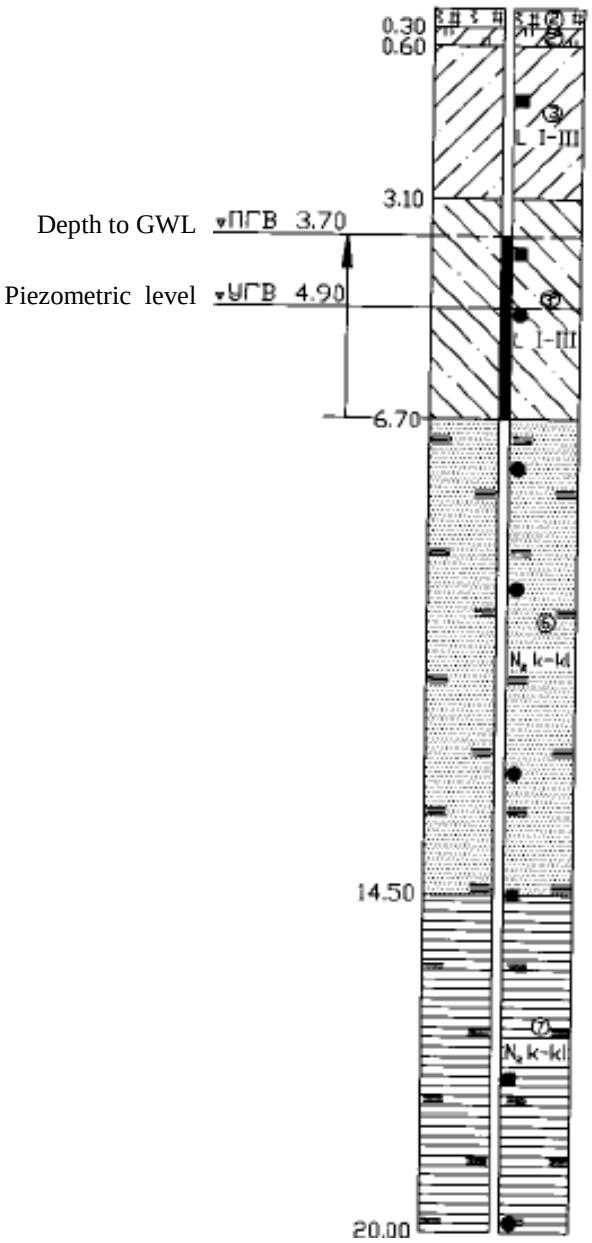
Engineering-Geological Passport, Site #7

Soil Characteristics	EGE-3	EGE-4[a]	EGE-6	EGE-7
Standard Values				
Natural moisture W, fractions	0.234	0.275	0.194	0.242
Density γ, g/cm^3	1.92	2.00		1.97
Dry density γ s, g/cm^3	1.55	1.62		1.64
Ground particle number density γ_d, g/cm^3	2.69	2.69		2.70
Porosity n, %	42.25	39.78		39.32
Porosity factor e, fractions	0.736	0.660		0.651
Degree of saturation S_r, fractions	0.867	0.962		0.997
Moisture at full saturation W_{sat}, fractions	0.273	0.245		0.242
Moisture at the liquid limit W_L, fractions	0.331	0.318		0.456
Moisture at the plastic limit W_p, fractions	0.202	0.178		0.224
Index of plasticity I_p, fractions	0.130	0.140		0.232
Index of consistency $I_{L,}$ fractions	0.255	0.693		0.080
Loose density, g/cm^3	-	-	1.29	-
Packed density, g/cm^3	-	-	1.63	-
Angle of repose, air-dry, degrees	-	-	37	-
Angle of repose, under water, degrees	-	-	33	-
Modulus of deformation E, MPa	14	12	11	22
Angle of internal friction φ, degrees	24	19	30	24
Specific cohesion, kPa	25.00	25.00	4.00	31.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.9				
Density γ, g/cm^3	1.89	1.96	1.94	1.93
Angle of internal friction φ, degrees	21	17	27	21
Specific cohesion c, kPa	17.00	16.70	3.00	20.70
Estimated Values of Bearing Capacity, Confidence Factor α=0.85				
Density γ, g/cm^3	1.92	2.00	1.98	1.97
Angle of internal friction φ, degrees	24	19	30	24
Specific cohesion c, kPa	25.00	25.00	4.00	31.00

At the structural embedment to a depth of 4 m the bottom of the foundation pit comes upon brown loam of high plasticity and wet consistency. Therefore, we believe it is necessary to deepen the pit by 0.5 m and replace the high plasticity soil with a bed of crushed granite or cast blast-furnace slag of stable structure (which will serve the base for foundation or caps of pile field).

Drilling Hole 8
Scale 1:100 Date of drilling: September 2009



Soil-vegetable layer
Dark greyish brown loam, humus, saline, hard, with plant roots
Pale yellowish brown loess loam, saline, with calcareous inclusions, medium-hard to low plasticity

Pale yellowish brown loess loam with calcareous inclusions, high plasticity to wet consistency

Yellowish grey silica sand, fine, in places pulverescent, with bands of greenish grey clay

Greenish grey and grey clay with ochreous wedges, oolitic inclusions of carbonates, Fe-Mn compounds, bands of greenish grey pulverescent silica sand, medium-hard to low plasticity

Prepared by: //signed// T.V. Lysa
Checked by: //signed// V.T. Golovko

Д 80206-337	Sheet 8

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Engineering-Geological Passport, Site #8

Soil Characteristics	EGE-3	EGE-3[a]	EGE-6	EGE-7
Standard Values				
Natural moisture W, fractions	0.224	0.282	0.221	0.319
Density γ, g/cm^3	1.87	1.98		1.82
Dry density γ_s, g/cm^3	1.53	1.56		1.33
Ground particle number density γ_d, g/cm^3	2.69	2.69		2.67
Porosity n, %	43.12	42.01		50.38
Porosity factor e, fractions	0.758	0.724		1.016
Degree of saturation S_r, fractions	0.795	0.996		0.971
Moisture at full saturation W_{sat}, fractions	0.282	0.269		0.381
Moisture at the liquid limit W_L, fractions	0.327	0.287		0.469
Moisture at the plastic limit W_p, fractions	0.197	0.177		0.269
Index of plasticity I_p, fractions	0.130	0.111		0.199
Index of consistency I_L, fractions	0.208	0.938		0.276
Loose density, g/cm^3	-	-	1.29	-
Packed density, g/cm^3	-	-	1.63	-
Angle of repose, air-dry, degrees	-	-	37	-
Angle of repose, under water, degrees	-	-	33	-
Modulus of deformation E, MPa	17	10	11	20
Angle of internal friction φ, degrees	23	20	30	11
Specific cohesion, kPa	25.00	26.70	4.00	32.00
Estimated Values of Bearing Capacity, Confidence Factor α=0.9				
Density γ, g/cm^3	1.84	1.94	1.94	1.79
Angle of internal friction φ, degrees	20	17	27	10
Specific cohesion c, kPa	16.70	17.80	3.00	21.30
Estimated Values of Bearing Capacity, Confidence Factor α=0.85				
Density γ, g/cm^3	1.87	1.98	1.98	1.82
Angle of internal friction φ, degrees	23	20	30	11
Specific cohesion c, kPa	25.00	26.70	4.00	32.00

At the structural embedment to a depth of 4 m the bottom of the foundation pit comes upon pale yellowish brown loess loam of wet consistency. We believe it is necessary to make a bed of crushed stone (which will serve the base for foundation or caps of pile field).

LEGEND

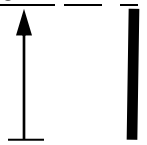
▿ УГВ 4.90 *Depth to groundwater level (GWL)*

■ *Undisturbed sample point*

● *Disturbed sample point*

③ *Number of Engineering-Geological Element – EGE*

▿ ПГВ 3.70



Piezometric level

Prepared by: //signed// T.V. Lysa
Checked by: //signed// V.T. Golovko

Д 80206-337	Sheet 9

Paper size A4 (0.125)

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III. GEOLOGICAL CROSS-SECTION AND STRUCTURE OF DRILLING HOLE # 1[r]

The holehead absolute elevation – 12.0 m
The drilling hole depth – 88.0 m

Scale	Layer No.	Geological age of the stratum	Stratum description	Structure of drilling hole specifying the depth of the casing shoe & the pipe section above screen	Thickness of the layer, m			Water level, m		Casing		Notes
					from the depth of	to the depth of	total thickness	first encountered at	steady	Diameter, mm	Depth, m	
0	1	Q	Soil-veget. layer Loam		0,0	6,0	6,0					
10	2	Q	Red-brown clay		6,0	12,0	6,0					
	3	N_2^{kl}	Fine sand		12,0	15,0	3,0					
20		N_2^{kl}	Green clay,						▼27,0			
30	4		high-density		15,0	35,0	20,0					
	5	N_2^{km}	Sandstone		35,0	38,0	3,0					
40		N_2^{km}	Interlayers of grey clays and grey sands, fine and inequigranular									
50	6				38,0	52,0	14,0					
	7	—	Carstone		52,0	56,0	4,0					
60		N_2^{km}	Dark green clay									
70	8				56,0	71,0	15,0					
	9	N_2^{km}	Carstone		71,0	77,0	6,0	77,0		273	77,0	
80	10	N_1^{s}	Limestone Shell rock		77,0	85,0	8,0					
	11	—	Sh.r.w/sand bands		85,0	88,0	3,0					
90												

The drilling hole is not screened

Checked for accuracy by:

Engineer-Hydrogeologist //signed// T.A. Vyshnyakova

//Stamp of State Geological Enterprise “Pivdenukrgeologia”, State Committee of Ukraine for Geology and Subsoil Use//

Copy

Duration of a pumping test is 1 day.
Duration of an extended pumping test is 6 days.

IV. RESULTS
Of the Extended Pumping Test Performed for the Drilling Hole # 22 (# 1)

Date	Static Level, m	Dynamic Level, m	Drawdown, m	Flow Rate, m^3/hr	Specific Discharge, m^3/hr	Airlift Pump Description				Pump Description
						Eductor Pipes		Air Pipes		
						Pipe Diameter, mm	Setting Depth, m	Pipe Diameter, mm	Setting Depth, m	
25 Feb 1978	27.0	37.0	10.0	40.0	4.0	127	65	73	60	ETsV 8-16-140 [ЭЦВ 8-16-140]
27 Feb 1978	27.0	37.0	10.0	40.0	4.0					
28 Feb 1978	27.0	37.0	10.0	40.0	4.0					
1 Mar 1978	27.0	37.0	10.0	40.0	4.0					
2 Mar 1978	27.0	37.0	10.0	40.0	4.0					
3 Mar 1978	27.0	37.0	10.0	40.0	4.0					

Pumping was carried out by:

Driller //signed// P.I. Pronyk
Date: 3 March 1978

Checked for accuracy by:

Engineer-Hydrogeologist //signed// T.A. Vyshnyakova

//Stamp of State Geological Enterprise “Pivdenukrgeologia”, State Committee of Ukraine for Geology and Subsoil Use//

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ARTESIAN WELL # 20 бис (1)

I. 1. Location: Oleksandrivka Village, Pryazovske Rayon, Zaporizhzhia Oblast, Ukraine

2. Assigned to: "Zavety Ilyicha" Collective Farm in Pryazovske Rayon of Zaporizhzhia Oblast

3. Artesian well application (potable water supply / service water supply / irrigation): service and potable water supply.

4. The well drilling was carried out according to the design of Zaporozhgiprovodkhoz.

II. 1. The production well was drilled by SPMK [*Specialized Mobile Mechanical Unit*] – 9 of "MVS" Trust.

2. Depth of the well is 88.0 m.

3. The work on the well started with drilling on 1 July 1963 and was completed with drilling on 8 July 1963.

The drilling was carried out by a mechanical rotary method with УРБ – 3 Ам drilling rig by a driller A. Okorochkov.

Diameters of the drilled well:
Dia = 346 mm at a depth of 0.0 to 77.0 m.
Dia = 243 mm at a depth of 77.0 to 88.0 m.

4. At a depth of 0.0 to 77.0 m the well is protected with casing pipes, 273 mm in diameter.

5. At a depth of 77.0 to 88.0 m the well is 243 mm in diameter and is not protected with casing.

6. The well is not screened.

The bottom part of the sump is plugged with a metal plug.

The screened section is at a depth of 77.0 – 88.0 m.

Copy

III. GEOLOGICAL CROSS-SECTION AND STRUCTURE OF DRILLING HOLE # 4[r]

The holehead absolute elevation – 12.0 m
The drilling hole depth – 85.0 m

Scale	Layer No.	Geological age of the stratum	Stratum description	Structure of drilling hole specifying the depth of the casing shoe & the pipe section above screen	Thickness of the layer, m			Water level, m		Casing		Notes
					from the depth of	to the depth of	total thickness	first encountered at	steady	Diameter, mm	Depth, m	
0	1	Q	Soil-veget. layer Loam		0,0	6,0	6,0					
10	2	Q	Red-brown clay		6,0	10,0	4,0					
	3	N$_2$kj	Fine sand		10,0	12,0	2,0					
20		N$_2$kj	Green clay, high-density						27,0			
30	4				12,0	32,0	20,0					
	5	-.-	Sandstone		32,0	34,0	2,0					
40		N$_2$kn	Interlayers of grey clays & sands,fine & inequigranular		34,0	49,0	15,0					
50	6											
	7	-.-	Carstone		49,0	52,0	3,0					
60		N$_2$km	Dark green clay		52,0	69,0	17,0					
	8											
70	9	N$_2$km	Carstone		69,0	77,0	8,0	77,0		273	77,0	The drilling hole is not screened
80		N, S	Limestone Shell rock		77,0	85,0	8,0					
90												

Checked for accuracy by:

Engineer-Hydrogeologist //signed// T.A. Vyshnyakova

//Stamp of State Geological Enterprise “Pivdenukrgeologia”, State Committee of Ukraine for Geology and Subsoil Use//

Copy

Duration of a pumping test is 1 day.
Duration of an extended pumping test is 6 days.

IV. RESULTS
Of the Extended Pumping Test Performed for the Drilling Hole # 4

Date	Static Level, m	Dynamic Level, m	Drawdown, m	Flow Rate, m^3/hr	Specific Discharge, m^3/hr	Airlift Pump Description				Pump Description
						Eductor Pipes		Air Pipes		
						Pipe Diameter, mm	Setting Depth, m	Pipe Diameter, mm	Setting Depth, m	
25 Feb 1978	27.0	37.0	10.0	40.0	4.0	127	64	73	59	ETsV 8-2G-100 [ЭЦВ 8-2Г-100]
27 Feb 1978	27.0	37.0	10.0	40.0	4.0					
28 Feb 1978	27.0	37.0	10.0	40.0	4.0					
1 Mar 1978	27.0	37.0	10.0	40.0	4.0					
2 Mar 1978	27.0	37.0	10.0	40.0	4.0					
3 Mar 1978	27.0	37.0	10.0	40.0	4.0					

Pumping was carried out by:

Driller

Checked for accuracy by:

Engineer-Hydrogeologist //signed// T.A. Vyshnyakova

//Stamp of State Geological Enterprise “Pivdenukrgeologia”, State Committee of Ukraine for Geology and Subsoil Use//

ARTESIAN WELL # 15 (# 4)

I. 1. Location: Oleksandrivka Village, Pryazovske Rayon, Zaporizhzhia Oblast, Ukraine

2. Assigned to: "Zavety Ilyicha" Collective Farm

3. Artesian well application (potable water supply / service water supply / irrigation): service and potable water supply.

4. The well drilling was carried out according to the design of Zaporozhgiprovodkhoz.

II. 1. The production well was drilled by SPMK [*Specialized Mobile Mechanical Unit*] – 9 of "MVS" Trust.

2. Depth of the well is 85.0 m.

3. The work on the well started with drilling on 1 February 1960 and was completed with drilling on 1 March 1960.

The drilling was carried out by a mechanical rotary method with УРБ – 3 АМ drilling rig.

Diameters of the drilled well:
Dia = 346 mm at a depth of 0.0 to 77.0 m.
Dia = 243 mm at a depth of 77.0 to 85.0 m.

4. At a depth of 0.0 to 77.0 m the well is protected with casing pipes, 273 mm in diameter.

5. At a depth of 77.0 to 85.0 m the well is 243 mm in diameter and is not protected with casing.

6. The well is not screened.

The bottom part of the sump is plugged with a metal plug.

The screened section is at a depth of 85.0 – 95.0 m.

Geotechnical Data on the Constructed Water Well # 828

The exploration well was drilled by Melitopol SPMK [*Specialized Mobile Mechanical Unit*] – 9 of Zaporozhvodstroy Trust on the territory of Dunayivka Village of Pryazovske Rayon. Total depth of the well is 80.0 m.

The drilling was carried out by a rotary method with УРБ – 3 АМ drilling rig.

Drilling starting date: 13 May 1969

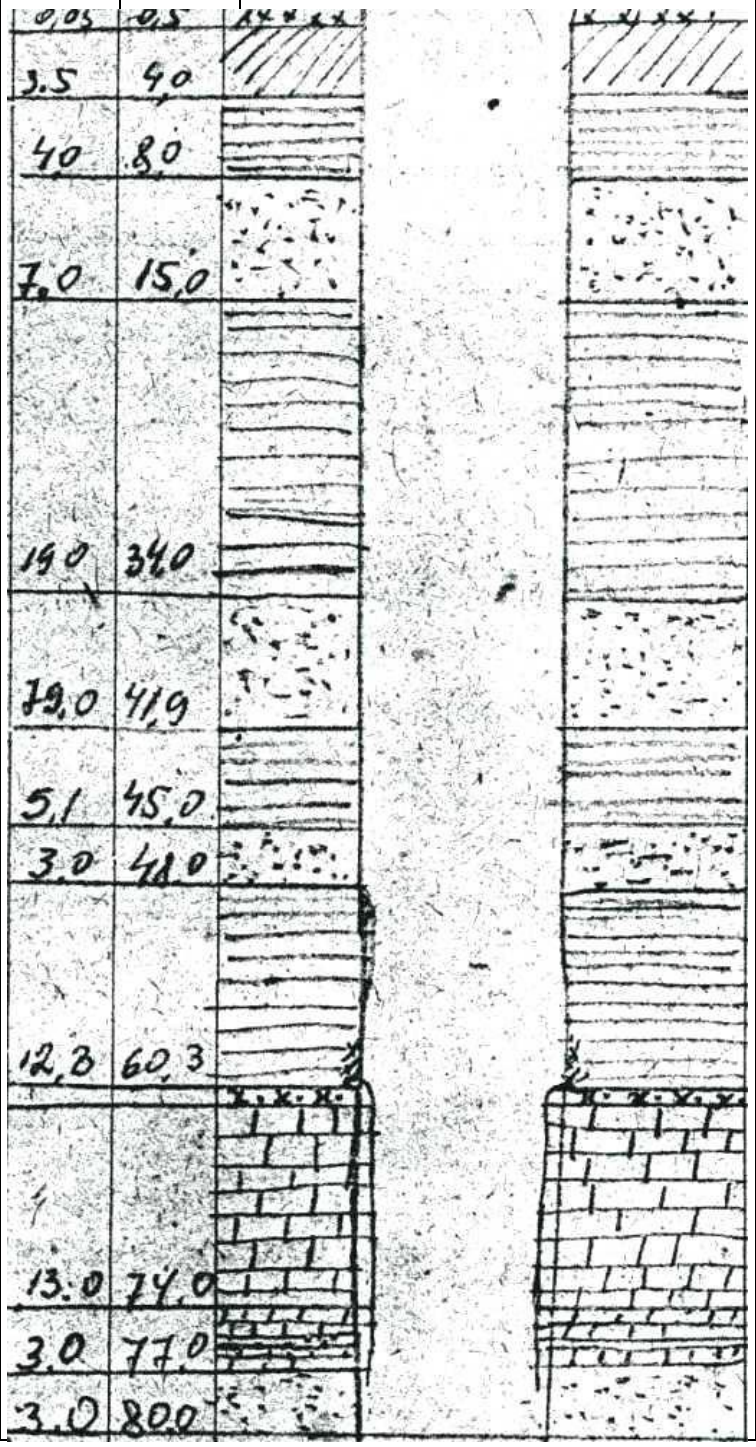
Drilling completion date: 27 May 1969.

The inspection document for the water well was signed on 27 May 1969.

The following strata were encountered in the process of drilling the water well # 828:

Item No.	Geological age of encountered stratum	Description of encountered stratum	Layer thickness, m	Depth of the bottom of the layer, m
1	Q_{IV}	Soil-vegetable layer	0.5	0.5
2	Q	Yellow-brown loam	3.5	4.0
3	eN_2^3	Red-brown clay	4.0	8.0
4	N_2kj	Yellow sand, fine	7.0	15.0
5	N_2kj	Light grey clay	19.0	34.0
6	N_2kj	Grey sand, fine	79.0	41.9
7	N_2kt	Carstone	5.1	45.0
8	N_2kt	Grey sand, fine	3.0	48.0
9	N_1S	Black clay	12.3	60.3
10	N_1S	Carstone	0.7	61.0
11	N_1S	Stratified grey limestone	13.0	74.0
12	N_1S	Grey limestone with bands of grey fine sand	3.0	77.0
13	N_1S	Inequigranular sand with fauna and bands of limestone	3.0	80.0

Scale 1:400
H = 80 m

Geological index	Layer thickness, m	Depth of the bottom of the layer, m	**Geotechnical cross-section**	Static level, m
	0,05 3.5 4,0 7,0 19,0 5,1 3,0 12,8 13.0 3,0 3,0	0,5 4,0 8,0 15,0 34,0 41,9 45,0 48,0 60,3 74,0 77,0 80,0		**8.0**

Geotechnical Data on the Constructed Water Well # 827

The exploration well was drilled by Melitopol SPMK [*Specialized Mobile Mechanical Unit*] – 119 of Zaporozhvodstroy Trust on the territory of Victorivka Village of Pryazovske Rayon. Total depth of the well is 80.0 m.

The drilling was carried out by a rotary method with УРБ – 3 ЖМ drilling rig.

Drilling starting date: 7 May 1969

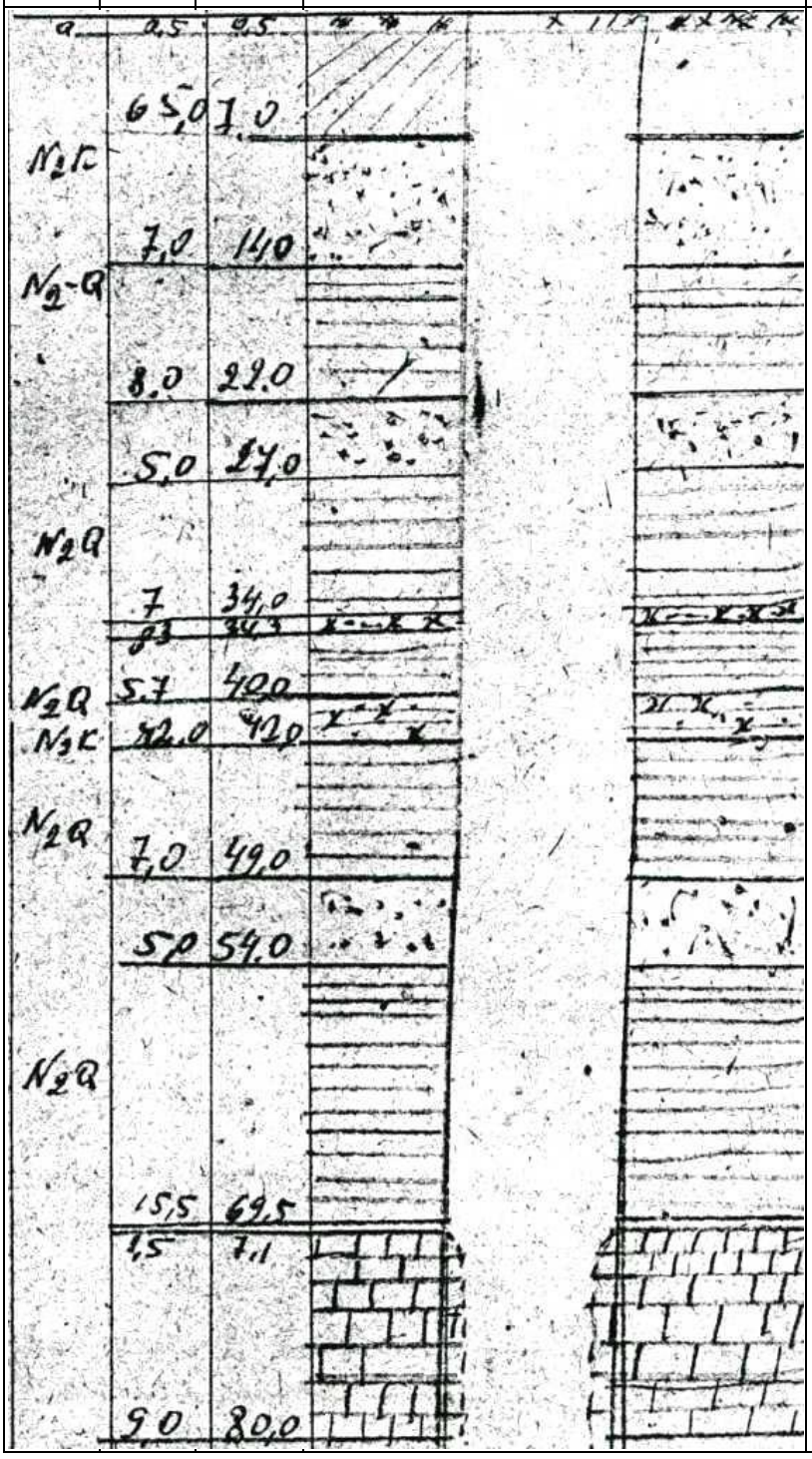
Drilling completion date: 16 May 1969.

The inspection document for the water well was signed on 16 May 1969.

The following strata were encountered in the process of drilling the water well:

Item No.	Geological age of encountered stratum	Description of encountered stratum	Layer thickness, m	Depth of the bottom of the layer, m
1	Q_{IV}	Soil-vegetable layer	0.05	0.05
2	Q_{1-3}	Yellow-brown loam	6.5	7.0
3	eN_2^3	Yellow sand, fine	7.0	14.0
4	N_2kj	Light yellow clay	8.0	22.0
5	N_2kj	Yellow sand, fine	5.0	27.0
6	N_2kj	Light grey clay	7.0	34.0
7	N_2kj	Grey sandstone	0.3	34.3
8	N_2kj	Grey clay	5.7	40.0
9	N_2kt	Carstone	2.0	42.0
10	N_2kt	Grey clay	7.0	49.0
11	N_2kt	Grey sand, very fine-grained	5.0	54.0
12	N_1S	Black clay	15.5	69.5
13	N_1S	Carstone	1.5	71.0
14	N_1S	Grey limestone with bands of clay	9.0	80.0

H = 80 m

Geological index	Layer thick-ness, m	Depth of the bottom of the layer, m	**Geotechnical cross-section**	Static level, m
				

III. GEOLOGICAL CROSS-SECTION AND STRUCTURE OF DRILLING HOLE # 14

(Dunayivka Village)

The holehead absolute elevation – 9.0 m
The drilling hole depth – 75.0 m

Scale	Layer No.	Geological age of the stratum	Stratum description	Structure of drilling hole specifying the depth of the casing shoe & the pipe section above screen	Thickness of the layer, m: from the depth of	Thickness of the layer, m: to the depth of	Thickness of the layer, m: total thickness	Water level, m: first encountered at	Water level, m: steady	Casing: Diameter, mm	Casing: Depth, m	Notes
	Q/IV		Loam		0.5	4.0	3.5	55.0	20.0	219	64.5	
5												
10	-4-		Clay		4.0	10	6.0					
	-11-		Sand		10	12	2.0					
15												
20												
	N_2^{rf}		Green									
25			clay									
30					12.0	30	18.0					
	-11-		Sand		30	32	2					
35	N_2 rm		Snuff-coloured									
40			sandstone		32	40	8					
	-16-		Sand		40	43	3					
45												
50	-11-		Sandstone									
55					43	55	12					
60	-11-		Clay									
65					55	64,5	9.5					
70	N_1^S		Limestone									
75					64.5	75.0	10.5					

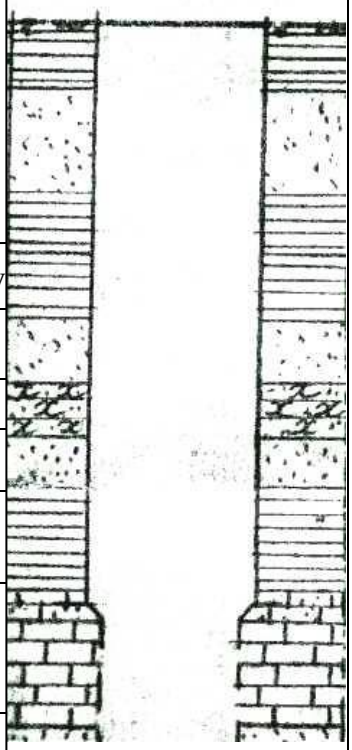
Date: 28 March 1954
Engineer-Hydrogeologist

GEOLOGICAL CROSS-SECTION AND STRUCTURE OF DRILLING HOLE # 733
(Dunayivka Village)

The drilling hole depth – 85.0 m

Scale 1:1,000

Geological index	Layer thick-ness, m	Depth of the bottom of the layer, m	Geotechnical cross-section	Static level, m
	0.5	0.5	Soil-vegetable layer	
Q	7.5	8.0	Light yellow clay w/ bands of red-brown clay	
	12.0	20.0	Agrillaceous sand, light grey to white, fine	
N_2kl	6.0	26.0	Light green clay	
	8.0	34.0	Grey clay, high-density	
	8.0	42.0	Grey sand, medium-grained	
	6.0	48.0	Carstone	
N_2k	6.0	54.0	Grey argillaceous sand, medium-grained	
	12.0	66.0	Black clay	
	2.3	68.3	Grey limestone	
N1S	13.7	82.0	Grey limestone, fissured	
	3.0	85.0	Grey sand, medium-grained	**12.5**



Water Chemical Analysis Data Record

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
1	16	1	5.00	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	76.95	3.84	8.41
Mg	75.88	6.24	13.67
K + Na	817.72	35.55	77.91
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	404.30	8.42	18.46
Cl	1,035.50	29.21	64.01
HCO_3	488.00	8.00	17.53
CO_3	0.00	0.00	0.00
Total ions		91.27	

Total hardness, mg-eq./l	10.08
Carbonate hardness, mg-eq./l	8.00
Non-carbonate hardness, mg-eq./l	2.08
Total hardness, German degrees	28.26
Carbonate hardness, German degrees	22.43
Dry residue, mg/l	2,702.00
Fe, mg/l	2.00

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.3

Salt content formula	M2.90 (CL 64 SO4 18 HC03 18 / K+NA 78)
Water description by salt content (S.A. Schukarev Classification)	sodium chloride

Total hardness, English degrees	35
Total hardness, French degrees	50
Total hardness, American degrees	504

Analysis conducted by: //signed// T.I. Zemliana

Water Aggressiveness Test Data Record

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
1	16	1	5.00	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l					
Portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l					
- for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l					
- fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
2	17	1	7.90	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	442.48	22.08	11.90
Mg	998.09	82.08	44.23
K + Na	1,872.68	81.42	43.87
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	3,516.27	73.26	39.47
Cl	3,790.50	106.93	57.62
HCO_3	329.40	5.40	2.91
CO_3	0.00	0.00	0.00
Total ions		371.16	

Total hardness, mg-eq./l	104.16
Carbonate hardness, mg-eq./l	5.40
Non-carbonate hardness, mg-eq./l	98.76
Total hardness, German degrees	292.06
Carbonate hardness, German degrees	15.14
Dry residue, mg/l	10,894.00
Fe, mg/l	0.10

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.4

Salt content formula	M10.95 (CL 58 SO4 39 / MG 44 K+NA 44)
Water description by salt content (S.A. Schukarev Classification)	chloride-sulphate-magnesium-sodium

Total hardness, English degrees	366
Total hardness, French degrees	521
Total hardness, American degrees	5,213

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
2	17	1	7.90	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Mildly aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l Portland cement	Strongly aggressive	Strongly aggressive	Strongly aggressive		
Slag portland cement	Mildly aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l - for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l - fresh natural waters					Strongly aggressive
- aggressiveness of soil below GWL to carbon steel					Medium-aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
3	10	2	3.20	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	1,385.16	69.12	16.07
Mg	1,324.96	108.96	25.33
K + Na	5,799.46	252.15	58.61
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	1,195.00	24.90	5.79
Cl	14,202.50	400.63	93.12
HCO_3	286.70	4.70	1.09
CO_3	0.00	0.00	0.00
Total ions		860.46	

Total hardness, mg-eq./l	178.08
Carbonate hardness, mg-eq./l	4.70
Non-carbonate hardness, mg-eq./l	173.38
Total hardness, German degrees	499.34
Carbonate hardness, German degrees	13.18
Dry residue, mg/l	24,156.00
Fe, mg/l	0.25

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell		Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	6.8

Salt content formula	M24.19 (CL 93 / K+NA 59 MG 25 CA16)
Water description by salt content (S.A. Schukarev Classification)	chloride-sodium-magnesium

Total hardness, English degrees	625
Total hardness, French degrees	891
Total hardness, American degrees	8,912

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
3	10	2	3.20	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Mildly aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Medium-aggressive	Mildly aggressive	Non-aggressive		
Sulphates content, mg/l					
Portland cement	Medium-aggressive	Mildly aggressive	Mildly aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l					
- for permanent immersion				Mildly aggressive	
- for periodical wetting				Strongly aggressive	
Total content of chlorides and sulphates, g/l					
- fresh natural waters					Strongly aggressive
- aggressiveness of soil below GWL to carbon steel					Medium-aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
4	9	2	3.70	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	788.77	39.36	11.03
Mg	1,354.14	111.36	31.20
K + Na	4,741.89	206.17	57.77
Anions	mg/l	mg-eq./l	% eq.
SO_4	2,562.62	53.39	14.96
Cl	10,592.50	298.80	83.72
HCO_3	286.70	4.70	1.32
CO_3	0.00	0.00	0.00
Total ions		713.78	

Total hardness, mg-eq./l	150.72
Carbonate hardness, mg-eq./l	4.70
Non-carbonate hardness, mg-eq./l	146.02
Total hardness, German degrees	422.62
Carbonate hardness, German degrees	13.18
Dry residue, mg/l	20,204.00
Fe, mg/l	0.25

Physical properties		Gas content	
Transparency level		Oxidability mg O_2/l	0.00
Color		Free CO_2	0.00
Smell		Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.0

Salt content formula	M20.33 (CL 84 SO4 15 / K+NA 58 MG 31)
Water description by salt content (S.A. Schukarev Classification)	chloride-sodium-magnesium

Total hardness, English degrees	529
Total hardness, French degrees	754
Total hardness, American degrees	7,543

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
4	9	2	3.70	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Mildly aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Medium-aggressive	Mildly aggressive	Non-aggressive		
Sulphates content, mg/l					
Portland cement	Strongly aggressive	Strongly aggressive	Strongly aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l					
- for permanent immersion				Mildly aggressive	
- for periodical wetting				Strongly aggressive	
Total content of chlorides and sulphates, g/l					
- fresh natural waters					Strongly aggressive
- aggressiveness of soil below GWL to carbon steel					Medium-aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
5	12	3	3.00	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	105.81	5.28	12.93
Mg	96.31	7.92	19.39
K + Na	635.75	27.64	67.68
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	519.31	10.82	26.49
Cl	883.50	24.92	61.02
HCO_3	311.10	5.10	12.49
CO_3	0.00	0.00	0.00
Total ions		81.68	

Total hardness, mg-eq./l	13.20
Carbonate hardness, mg-eq./l	5.10
Non-carbonate hardness, mg-eq./l	8.10
Total hardness, German degrees	37.01
Carbonate hardness, German degrees	14.30
Dry residue, mg/l	2,466.00
Fe, mg/l	1.00

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.8

Salt content formula	M2.55 (CL 61 SO4 26 HCO3 12 / K+NA 68 MG 19)
Water description by salt content (S.A. Schukarev Classification)	chloride-sulphate-sodium

Total hardness, English degrees	46
Total hardness, French degrees	66
Total hardness, American degrees	661

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
5	12	3	3.00	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l Portland cement	Mildly aggressive	Non-aggressive	Non-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l - for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l - fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
6	11	3	7.30	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	298.20	14.88	17.13
Mg	283.08	23.28	26.80
K + Na	1,119.93	48.69	56.06
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	1,470.70	30.64	35.28
Cl	1,776.50	50.11	57.70
HCO_3	372.10	6.10	7.02
CO_3	0.00	0.00	0.00
Total ions		173.70	

Total hardness, mg-eq./l	38.16
Carbonate hardness, mg-eq./l	6.10
Non-carbonate hardness, mg-eq./l	32.06
Total hardness, German degrees	107.00
Carbonate hardness, German degrees	17.10
Dry residue, mg/l	5,236.00
Fe, mg/l	0.50

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.5

Salt content formula	M5.32 (CL 58 SO4 35 / K+NA 56 MG 27)
Water description by salt content (S.A. Schukarev Classification)	chloride-sulphate-sodium-magnesium

Total hardness, English degrees	134
Total hardness, French degrees	191
Total hardness, American degrees	1,910

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
6	11	3	7.30	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l Portland cement	Medium-aggressive	Mildly aggressive	Non-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l - for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l - fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
7	24	4	6.00	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	115.43	5.76	8.62
Mg	151.76	12.48	18.68
K + Na	1,117.20	48.57	72.70
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	1,139.86	23.75	35.54
Cl	1,257.30	35.47	53.08
HCO_3	463.60	7.60	11.37
CO_3	0.00	0.00	0.00
Total ions		133.63	

Total hardness, mg-eq./l	18.24
Carbonate hardness, mg-eq./l	7.60
Non-carbonate hardness, mg-eq./l	10.64
Total hardness, German degrees	51.14
Carbonate hardness, German degrees	21.31
Dry residue, mg/l	4,062.00
Fe, mg/l	0.10

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.5

Salt content formula	M4.25 (CL 53 SO4 36 HCO3 11 / K+NA 73 MG 19)
Water description by salt content (S.A. Schukarev Classification)	chloride-sulphate-sodium

Total hardness, English degrees	64
Total hardness, French degrees	91
Total hardness, American degrees	913

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
7	24	4	6.00	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l Portland cement	Mildly aggressive	Non-aggressive	Non-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l - for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l - fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
8	18	5	2.20	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	654.11	32.64	14.77
Mg	747.11	61.44	27.81
K + Na	2,917.89	126.86	57.42
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	1,594.57	33.22	15.04
Cl	6,431.50	181.42	82.11
HCO_3	384.30	6.30	2.85
CO_3	0.00	0.00	0.00
Total ions		441.89	

Total hardness, mg-eq./l	94.08
Carbonate hardness, mg-eq./l	6.30
Non-carbonate hardness, mg-eq./l	87.78
Total hardness, German degrees	263.80
Carbonate hardness, German degrees	17.67
Dry residue, mg/l	2,912.03
Fe, mg/l	2.50

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellow	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.1

Salt content formula	M12.73 (CL 82 SO4 15 / K+NA 57 MG 28)
Water description by salt content (S.A. Schukarev Classification)	chloride- sodium-magnesium

Total hardness, English degrees	330
Total hardness, French degrees	471
Total hardness, American degrees	4,708

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
8	18	5	2.20	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l					
Portland cement	Strongly aggressive	Medium-aggressive	Non-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l					
- for permanent immersion				Mildly aggressive	
- for periodical wetting				Strongly aggressive	
Total content of chlorides and sulphates, g/l					
- fresh natural waters					Strongly aggressive
- aggressiveness of soil below GWL to carbon steel					Medium-aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
9	19	5	3.00	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	269.34	13.44	9.85
Mg	408.57	33.60	24.62
K + Na	2,056.90	89.43	65.53
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	725.07	15.11	11.07
Cl	4,075.50	114.96	84.24
HCO_3	390.40	6.40	4.69
CO_3	0.00	0.00	0.00
Total ions		272.94	

Total hardness, mg-eq./l	47.04
Carbonate hardness, mg-eq./l	6.40
Non-carbonate hardness, mg-eq./l	40.64
Total hardness, German degrees	131.90
Carbonate hardness, German degrees	17.95
Dry residue, mg/l	7,816.00
Fe, mg/l	2.50

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellow	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.3

Salt content formula	M7.93 (CL 84 SO4 11 / K+NA 66 MG 25)
Water description by salt content (S.A. Schukarev Classification)	sodium chloride

Total hardness, English degrees	165
Total hardness, French degrees	235
Total hardness, American degrees	2,354

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
9	19	5	3.00	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l					
Portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l					
- for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l					
- fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
10	25	6	6.40	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	250.10	12,48	17.77
Mg	163.43	13.44	19.14
K + Na	1,018.89	44.30	63.09
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	1,191.30	24.82	35.34
Cl	1,336.50	37.70	53.69
HCO_3	469.70	7.70	10.97
CO_3	0.00	0.00	0.00
Total ions		140.44	

Total hardness, mg-eq./l	25.92
Carbonate hardness, mg-eq./l	7.70
Non-carbonate hardness, mg-eq./l	18.22
Total hardness, German degrees	72.68
Carbonate hardness, German degrees	21.59
Dry residue, mg/l	4,276.00
Fe, mg/l	0.10

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.5

Salt content formula	M4.43 (CL 54 SO4 35 HCO3 11 / K+NA 63 MG 19)
Water description by salt content (S.A. Schukarev Classification)	chloride-sulphate-sodium

Total hardness, English degrees	91
Total hardness, French degrees	130
Total hardness, American degrees	1,297

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
10	25	6	6.40	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l Portland cement	Mildly aggressive	Non-aggressive	Non-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l - for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l - fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
11	21	7	5.10	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	86.57	4.32	8.00
Mg	145.92	12.00	22.23
K + Na	866.21	37.66	69.77
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	344.84	7.18	13.31
Cl	1,386.00	39.10	72.43
HCO_3	469.70	7.70	14.26
CO_3	0.00	0.00	0.00
Total ions		107.96	

Total hardness, mg-eq./l	16.32
Carbonate hardness, mg-eq./l	7.70
Non-carbonate hardness, mg-eq./l	8.62
Total hardness, German degrees	45.76
Carbonate hardness, German degrees	21.59
Dry residue, mg/l	3,086.00
Fe, mg/l	2.00

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellow	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.4

Salt content formula	M3.30 (CL 72 HCO3 14 SO4 13 / K+NA 70 MG 22)
Water description by salt content (S.A. Schukarev Classification)	sodium chloride

Total hardness, English degrees	57
Total hardness, French degrees	82
Total hardness, American degrees	817

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
11	21	7	5.10	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l					
Portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l					
- for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l					
- fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
12	22	8	3.70	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	673.34	33.60	14.32
Mg	723.77	59.52	25.37
K + Na	3,254.82	141.51	60.31
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	2,026.64	42.22	17.99
Cl	6,583.50	185.71	79.15
HCO_3	408.70	6.70	2.86
CO_3	0.00	0.00	0.00
Total ions		469.27	

Total hardness, mg-eq./l	93.12
Carbonate hardness, mg-eq./l	6.70
Non-carbonate hardness, mg-eq./l	86.42
Total hardness, German degrees	261.11
Carbonate hardness, German degrees	18.79
Dry residue, mg/l	13,620.00
Fe, mg/l	0.10

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.2

Salt content formula	M13.67 (CL 79 SO4 18 / K+NA 60 MG 25)
Water description by salt content (S.A. Schukarev Classification)	chloride-sodium-magnesium

Total hardness, English degrees	327
Total hardness, French degrees	466
Total hardness, American degrees	4,660

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
12	22	8	3.70	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Mildly aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l					
Portland cement	Strongly aggressive	Strongly aggressive	Mildly aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l					
- for permanent immersion				Mildly aggressive	
- for periodical wetting				Strongly aggressive	
Total content of chlorides and sulphates, g/l					
- fresh natural waters					Strongly aggressive
- aggressiveness of soil below GWL to carbon steel					Medium-aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
13	23	8	4.90	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	86.57	4.32	7.92
Mg	169.27	13.92	25.53
K + Na	834.52	36.28	66.55
Anions	**mg/l**	**mg-eq./l**	**% eq.**
SO_4	376.06	7.65	14.03
Cl	1,395.90	39.38	72.22
HCO_3	457.50	7.50	13.76
CO_3	0.00	0.00	0.00
Total ions		109.05	

Total hardness, mg-eq./l	18.24
Carbonate hardness, mg-eq./l	7.50
Non-carbonate hardness, mg-eq./l	10.74
Total hardness, German degrees	51.14
Carbonate hardness, German degrees	21.03
Dry residue, mg/l	3,090.00
Fe, mg/l	1.50

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellow	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.7

Salt content formula	M3.31 (CL 72 SO4 14 HCO3 14 / K+NA 67 MG 26)
Water description by salt content (S.A. Schukarev Classification)	chloride-sodium-magnesium

Total hardness, English degrees	64
Total hardness, French degrees	91
Total hardness, American degrees	913

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
13	23	8	4.90	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l					
Portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l					
- for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l					
- fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
14	14	Well (Frunze St., Dunayivka Village)	3.60	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	625.25	31.20	41.06
Mg	350.21	28.80	37.90
K + Na	367.74	15.99	21.04
Anions	mg/l	mg-eq./l	% eq.
SO_4	1,923.77	40.08	52.74
Cl	1,035.50	29.21	38.44
HCO_3	408.70	6.70	8.82
CO_3	0.00	0.00	0.00
Total ions		151.98	

Total hardness, mg-eq./l	60.00
Carbonate hardness, mg-eq./l	6.70
Non-carbonate hardness, mg-eq./l	53.30
Total hardness, German degrees	168.24
Carbonate hardness, German degrees	18.79
Dry residue, mg/l	4,660.00
Fe, mg/l	0.10

Physical properties		Gas content	
Transparency level	transparent	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.5

Salt content formula	M4.71 (SO4 53 CL38 / CA41 MG 38)
Water description by salt content (S.A. Schukarev Classification)	sulphate-chloride-calcium-magnesium

Total hardness, English degrees	211
Total hardness, French degrees	300
Total hardness, American degrees	3,003

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
14	14	Well (Frunze St. Dunayivka Village)	3.60	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l Portland cement	Strongly aggressive	Medium-aggressive	Mildly aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l - for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l - fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
15	13	Drilling hole (Kotovskogo St., Dunayivka Village)	3.70	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	163.53	8.16	11.65
Mg	192.61	15.84	22.61
K + Na	1,059.45	46.06	65.75
Anions	mg/l	mg-eq./l	% eq.
SO_4	1,342.52	27.97	39.92
Cl	978.20	27.59	39.38
HCO_3	884.50	14.50	20.70
CO_3	0.00	0.00	0.00
Total ions		140.13	

Total hardness, mg-eq./l	24.00
Carbonate hardness, mg-eq./l	14.50
Non-carbonate hardness, mg-eq./l	9.50
Total hardness, German degrees	67.30
Carbonate hardness, German degrees	40.66
Dry residue, mg/l	4,280.00
Fe, mg/l	0.10

Physical properties		Gas content	
Transparency level	transparent	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.3

Salt content formula	M4.62 (SO4 40 CL 39 HCO3 21 / K+NA 66 MG 23)
Water description by salt content (S.A. Schukarev Classification)	sulphate-chloride-sodium

Total hardness, English degrees	84
Total hardness, French degrees	120
Total hardness, American degrees	1,201

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
15	13	Drilling hole (Kotovskogo St. Dunayivka Village)	3.70	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l Portland cement	Medium-aggressive	Mildly aggressive	Non-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l - for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l - fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive

Item No.	Lab. No. of sample	Pit No.	Sampling depth, m	Type of sample
16	15	Drilling hole (Frunze St., Dunayivka Village)	3.80	Groundwater

Cations	mg/l	mg-eq./l	% eq.
Ca	432.86	21.60	23.79
Mg	443.60	36.48	40.17
K + Na	752.82	32.73	36.04
Anions	mg/l	mg-eq./l	% eq.
SO_4	2,379.50	49.57	54.59
Cl	997.50	28.14	30.99
HCO_3	799.10	13.10	14.43
CO_3	0.00	0.00	0.00
Total ions		181.62	

Total hardness, mg-eq./l	58.08
Carbonate hardness, mg-eq./l	13.10
Non-carbonate hardness, mg-eq./l	44.98
Total hardness, German degrees	162.86
Carbonate hardness, German degrees	36.73
Dry residue, mg/l	5,522.00
Fe, mg/l	0.25

Physical properties		Gas content	
Transparency level	turbid	Oxidability mg O_2/l	0.00
Color	yellowish	Free CO_2	0.00
Smell	no smell	Aggressive CO_2	0.00
Taste			
Temperature, ^oC	21.0	pH	7.0

Salt content formula	M5.81 (SO4 55 CL 31 HCO3 14 / MG 40 K+NA 36)
Water description by salt content (S.A. Schukarev Classification)	sulphate-chloride-magnesium-sodium

Total hardness, English degrees	204
Total hardness, French degrees	291
Total hardness, American degrees	2,907

Analysis conducted by: //signed// T.I. Zemliana

Item No.	Lab No. of sample	Pit No.	Sampling depth, m	Type of sample
16	15	Drilling hole (Frunze St. Dunayivka Village)	3.80	Groundwater

Aggressiveness parameter	Degree of aggressiveness				
	Grade of concrete			to concrete reinforcement	to metal structures
	W4	W6	W8		
Bicarbonate alkalinity, mg-eq./l (HCO3)	Non-aggressive	Non-aggressive	Non-aggressive		
pH value	Non-aggressive	Non-aggressive	Non-aggressive		
Aggressive carbonic acid content, mg/l (CO2)					
Magnesium salts content, mg/l (in Mg equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Ammonium salts content, mg/l (in NH4 equivalent)					
Caustic alkalis content, mg/l (in K and Na ions equivalent)	Non-aggressive	Non-aggressive	Non-aggressive		
Total content of chlorides, sulphates, nitrates and other salts, mg/l	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphates content, mg/l Portland cement	Strongly aggressive	Strongly aggressive	Medium-aggressive		
Slag portland cement	Non-aggressive	Non-aggressive	Non-aggressive		
Sulphate-resistant cements	Non-aggressive	Non-aggressive	Non-aggressive		
Chlorides content, mg/l - for permanent immersion				Non-aggressive	
- for periodical wetting				Medium-aggressive	
Total content of chlorides and sulphates, g/l - fresh natural waters					Medium-aggressive
- aggressiveness of soil below GWL to carbon steel					Mildly aggressive