PROGRAM

of engineering and geological surveys

on the site: "Copper-pyrite Tailings Dump of Madneuli MPP"

Stavropol

2023

Contents

1. GENERAL INFORMATION

1.1 **Name of the site** - Copper-pyrite tailings dump of the Madneuli MPP

1.2. **General Customer** - JSC RMG Copper (Georgia)

1.3. **Customer** - Migroup Project Ltd. (St. Petersburg)

1.4. **Designer** - Migroup Project Ltd.

1.5. **Contractor** - Stavprojectstroy Ltd. (Stavropol)

1.6. **Basis for compilation of the program**:

Customer-approved Terms of Reference for additional engineering and geological survey.

1.7. **Design stage** - operation.

1.8. **Site location** – village Kazreti, Bolnisi municipality, Georgia

1.9. **Information about surveys previously performed**:

- 1988 (KAZKAZGIPROTSVETSMET Institute - for construction of Madneuli MPP;
- 2007 (State Enterprise Mining Institute named after G. Tsulukidze) - studies of physical and mechanical properties of the band wall soils;
- 2016 (Geoengineering Ltd.) - drilling of one well to justify construction of the band wall of the 35th deck of the tailings dump;
- 2018 (GIMI LLC) - drilling of wells to justify construction of the band wall of the 36th deck of the tailings storage facility.
- 2021 (Neftegazproektstroy LLC) – "Engineering-geological and engineering-geophysical surveys (seismic microzoning) for the existing copper-pyrite tailings dump in the Republic of Georgia".

1.10. Types and objectives of the survey

The purpose of the survey is to carry out additional engineering-geological survey to study the properties of existing tailings sediments of various zones of the raised embankment of the tailings dump for given loads.

According to the results of the survey it is necessary to obtain physical and mechanical characteristics of tailing sediments of soils for given loads, to update the materials of earlier surveys, to determine the chemical composition of ground waters.

2. INFORMATION ON SURVEY AREA

The copper-pyrite tailings dump is located at a distance of ~2.5 km from the OF in the valley of Boliskhevi creek. The stream channel is slightly mandering. The average slope of the stream by talweg is 0.06÷0.09. The valley slopes are forested; the slope of the sides is from 15° to 45°. Absolute elevations of the relief are within the limits of 700-950 m.

The climate of the area is moderately warm and dry. Humidity and average annual air temperature varies in different parts of the area. The average annual air temperature is plus 10°C. Absolute minimum air temperatures are minus 26°C, and absolute maximum temperatures are plus 38°C. The average temperature of the coldest days is minus 13°C. The average temperature of the coldest five-day period is minus 10°C.

The average annual wind speed varies from 2.1 to 2.5 m/s. Winds of NE, NE, W, NW directions are typical for the projected area. There are 19-25 days per year on average with strong winds up to 15m/s.

In geological and lithological structure of the site of the tailing dump and tracks, loam with 1-3 m thickness, interlayers of eluvial rubble grounds with thickness up to 2.5 m, and rocky grounds represented by slightly fissured tuff-sandstones take part. Soil freezing depth is 0.8 m.

Seismicity of the survey area based on results of seismic microzoning is 9 points.

3. TYPES, SCOPE AND METHODOLOGY OF WORKS

To specify engineering-geological conditions of the tailing dump site it is necessary to execute a complex of works on systematization of available materials, field, laboratory and office works.

3.1. Engineering-geological survey

It is envisaged to carry out reconnaissance (route) surveys - 3 km – on good going, II category of complexity to describe the terrain relief, outcroppings, elements of hydrographic network, as well as to identify the presence of dangerous geological processes (talus, landslides, water seepage through the band wall , waterlogging, etc.).

During the survey the local population (employees of the MPP) are interviewed about the occurrence of hazardous geological processes, emergencies associated with natural phenomena, etc.

3.2. Excavation of mine workings

Drilling are carried out in accordance with the requirements of the Terms of Reference and the regulations (SP 47.13330.2016 (updated edition of SNiP 11-02-96) and SP 11-105-97 Part 1. 2, 3, 4). Drilling is carried out to study the geological and lithological structure of the tailings sediments, which will be the basis for the design of the raised embankment and sampling of monoliths and water for laboratory studies.

The boreholes on the tailings are to be drilled from the access roads prepared in advance by the customer using dry mechanical coring method with diameter of 108-146 mm. The borehole walls are to be fastened with casing tubes of diameter 146 mm.

In the process of drilling the documentation of the obtained core, sampling of monoliths, water sampling for laboratory research and observation of the level of opened groundwater will be carried out. Soil sampling, packing and transportation are performed in accordance with the requirements of GOST 12071-2014. Quantity of soil samples to be taken for laboratory examination shall be determined according to the requirements of Clause 7.1 of the Terms of Reference.

It should be ensured that the composition and structure of the core is preserved during the work.

During field documentation all information shall be recorded in the mine workings log of the surveyor's standard form.

Drilling of 3 boreholes in one line of sight is envisaged on the site of the **raised embankment of the tailings dump**. Depth of stable holes: No. 1 - 40 m, No. 2 - 50 m, No. 3 - 60 m. Total: 150 m. In order to fasten the walls of the boreholes with casing pipes, 150 m of drilling out is envisaged.

3.3. Field testing of soils

Field experimental works, which are direct methods of investigation of soils: static plate load test of tailings soils are to be performed.

3.3.1. **Soil tests with S=600 cm^2** are carried out to determine the strain modulus E of soils - **6 experiments** (three on the selected in the upper part of the tailings up to a depth of 5 m for 2 EGE). The properties are determined by the results of the vertical loading of soil in the face of the mine working with the help of a static plate

According to the results of static plate load tests we get the conversion factor mk to clarify the strain moduli obtained by laboratory methods (simulation) (p.7.13 SP 11-105-97 and 6.3.16 SP 47.13330.2016).

Static plate load tests of soils shall be carried out in accordance with the requirements of GOST 20276-2012 "Soils. Methods of field determination of strength and deformability characteristics".

Photo 1. Screw test of static plate load of soils S=600 cm^2

3.4. Hydrogeological experiments

To obtain data on hydrogeological conditions of the work site, presence of groundwater horizons, to determine filtration properties of soils on the territory of the tailings dump within the framework of engineering-geological surveys, hydrogeological works are performed.

It is planned to perform **6 express well pumpings.**

For pumping the borehole is drilled by core drilling. The borehole is equipped with a filter column and filter to ensure stability of the borehole walls. The internal diameter of the pipes in the upper part of the filter column shall allow for the installation of water lifting equipment of the required capacity and the measurement of the dynamic water level during testing, as well as the lowering of the sensor of the level measuring device and the possibility of cleaning the filters and pumping water. The well must be reliably sealed from surface water and precipitation.

The methodology of the experiment is to rapidly ("instantaneously") lower the level in the well to the maximum possible value by pumping with available water lifting

means, followed by observation of level recovery using a level gauge. The frequency of flow rate and dynamic water level measurements during the test should be sufficient to produce a time schedule to follow the water level decline (rise during recovery). The flow measurements must be made at the same time as the level measurements.

3.5. Sampling

During excavation works the undisturbed soil (monoliths), as well as groundwater samples are taken from the key wells for laboratory tests.

The number of samples to be taken for laboratory examination are to be determined in accordance with SP 47.13330.2012, SP 11-105-97 and the requirements of the assignment. Taking into account the use of materials of surveys performed by Neftegazproektstroy LLC in 2021 it is envisaged to take monoliths from allocated engineering and geological elements according to Table 1 below.

Table 1

Well number	NGPS well number	Sampling depth, m	EGE number	Comments
1	5	6.0 9.0 15.0 20.0	5	
		38.0 40.0	1	
2	4	15.0 16.0 17.0 18.0 19.0 20.0	1	
		22.0	5	
		26.0 26.5 27.0 27.5 28.0 28.5 29.0 29.5 30.0	9	
		31.0 31.5 32.0 32.5 33.0 33.5	10	

		34.0 34.5 35.0 35.5		
		38.0 39.0 40.0 41.0 43.0	5	
		45.0 48.0 50.0	6	
3	2	12.0 13.0	1	
		15.0 18.0 21.0 24.0 27.0 30.0 31.0	6	
		49.0 50.0 52.0 54.0 55.0 56.0 57.0 58.0 60.0	8	

Selection, packaging, transportation and storage of samples are carried out in accordance with the requirements of ***GOST 12071-2014 "GRUNTS. Sampling, packing and transportation".***

Soil monoliths are sampled with a clay cutter SV (designed by JSC StavropoTISIZ, 108-127 mm in diameter).

Photo 2. Sampling of monoliths with clay cutter SV-127

For non-cohesive soils samples of undisturbed soil structure should be taken in rings from the device UGPS-12M (3-4 rings per monolith) with their subsequent compression test in these devices and shear test in the device PSG (for the transfer to the laboratory of Stavprojektstroy LLC).

The number of samples of disturbed structure to determine lithological and granulometric composition and condition of soils is specified by geologist on site depending on specific geological conditions.

Sampling, packaging, transportation and storage of ground water samples for chemical analysis is carried out according to ***GOST 31861-2012 "WATER. General requirements for sampling".*** At least 3 samples are taken from each horizon of ground water during drilling. In the process of pumping the hydrochemical sampling will be performed.

3.6. Types and scope of field work

Types and scope of field works are specified in accordance with the requirements of the Terms of Reference for geotechnical surveys and current normative literature and are given in Table 2.

Table 2

N	***Type and methodology of works***	***Cat.***	***UOM***	***Volume***	***Well***
1	Engineering and geological reconnaissance on good going of the route.	II	rm	3	-
2	Layout and alignment of geological excavations	II	point	12	
3	Core drilling for wells up to 50 meters deep		m	90	2
4	Core drilling for wells up to 100 meters deep		m	60	1
5	Hydrogeological observations in boreholes up to 146 mm in diameter, up to a depth of 100 m		m	90 60	
6	Fixing the borehole walls		m	150	3
7	Sampling of cohesive soil monoliths from boreholes to depth: 10m 10-20 m 20-30 m 30-40 m More than 40 m		Mon.	 2 12 14 16 16	
8	Vertical static plate load test with area 600 cm^2 with specific pressure up to 1.0 MPa, category III		test	6	
12	Water pumping from well		Pumping	6	-
13	Production of filters 2 m long with 3x usage		rm	6	-
14	Installation and removal of the filter column		rm	36	

****The methodology, types and scope of fieldwork may be varied depending on the specific geological section as agreed with the Customer.***

3.7. Laboratory tests

Types of laboratory determinations of physical and mechanical properties are specified by the *Customer's Terms of Reference* and according to SP 11-105-97.

Physical properties of soil (humidity, total humidity, moisture of mineralized layers, liquid limit, plastic limit, density of soil, density of soil particles) must be determined according to GOST 5180-84 "Soils. Methods for laboratory determination of physical characteristics". Laboratory determinations of granulometric composition of soils are carried out according to GOST 12536-2014.

Strength and strain characteristics of soils are determined according to GOST 12248-2010 "Soils. Methods for laboratory determination of strength and strain characteristics".

During the office study the obtained values of characteristics will be clarified by comparing them with the characteristics obtained by direct methods (field tests of soils).

Filtration coefficients of soils will be done according to GOST 25584-2016 at the loads specified by the technical design specification.

Laboratory tests to determine chemical composition of ground waters and surface waters as well as aqueous extracts from soils are to be carried out to determine their aggressivity to concrete and metal structures (p. 6.2.11 RD-91.020.00-KTN-042-12); estimation of influence of underground waters on geological and engineering geological processes.

Sampling, preservation, storage and transportation of water samples for laboratory researches shall be made in accordance with GOST R 51592-2000. Volumes of planned laboratory works are given in Table 3.

Table 3

Kinds of laboratory works	Number of determinations	Comments
Full range of physical and mechanical properties of clayey soil with determination of shear strength (consolidated shear) under load up to 2.5 MPa (shear under 4 loads - 12 points)	48	Strain modulus to be determined for loads up to 1.5 MPa; strength properties to be determined at loads of 0.3 MPa, 0.5 MPa, 1.0 MPa, 1.5 MPa
Pre-compaction of clayey soils before cutting	48	
Consolidated undrained clayey soil test in triaxial compression apparatus (shear under 4 loads)	12	Strain modulus to be determined for loads up to 1.5 MPa; strength properties to be determined at loads of 0.3 MPa, 0.5 MPa, 1.0 MPa, 1.5 MPa
Consolidated drained test of clayey soils in triaxial compression apparatus (shear	12	Strain modulus to be determined for loads up to 1.5

under 4 loads)		MPa; strength properties to be determined at loads of 0.3 MPa, 0.5 MPa, 1.0 MPa, 1.5 MPa
Soil moisture determination	12	
Soil density using the cutting ring method	12	
Determination of optimum moisture and maximum density	60	
Cohesive soils permeability	54	Soil permeability to be determined for specific soil loads of 0.3 MPa, 0.5 MPa, 1.0 MPa.
Standard water test	3	

3.8. Office study

Office study of materials and report preparation is performed in accordance with the requirements of acting regulatory documents SP 47.13330.2016 (updated edition of SNiP 11-02-96), p. 6.7, SP 11-105-97 and others (see regulatory references).

During the office study of materials, it is necessary to use materials of previously performed surveys, to conduct a thorough analysis of changes in physical and mechanical characteristics of tailings soils over time. The 2021 technical report of Neftegazproektstroy Ltd. shall be taken as the basis.

At construction of geotechnical cross-sections the previously drilled wells at the site shall be used as much as possible.

The composition and content of the Technical Report on the results of geotechnical exploration must comply with the requirements of SP 47.13330.2016, p.7.20 SP 11-105-97.

When analyzing the results of geotechnical surveys it is necessary to:

- provide information on the engineering-geological structure and lithological composition of the soil strata of the band wall base and tailings dump bed;
- give the hydrogeological characteristics of the survey site;
- indicate the presence (or absence) of adverse physical and geological processes and phenomena at the site and specific soils;
- give normative and calculated characteristics of physical-mechanical properties of soils, results of laboratory tests of soils and passports of field tests;

- forecast changes in the geotechnical and hydrogeological conditions of the work site in the course of reconstruction and further operation of the tailings facilities.

3.9. Quality control and acceptance of works

3.9.1. Field inspection

The field inspection is performed by chief of party (chief of division) during and after completion of field works in accordance with applicable regulatory documents. The purpose of the field inspection is to provide objective data to assess the quality of the work, as well as to prevent defects in the work and to provide necessary assistance in the performance of the work.

The field inspection verifies:

- compliance of the processes as well as the results of the work performed and their design with the requirements of the assignment, the F&I program and the applicable regulations;
- degree of work completion;
- condition of instruments and accessories, their proper operation and storage.

According to the results of field inspection the work control and acceptance act of the set pattern is drawn up.

3.9.2. Quality control and acceptance of office studies

The quality control of the office studies is done by the executor (self-edition), the team leader or the head of the department.

During the office studies the following methods of control are used:

- input control of incoming data;
- inspection of consistency with the materials of previously completed works;
- direct observation of the work in order to control the compliance with the technological process and requirements of the normative documentation;
- re-editing.

The results of the control are recorded by signature on the reporting documents (text and graphic annexes, drawings and explanatory note) being developed and checked.

Completed work is submitted by the executor for acceptance to the head of the office team, proofreader, chief specialist, who establish the compliance of the presented materials with the requirements of the Customer's assignment and current regulatory documents in the process of work acceptance.

4. METROLOGICAL ASSURANCE

All measuring instruments shall be calibrated in due time and have verification certificates. It is not allowed to make measurements with defective devices and measuring instruments with expired date of verification.

5. SAFETY AND ENVIRONMENTAL PROTECTION

Occupational safety during geotechnical works is organized in accordance with the requirements of: "Safety Regulations on Topographic and Geodesic Works" /PTB-88/, "Regulations on Occupational Safety on Road Transport" POT RM-027-2003, "Safety Rules for Geological Exploration" and other acting regulatory documents on occupational safety.

The employees should be instructed and trained in a timely manner when carrying out engineering surveys. The employees should be familiarized with safety risks and provided with certified personal protective equipment.

Environmental safety measures:

The employees should be familiarized in a timely manner with environmental aspects and waste management instructions before the start of site engineering surveys.

During works to mitigate environmental impacts, the following measures shall be implemented:

- drilling equipment with leaking fuel and lubricants shall not be allowed on the site;
- prohibition of any discharge of fuel and lubricants at the drilling site onto the ground and into water;
- prohibition of washing, fueling and servicing drilling and transportation equipment of the contractor carrying out drilling operations in the gas pipeline protection zone;
- strict observance of rules for collection, storage and disposal of waste generated in the process of drilling.

Upon completion of works, the excavation should be liquidated in accordance with the Rules for Liquidation of Plugging of Drilling Wells for Various Purposes, Backfilling of Excavations and Abandoned Wells to Prevent Groundwater Pollution and Depletion; the site should be levelled. An act on the performed works on conservation of excavations in the territory of the tailings dump bowl should be drawn up.

The removal of the generated domestic and other rubbish from the work site shall be performed by the contractor.

6. MEASURES OF TECHNICAL SUPERVISION OVER THE ENGINEERING SURVEYS

1. Quality control of engineering surveys is carried out on the basis of analysis of documented fieldwork materials and visual control of applied methods of their execution and applied measuring instruments (MI).
2. Scope of engineering survey, for which the field and laboratory documentation is not drawn up or is improperly drawn up, shall be considered as not implemented.
3. Current quality control of execution of office studies is performed at all stages of processing of field and laboratory works by responsible executors (leading and chief geologist) in accordance with the regulatory documentation. The readiness of the report for submission to the Customer is determined by the conclusion of the internal expertise.
4. The external independent expertise by the decision of the Customer is carried out by an external organization. Representatives carrying out technical supervision of engineering surveys should have unimpeded access to field survey sites, intermediate survey materials, field logs, etc. The office studies and the process of issuing technical reports on engineering surveys should be controlled.

7. REPORT MATERIALS TO BE SUBMITTED

Following the results of executed works a technical report on the site survey should be submitted in accordance with the requirements of SP 47.13330.2016 (updated edition of SNiP 11-02-96), SP 11-105-97. Number of copies of the report in paper form - 3 copies, in electronic form - 1 copy.

- scanned report with captions PDF format;
- development format:
- text documents - MS Office;
- drawings - AutoCAD, dwg format.

The composition and structure of the electronic version of the report materials shall be identical to the paper copy. The electronic version of the documentation set is

transferred on a USB flash drive. In the root directory of the drive there must be a text file of the content.

The composition and content of the electronic version of the materials must correspond to the documentation set. Each physical section of the set (volume, book, album of drawings, etc.) should be represented in a separate catalogue by a file (group of files) of electronic document. The name of the catalogue should correspond to the name of the section.

8. REFERENCES

Engineering survey should be carried out in accordance with the requirements of regulatory documents:

1. SP 47.13330.2016 Engineering surveys for construction. General provisions. Updated edition of SNiP 11-02-96.
2. SP 11-105-97. Engineering and geological surveys for construction.
3. SP 22.1333..2011 Foundations of buildings and structures.
4. SP 14.13330.2014. Construction in seismic areas.
5. SNiP 12-03-2001. Occupational safety in construction. Part 1.
6. SNiP 12-04-2002. Occupational safety in construction. Part 2.
7. SNiP 22.02.2003 Engineering protection of territories, buildings and structures against dangerous geological processes. General provisions for design.
8. GOST 20276-2012. Soils. Field methods of determining the strength and deformability characteristics.
9. GOST 25100-2011. Soils. Classification.
10. GOST 20522-2012. Soils. Methods of statistic processing of test results.
11. GOST 30672-2012. Soils. Field test. General provisions.
12. GOST 5180-84. Soils. Laboratory methods of testing of physical properties.
13. GOST 12248-2010. Soils. Laboratory methods for determining the strength and strain characteristics.
14. GOST 12536-2014. Soils. Laboratory methods for determining the granulometric (grain) and microaggregate composition.
15. GOST 12071-2014. Soils. Selection, packing, transport and storage of samples.
16. GOST 31861-2012. Water. General requirements for sampling.
17. GOST 21.302-2013 Graphical symbols in documentation of engineering and geological surveys.
18. GOST 23278-2014 Soils. Field methods of permeability tests.

Developed by:

General Director of Stavprojektstroy Ltd. D.A. Mostunenko "___"_____2023