Sustainable Wastewater Management Project

Subproject on the Construction and Operation of Tskaltubo Wastewater Treatment Plant (with a Design Capacity of 6171 m³/d)

Environmental Impact Assessment Report

Executor

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Non-technical Summary

Introduction

Water supply and wastewater treatment systems in most of the large settlements of Georgia are in poor condition. Due to outdated and faulty infrastructure, the water resources are irrationally used, and as a result of improper wastewater management and absence of treatment facility, in most cases, the qualitative condition of environmental receptors is deteriorated. Accordingly, this is negatively reflected on the living level of the local population, tourism, etc.

Considering the current situation, the Government of Georgia, with the support of international donor organizations, is planning to improve existing water supply and wastewater treatment systems. The ongoing Sustainable Wastewater Management Project is contributing to this initiative. The Project is financed by the Government of Sweden through SIDA, administered by the World Bank (WB) and implemented by the Municipal Development Fund of Georgia (MDF) – a Legal Body of Public Law. The Project consists of two sub-projects to be implemented in various geographic locations. One of them will finance construction of wastewater treatment plant (WWTP) in Tskaltubo. Present EIA report is for the construction and operation of Tskaltubo Wastewater Treatment Plant (with a Design Capacity of 6171 m^3/day). The project also considers rehabilitation of the inlet pumping station, located nearby and rehabilitation of the sewer from pumping station to WWTP.

This subproject will improve wastewater management: Wastewater discharge will be provided in one point of the surface water body (Tskaltubostskali river); In normal operation conditions treated wastewater quality will meet the requirements of standard, defined by technical regulation – "Methods for Calculation of the Standards for Pollutants Discharged with Wastewater into Surface Water Bodies", approved by the decree №414 of the Government of Georgia on December 31, 2013.

Consequently, negative impact risks, related to deterioration of qualitative state of the environment and public health will be significantly reduced.

Legal Basis for Preparation of EIA Report:

EIA report on Tskaltubo WWTP project is prepared on the basis of the national legislation, as well as on World Bank Safeguard Policy Requirements. According to the national legislation, the basis for preparation of EIA report is the Law of Georgia on "Environmental Permit", which states that "Arrangement of wastewater treatment plant (with a capacity of 1000 m^3 and more) and main sewer " is subject to ecological expertise and consequently, it is necessary to issue environmental permit on the project. The project is classified as the environmental category B, according to the WB Safeguard Policy Principle - OP/BP 4.01 Environmental Assessment, thus it is necessary to prepare EIA report.

EIA Objectives:

The objective of EIA report for the construction and operation of Tskaltubo WWTP is: definition of mitigation measures for the expected negative impacts; development of environmental management and monitoring schemes; provision of information on planned activities, and their environment and social impacts with the purpose of public engagement and feedback solicitation.

Subproject Alternatives

Zero Alternative (no action)

While discussing the no action alternative, the current unorganized situation of wastewater management was considered. Due to the discharge of untreated wastewater into the river, the natural environment and the human health is exposed to serious threat. The implementation of the sub-project and normal operation of treatment facility will significantly eliminate the poor sanitary condition and improve qualitative value of some receptors. In the result, we receive the increased tourism potential and raised living standards of local population in Tskaltubo city. Therefore, no action alternative was rejected.

Location Alternative 1:

The area of an old wastewater treatment plant in a south part of the village Gvishtibi, Tskaltubo Municipality has been discussed. The area was already used for the same purpose (old WWTP operated here) and construction works will not increase the environmental footprint of the WWTP. Also, the land under the dilapidated former WWTP is in the State ownership and subproject implementation will not require any type of involuntary resettlement.

Location Alternative 2

Agricultural lands in the south-west of Gvishtibi village were also considered as a potential location of the new WWTP. In case of the given alternative, the project implementation would be related to economic resettlement. In addition, risks associated with visual-landscape impact, topsoil damage-degradation would grow. Accordingly, the location alternative 2 cannot be accepted.

Three main technological alternatives were discussed in the EIA report, including: I -Arrangement of the individual treatment system; II - Biological treatment using the phytodepuration method, which considers water treatment in the canal and pond systems, and III - The biological treatment by the treatment plant equipped with modern technology. These alternatives were compared based on the costs, environmental and social impacts, and expected challenges at the construction and operation phases. As a result, the third alternative was given preference over the others. 3 additional options of the chosen alternative were discussed:

- 1 – The wastewater treatment using the primary sedimentation and trickling filter;
- 2 – The wastewater treatment using the anaerobic tanks and trickling filter;
- 3 – The wastewater treatment using primary sedimentation and activated sludge.

The preference was given to the alternative 2. It is acceptable based on various criteria: small amount of generated sludge and easy technology of sludge treatment. It is noteworthy that the alternative is acceptable from economic viewpoint as investment costs and operational costs are low. Accordingly, growth of tariffs on wastewater treatment services is expected *to remain at the lower end of the standard affordability limits for families (3-5% of household income); a social-tariff may be considered for customers below the poverty line.*.

Description of the Adopted Alternative:

According to the chosen alternative, Tskaltubo WWTP arrangement is considered on the territory of old treatment plant (Cadastral Code of the plot: 29.07.35.021). The area of the territory is 31 827 m^2 (3 ha) and it is located on 86-90 m a.s.l. The selected area is exposed to significant anthropogenic load and has no high conservative value.

The project implementation is decided in two phases: On the first phase, the infrastructure facilities, that provide wastewater treatment from suspended solids, BOD and COD in the amount (6171 m^3/d) expected for 2028, will be arranged. On the second phase, additional infrastructure facilities will be arranged, after which it is expected wastewater treatment in the amount (6477 m^3/d) expected for 2038.

On Phase 2 nitrogen and phosphorus removal will be provided in a future, separate investment, applying activated sludge technology for nutrient removal. The Phase 1 of the project, now under consideration, envisages the installation of the main infrastructural units: anaerobic tanks, trickling filters, secondary sedimentation tanks, sludge dewatering on sludge drying beds etc. WWTP will be equipped with modern operation, control, alarm and firefighting systems.

Construction works planned under the present subproject imply: (i) work site preparation (mobilization of temporary infrastructure, required for the construction, removal of debris of the old WWTP, clearance of vegetation, and topsoil stripping, marking and fencing of the work sites); (ii) earth works, (iii) construction of the main structures of WWTP; and (iv) site reinstatement. Power and water supply for the construction works will be provided from the local networks.

Approximate duration of the construction works is about 12 months; number of workers – 35 people (including locals - 80%). Arrangement of living camp for non-local workers is not considered (if required, private residential houses adjacent to the project area will be rented). Temporary buildings required for the construction works (container type offices, changing rooms for working personnel, meeting room, area for disposal of construction equipment and transportation means, mechanical processing site, storage area for disposal of waste and construction materials) will be arranged on the inner perimeter of allocated area (the area is owned by UWSC of Georgia). Arrangement of crushing and sorting plant and concrete plant is not required on the area. Accordingly, the construction phase does not consider arrangement of independent camp.

The 24 hour work mode is considered for the WWTP operation phase. About 15-20 people will serve the WWTP, who work according to 8 hour work shift.

Baseline Condition of the Project Area:

From administrative consideration the project area belongs to Tskaltubo Municipality of Imereti region, and according to the physical-geographic zoning – to the East part of the Kolkheti Lowland, to the Basin of Rioni River and Gubistskali River.

There is subtropical climate within the area of work implementation,. The winter is short, and summer is long and hot. The average annual temperature is 14,6^{0}C, average relative humidity - 73%, number of precipitation - 1818 mm/y. North-Eastern, Eastern and Western winds dominate.

According to geotectonic zoning of Georgia, the study area (downstream of Rioni River basin) is included within the western molasses subsiding zone (Rioni intermountain cavity). Based on the conducted engineering-geological study results, within the area allocated for project implementation, the ground is presented by clay, clayey loam, clayey sand and tuff sandstones. There is no engineering-geological event or process expected on the construction site that can prevent to the construction and further operation of WWTP. Ground water is identified at 1.5-3.8 m depth from the surface. Seismicity of the area is defined by 8 points (according to MSK scale).

It is noteworthy, that the difference in elevation between active riverbed and project area is 4-5 m, and according to the appropriate calculations the increase of water level is expected by 3.49 m. Accordingly, the flood risk is not high.

Due to the high anthropogenic load of the project area, the existing soil is of low value. The vegetation cover presented within the area is also of low value. Mainly following species grow here: cypress (*Cupressus* sp.), Himalayan cedar (*Cedrus deodora),* Privet *(Ligustrum vulgare).* Within the study two species included in the Red List of Georgia Imeretian Oak (*Quercus imeretina)* (VU) and Sweet bay (*Laurus nobilis)* (VU) have been identified.

The area is rich neither with animal species. Mainly synanthropic (adapted to the intensive human activities) species are distributed, namely, reptiles (Sand lizard *(Lacerta agalis)*, sheltopusik (*Poseudopus*

apodus), grass snake (*Natrix natrix)*, amphibians *(*European green toad *(Bufo vitatus)*, water frog (*Rana rididunda)*, European tree frog (*Hylidae arborea)*, small birds (Hooded crow (*Corvus cornix) ,* Eurasian tree sparrow (*Passer montanus)*, common chaffinch (*Fringilla coelebs) etc.).*

From mammals rodents live on the area. During field surveys, there were no trails of Red List species identified within the area. Due to the high anthropogenic load and low density of vegetation cover, the plot is not attractive for wild animals.

Protected Areas are far from designated area and the risks of direct impact on them are very low.

WWTp site is in significant distance from touristic zones of Tskaltubo (the distance from Tskaltubo mineral water park is about 2 km).

There are no historical-architectural monuments within WWTP location area and its surroundings.

EIA Methodology:

The assessment methodology of possible environmental impact caused by implementation of the project has been developed based on the recommendations of the World Bank and other international financial institutions (EBRD, IFC and ADB).

The values for qualitative indicators of the environment (air, water, soil, etc.) established in regulatory documents of Georgia, EU and the International Financial Corporation / World Bank, are used for quantitative criteria. For those factors of impact, having no qualitative indicators established, quantitative criteria are defined on the basis of baseline data analysis, considering the value and sensitivity of the impact.

EIA process comprised the following activities: overview of available literature; baseline study and identification of sensitive environmental and social receptors; determination of significance and characteristics of the expected impacts; development of mitigation measures to address the expected negative impacts; development of environmental management and monitoring plans, holding public consultations.

Each identified negative impact was ranked on the 5 point scale: **Very low, Low, Moderate, High or Very high**, based on the pre-established qualitative criteria.

Possible Environmental Impact and Mitigation Measures:

After analyzing of WWTP design parameters and defining baseline condition of the environment, the scale of possible negative impact was determined using previously developed methodology and assessment criteria. Afterwards mitigation measures for each receptor negative impacts have been developed:

Emission of harmful substances in ambient air: On construction phase, that lasts about 12 months, the main source of emission of the pollutant substances is road-construction vehicle engines.

During operation process, degradation of organic matter is accompanied by production of hydrogen sulfide (H_2S), which is the source of foul odor spread.

According to the modeling carried out during EIA process, on WWTP construction and operation phases, the ambient air pollution do not exceed maximum allowable concentrations established by Regulatory Document of Georgia document (order #297/n dated August 16, 2001 of the Minister of Labor, Health and Social Affairs "On approval of the norms of qualitative state of the environment), within the borders, established by regulatory document (Technical Regulation – "Methods of calculation

of maximum permissible emission of hazardous substances into ambient air", approved by the order №408 of the Government of Georgia):

- At the nearest residential house (distance – 300 m);
- At the border of 500 m radius[1].

Negative impact significance can be assessed as within permissible limit.

In order to protect ambient air quality, appropriate mitigation measures have been developed for the construction and operation phases. Mitigation measures on construction phase consist: To ensure proper maintenance of the machinery; to maintain the optimal speed of the traffic movement; to cover properly materials from where the dust can be easily spread, etc.
In order to mitigate odor nuisance propagation on operation phase, the modern approach is considered by the project, particularly, spread of odor nuisance will be monitored within WWTP area and at the border of residential zone (monitoring process will be provide using modern portable and stationary devices). Plant performance requirements (functional guarantees) require limits below community-level threshold for 95% of time. In case of identification of high impact during monitoring, floating aerator devices will be activated on each anaerobic tank, which produces oxygenated layer and ensures suppression of odor nuisance.

Noise propagation: WWTP construction complies of intensive activity that possibly impact on baseline noise. The main receptors of the negative impact connected with the noise will be local population, wild life and workers. According to calculations made within EIA preparation, at the border of settled area (distance – 300 m), the noise level will not exceed 46,2 dBA, and it is in compliance with the established standard during daytime. As intensive construction works are not implemented at night, the negative impact can be qualified as "Low".

The main source of noise propagation on the operation phase is working electric engines and diesel-generators. Considering the fact that the noise propagation levels produced during working process of electric engines are not high, and the machinery will be located in closed containers, the noise propagation impact will not be significant either on operation level.

By ensuring proper maintenance of the machinery, implementing noisy work during daytime, providing personnel with private protective equipment and carrying out other similar mitigation measures, it will be possible to minimize impact.

Impact on surface water: As the project area is near Tskaltubostskali River, there are certain risks of water body pollution during construction process. Risks will be mainly connected to non-compliance with environmental requirements, namely: waste littering/pouring into the river, improper management of industrial-fecal wastewater and so on. In order to minimize such risks, the civil contractor should closely follow the requirements considered by environmental management and instruct working personnel.

During assessment of possible impact on operation phase, it is crucial to consider existing negative condition, in particular: Due to the current situation concerning improper management of Tskaltubo city wastewater, there is significant negative impact on the local surface water, including

[1] According to technical regulation on ,, Calculation of Standards for Maximum Permissible Emissions of Pollutants into Ambient Air", maximum permissible emissions (MPEs) into ambient air is determined for:"the nearest residential zone from the facility, preschools, schools, higher educational institutions, sport complexes, parks, public health recovery institutions, food industry objects, airports, aerodromes and railway stations, but not for the distance, more than 500 m radius from the facility". According to the mentioned requirements, we could carry out the calculation only for the border of 300 m radius. However, according to the practice, introduced in Georgia, MPE standards should be determined for the border of residential zone, as well as for the border of 500 m radius (even in case if the nearest residential zone is within 500 m radius). The mentioned note of the regulatory document does not consider that there should be no population within the 500 m radius.

Tskaltubostskali river. Untreated wastewater is discharged in several points of the river. Project implementation (in case of normal operation) will positively effect on local water quality.

It is noteworthy that based on the corresponding calculations within the EIA, the impact scale on Tksltubostskali river water quality in normal operation conditions of WWTP has been determined. According to calculations in both phases of the subproject, negative impact on river water quality will be minimal and in line with the requirements of the technical regulation - " Methods for Calculation of the Standards for Pollutants Discharged with Wastewater into Surface Water Bodies", approved by the order №414 of the Government of Georgia on December 31, 2013. .

In order to mitigate negative impact on surface water quality on operation phase, the monitoring will be set on the efficiency of wastewater plant operation and in case of failure, corresponding corrective measures should be carried out; Systematic control will be established on implementation of requirements considered by Waste Management Plan, etc.

Impact on Ground Water: According to the engineering-geological survey, conducted within the project area, showed that ground water level is quite close to the surface level (1.5-3.8 m). Therefore, the ground water pollution risks are very important. Deterioration of groundwater quality may be caused by accidental spillage of oil and movement of pollutants into the deeper layers of the soil, as well as by excavations. In order to reduce the impact, it is necessary to implement measures related to the protection of soil and surface water quality.

On operation phase ground water pollution risks are relatively low and there is no need in implementing any special mitigation measures.

Impact on Soil Stability and Quality: It should be considered that project implementation is planned within the zone of high technogenic load, where the topsoil layer is degraded. Accordingly, construction works cannot significantly impact on existing baseline condition. On construction phase the impact on soil quality is expected from working equipment, improper usage of toxic substances and unorganized topsoil management cases.

Impact on the integrity and stability of soil or the loss and damage of the topsoil is not expected during the operational phase.

In order to prevent soil contamination-damage, the civil contractor should follow environmental requirements, detailed in EIA report.

Geological Hazards: According to conducted engineering-geological study, it is defined that selected area for WWTP is stable and signs of serious geodynamic hazard development have not been identified within the study area. The project does not require planning-implementation of significant mitigation measures.

Possible visual-landscape alterations: During preparation and construction works, certain visual impacts of -landscape transformation will take place due to the increased traffic flow, existence of construction sites and working equipment and people, construction materials and waste. However, it should be noted that the project area does not get within the vision of local population. Considering anthropogenous load of the site, the visual-landscape impact will be insignificant. After completion of the construction, machinery, material and waste will be removed from the construction camp and construction site. Reinstatement of the area is envisaged.

Impact on Biological Environment: The project area is not a habitat of special value. The secondary landscape is distributed here. Trees and vegetation cover are not represented on the major part of the area. The total number of trees and shrubs that will possibly be impacted is equal to 112. In case of impact on the woody Red List species, compensating measures will be determined in accordance of acting legislation (Decree #242 of the Government of Georgia, on "Rules of Forest Usage" dated as August 20, 2010). According to requirements of regulatory document of Georgia, the fee to be paid for

extraction of 1 m^3 oak from the environment is 300 GEL (including VAT). As for laurel, which is non-woody plant, compensation fee for this specie is not determined by regulatory document. Compensation fee will be defined by permit issuing body (the Ministry of Environment and Natural Resource Protection of Georgia). (For orientation, fee for extraction of 1 m^3 laurel from the environment will not be more than 320 GEL). After payment of compensation fee, it is recommended to replant the mentioned specie outside the project impact zone, to the analogous environment.

Expected impact on vegetation cover within the area can be classified as "moderate" or "low". After completion of construction, considered recultivation works will partly mitigate the impact. The direct impact on vegetation cover during operation phase is not expected.

The impact on wild life is expected from noise, dust propagation, tree felling. The direct impact is also expected (damage of the nests, collision, falling into the holes and so on). Mainly rodents will be impacted (social vole (*Microtus socialis),* broad-toothed field mouse (*Apodemus mystacinus);* reptiles (Sand lizard *(Lacerta agalis)*, sheltopusik (*Poseudopus apodus)*, grass snake (*Natrix natrix))*, and amphibians *(*green toad *(Bufo vitatus)*, water frog (*Rana rididunda)*, European tree frog (*Hylidae arborea).* Due to creation of the disturbance sources, small-scaled disturbance may take place, leading to the migration from the project area. In the operation phase, Tskaltubostskali river water contamination risks should be singled out in terms of impact on wildlife. In normal operation conditions of Tskaltubo WWTP, likelihood of impact on fish and in general on wildlife is at minimum. Positive effect is also expected, as as discharges of untreated wastewater into the river will be eliminated and living conditions will be improved for certain species.

Waste: On construction and operation phase generation of significant amount of hazardous and other type of waste is expected. Following should be singled out from hazardous waste:

- Oil-contained liquid and solid waste, which can be generated during maintenance of construction equipment, transportation means, transformers and other oil containing devices;
- Lead-containing accumulators of transportation means, used for the construction and special equipment;
- Luminescent bulbs and other mercury containing substances.

Taking into consideration the specificity of the work and the fact that the maintenance of the equipment /transportation means used in the construction and operation phases will be rarely carried out on WWTP site, only in urgent cases, the amount of hazardous waste generated will not be significant. There are no landfills in Georgia for disposal of hazardous waste. Generated hazardous waste will be handed over for further utilization to the contractor, having appropriate permit.

As for the amount of waste, the construction waste (up to 2700m^3) generated in the result of demolishing works and sludge (1406 m^3/a) resulting from wastewater processing on operation phase should be highlighted.

Inert material, generated in the result of dismantling works will be disposed in compliance with par. 5^1, Article 21 of the Waste Management Code, namely: "Inert waste that is suitable for backfilling operations or for construction purposes does not need to be disposed of in landfills, if agreed with state or municipal bodies, they will be used for backfilling operations or project considered construction purposes". Accordingly, under agreement with Tskaltubo Municipality Administration, inert construction materials will be used for backfilling of such areas, which requires vertical planning in order to avoid further negative processes (erosion, etc.).

Two alternatives for excess sludge handling can be discussed: 1. Sludge drying (composting) and further usage as fertilizer and 2. Final disposal of dried sludge to sanitary landfill, having environmental impact permit. As the country does not have legislative basis for using the sludge for agricultural purposes and there is no practice of sludge utilization as fertilizer , for the nearest future the only alternative of sludge

handling is its disposal on landfill (In prospect this issue can be reviewed). Considering the project WWTP site, theusage of the landfill, existing near Dapnari village in Samtredia municipality is the most suitable for sludge transportation.

Total storage volume of sludge drying beds is 1621 m^3. According to the project annual production of sludge is 1406 m^3. Thus the maximum storage of sludge is 421 days. Accordingly, the off-site sludge disposal will be organized once (maximum twice) a year. The sludge will be transported to the offsite disposal site by the transportation means owned or hired by UWSC of Georgia and its existing personnel. It is supposed to use 10 m^3 capacity dump trucks (with covered top) for sludge transportation, to avoid sludge scattering or dusting risks during transportation process.

Annual transportation cost for sludge transportation, generated during Tskaltubo WWTP operation will be 56240 GEL (23435 USD). Based on active tipping fees for sludge disposal on landfill, overall cost for disposal of generated sludge will be 28120 GEL (11 700 USD). Overall cost for sludge transportation-disposal will be about 84 360 GEL (35 150 USD).

The issue and conditions for sludge disposal on landfill should be agreed with Solid Waste Management Company of Georgia.

Impact on Social-economic Environment: The project area is within state ownership of United Water Supply Company of Georgia LLC and accordingly the project is not connected with physical and economic resettlement.

During project implementation, there are some risks to the health and security of working personnel and local population, which should be prevented by following security standards. According to the construction organization plan, arrangement of the construction camp is not considered. Only container-type offices, changing rooms for working personnel, meeting room, parking, mechanical processing site, storage areas for waste and construction material disposal will be arranged on the site. Arrangement of facilities, such as crushing and sorting plant and concrete plant, which pose threat to the health and security of personnel, are not considered. On construction phase the number of working personnel will be 35 people. The absolute majority of them will be locals and accordingly, permanent living (sleeping) containers will not be arranged on the site. Private residential houses will be rented for non-local workers.

Intensive traffic movement will be increased during construction phase, and this can be the reason of local population dissatisfaction. In order to reduce negative impact , optimal routes to access to the work sites should be selected and determined. Movement of caterpillar equipment should be limited. If required, dedicated personnel will control intensive movement. After completion of the construction works, all damaged sections of the road must be restored to ensure accessibility for population. In the operation phase the impact on traffic flows will be related to sludge transportation. It is significant to carry out sludge transportation operations not during peak working hours.

From socio-economic point of view it is significant that the project will be implemented in two stages. On the first stage economically advantageous technology for wastewater treatment will be applied - the preferred option is usage of the trickling filter, to realize the lowest possible tariffs and maximize customer ability-to-pay. The future forecasted tariffs in the result of project Phase 1 implementation will be affordable for average income population, however it will be necessary to develop social tariff for low-income families (10% of population).

Environmental Management and Monitoring:

The aim of the environmental management and monitoring is to ensure compatibility of the project implementation with National Environmental Legislation and WB Environmental and Social Policy.

On construction phase the Municipal Development Fund of Georgia (MDF) will control the performance of Environmental Management Plan by the constructor contractor through supervisor contractors. The supervisor, according to EMP will check the performance quality and reveal violations. Once a month the supervisor submits summarizing report to MDF, where the information about ongoing works and the performance of measures, determined according to EMP will be reflected. MDF is authorized to require corresponding environmental documents and records from constructor contractor. In case of failing the performance of EMP and violation of environmental standards, MDF will provide appropriate response toward constructor contractor. MDF ensures WB accessibility to all reports, submitted by the supervisor.

In operation phase, the operator company – United Water Supply Company of Georgia LLC will take responsibility on performance of measures, determined by Environmental Management and Environmental Monitoring Plans. Measures defined by management plan will be implemented by Tskaltubo Regional Service Center. Performance of EMP will be monitored by environmental supervisor, assigned by central office.

Stakeholder Engagement and Grievance Redress Mechanism:

The consultation with stakeholders and grievance discussion procedure will be carried out in accordance with World Bank Policy, consideration of national legislation requirements and according international practice.
The main principles of stakeholder engagement consider:

- To publish information about public hearing of EIA in central and local press;
- To ensure accessibility of electronic and printed versions of EIA;
- To receive/discuss written notes and proposals during public hearing;
- To hold a public hearing, open to any stakeholder to attend;
- To analyze notes and proposals received during public hearing and consider them in the final version of EIA;
- To ensure accessibility of final version of EIA report.

Methods for receiving grievance/information from public during construction process are developed within the framework of EIA report. Corresponding grievance forms are composed, the copies of which will be published on the project web-sites in construction phase, and in operation phase they will be available in the office of United Water Supply Company of Georgia LLC.

1 Introduction

General Overview

In spite of the fact that Georgia is rich in water resources, unconstrained water supply to final users cannot be achieved even in recent years. The main reason is unsatisfactory condition of water supply infrastructure (pipes, pumping stations, etc.).

Even more difficult is the situation in the field of sanitation. Sewage services are often blocked by inadequate levels of sanitation and destroyed (or lack of) infrastructure. Most settlements have no sanitary facilities for wastewater discharge, which refers as to the "decentralized" (existing houses) so to the "centralized" (wastewater collection network to the wastewater treatment plant) systems.

The above-mentioned situation have influenced the level of living, the health of the population, the livelihood of economy (especially where tourism development is essential) and quality of the environment throughout Georgia. Roughly 35% of the service is provided through a sewage collection network in about 45 urban centers; Generally, the pipes are decades old and in poor condition. Five out of 29 wastewater treatment plants operate with minimal efficiency (with the exception of the one new water treatment facility); consequently, dense sewerage network collects wastewater, but discharge it untreated, thus polluting waterways.

Therefore, the government of Georgia is committed to improve and expand water supply and sanitation services of urban centers by attracting funding from donor and private sector. Georgia, with the help of the World Bank within the framework of Municipal and Regional Infrastructure Development Project financed by IDA- drafted a Wastewater Management Strategy and feasibility studies for wastewater treatment in six selected cities.

Wastewater Management Project aims to promote this sector in Georgia and implement Wastewater Treatment Plant Project, which is aligned with World Bank Safeguard Policies and EU- legislation. The project includes the environmental, social and economic components and will focus on an integrated approach to improvement wastewater management. SWMP, the government of Georgia, municipalities, with engagement of bilateral donors and international financing institutions, will contribute to the improvement of overall efficiency of water supply and sanitation sector. This will ensure the development of tourism, which is sustainable and conducive to the environment.

Within the project, investment of construction works of the sub-project of Tskaltubo Wastewater Treatment Plant (with a design capacity of 6171 m3/day) is envisaged. Rehabilitation of the existing inlet pumping station and sewer between the pumping station and WWTP will be provided within the project. The implementing agency of the mentioned investment sub-project is Municipal Development Fund of Georgia LEPL.

Tskaltubo city is a unique resort, with the mineral waters, the development of which is considered as a priority by the government of Georgia. The major project for public infrastructure improvement and tourism development in the city is the arrangement of the new wastewater treatment plant.

Currently, the wastewater generated in the settlements is discharged in the surface water body without preliminary treatment. That results the contamination of the surface water body. Accordingly, the health of population and the environmental receptors, connecting with aquatic environment are under the threat.

The implementation of the sub-project will significantly improve the sewage system in the city and surface and ground water condition. This will bear positive impact on further development of the population, increase tourism potential and raise living standards of local population.

After the completion of construction works, the operator company of WWTP will be United Water Supply Company of Georgia Ltd, which is under the subordination of the Ministry of Regional Development and Infrastructure of Georgia. The company provides water supply and sewerage system services to the country, in urban settlements (Tbilisi, Georgia, Mtskheta, Georgia, except Rustavi and Autonomous Republic of Adjara). The mission of the company is to provide delivery of potable water to the population in uninterrupted, 24-hour mode, regulate water supply and sewerage system in all regional centers of Georgia and bring this system closer to the global standards. The company serves 289 343 residential subscribers and 15 578 legal entities.

This report shows the expected EIA results of the wastewater treatment plant during the construction and operation. The report is prepared by the consulting company – Gamma Consulting Ltd ordered by Municipal Development Fund of Georgia LEPL.

Information about Municipal Development Fund of Georgia and the consulting company - Gamma Consulting Ltd is in the following table.

The implementing organization	LEPL - The Municipal Development Fund of Georgia
Legal address	D.Agmashenebeli ave. 150, Tbilisi
Type of activity	The construction and Operation of the wastewater treatment plant in Tskaltubo.
Executive director	Ilia Darchiashvili
The contact person	Ana Rukhadze
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The consulting company	Gamma Consulting Ltd
The head of Gamma Consulting Ltd	Z. Mgaloblishvili
The contact number	2 60 44 33; 2 60 15 27

Legislative Basis for EIA Report Preparation

The present sub-project of EIA report is prepared on the basis of national legislation and World Bank Safeguard Policy Requirements, namely:

"Arrangement of wastewater treatment plant (with a capacity of 1000m3/ and more) and main sewer " is subject to ecological expertise in accordance with the Article 4, Paragraph 1, subsection "O" of the Law of Georgia on "Environmental Permit". Therefore, the project on the construction and operation of Tskaltubo wastewater treatment plant falls within the activities that are subject to ecological expertise and its implementation should be carried out based on the conclusion of ecological expertise. Conclusion of ecological expertise is issued by the Ministry of Environment Protection and Natural Resources of Georgia, based on ecological expertise of the environmental impact assessment report on the planned activities.

As World Bank is the administrative organization of grant funds provided by SIDA for implementation of sub-project, WB Safeguard Policy Principle - OP/BP 4.01 Environmental Assessment also should be applied. Based on the Principle OP/BP 4.01, the Sustainable Wastewater Management Project is granted the environmental category B and all its investment sub-projects are united under the environmental category B.

Objectives of EIA

Along with positive impacts, the project implementation will have some kind of negative impact on the natural environment and socio-economic conditions of the region. The main goal of the EIA report is to

carry out quantitative evaluation and define the spatial boundaries of such negative impacts. The following activities have been carried out:

- Collection of technical documentation of the planned activities and obtaining the information on the natural and social environment conditions;
- Summarization and analysis of the obtained information. Identification of environmental and social impacts of the project and its potential alternatives at different stages of the project;
- Development of the environmental management and monitoring schemes. Informing the public on planned activities and ensuring their participation in the process;
- Development of effective mitigation measures aimed at reducing the environmental impact is the most significant goal of the EIA report.

2 Legal and Administrative Aspects

2.1 National Environmental Legislation

Georgian legislation comprises the Constitution, environmental laws, international agreements, subordinate legislation, normative acts, presidential orders and governmental decrees, ministerial orders, instructions and regulations. Georgia is signatory of a number of international conventions, including those related to environmental protection.

Below is the brief description of main national environmental laws related to the implementation of the project on the construction and operation of Tskaltubo WWTP:

Law of Georgia on Protection of Environment (adopted in 1996 by the parliament of Georgia. Final version - 06/09/2013) regulates legal relationship between the bodies of the state authority and physical persons/legal entities in the scope of environmental protection and consumption of natural resources on all Georgian territory including its territorial waters, airspace, continental shelf and special economic zones.

The law concerns environmental education, environmental management, economic sanctions, licensing, standards, environmental impact assessment and related issues. The law considers various aspects of ecosystem protection, protected areas, global and regional environmental management, protection of ozone layer, biodiversity and the Black Sea, as well as discusses international cooperation aspects.

The law defines the rule for determining the maximum permissible norms of the emission of harmful substances and microorganisms in the environment during the implementation of works. During the operation of treatment plant, emission of harmful substances into ambient air, as well as in surface water bodies is expected. Therefore, under the requirements of the law it will be necessary to develop maximum permissible norms of harmful substances for each specific source so that not to exceed maximum permissible concentrations of harmful substances within the control area.

Law of Georgia on Environmental Impact Permit (adopted in 2007 by the parliament of Georgia. Final version 06/02/2014) - The law gives a complete list of activities subject to ecological examination (Article 4, Chapter II) and defines examination as an obligatory step for obtaining authorization for implementation of the planned development – environmental impact permit. The document sets legal basis for issuance of environmental permit, including implementation of ecological examination, public consultations and community involvement in the processes. According to the established procedure granting of permission or refusal to issue a permit is based on examination of environmental documents presented to the Ministry of Environment Protection and Natural Resources by a proponent.

According to the Law, planned activities are subject to ecological expertise and obtaining of environmental permit is required for its implementation. Environmental permit for this subproject should be obtained according to the procedures prescribed by this law. Also, under the requirements of the law, public awareness on the expected negative impacts due to the implementation of the subproject and their engagement in the process will be ensured.

Requirements of the law will be met during the implementation of the subproject and environmental permit will be obtained through the following procedures:

- Prior to the submission of EIA report to the Ministry of Environment Protection and Natural Resources of Georgia, information on planned activities and public hearing will be published in the central and the local press. The statement will contain information about the objectives, the name and location of the planned activities; addresses where the public will have access to the project related documents (including EIA report) will be indicated; The deadline for submitting the opinions of public will be determined; date and location of public hearing will be also indicated;
- Hard copy and electronic version of EIA report will be submitted to the permit issuing administrative body (the Ministry of Environment Protection and Natural Resources) within a 3 days after publication of information on planned activities;
- Submitted written comments and suggestions from the representatives of public will be discussed within 45 days after publication of information on planned activities;
- Public hearing of EIA report will be held within not earlier than 50 and no later than 60 days after publication of information on planned activities. Public hearings will be held in the municipality where the project is to be implemented (in our case Tskaltubo municipality). Any representative of the public will be able to attend the public hearing;
- Protocol on the results of the public hearing will be provided within 5 days after the meeting, in which all the comments and suggestions of the public hearing will be reflected in detail;
- After the public hearing of EIA report is held, protocol is drawn up and final version of EIA report is developed, required documentation will be submitted to the permit issuing administrative body (the Ministry of Environment Protection and Natural Resources) within one year. Documentation required for the permit includes: EIA report (5 copies and electronic version); layout plan of the project area (distances should be marked); scale and type of expected emissions; a short summary of the activities (in the form of technical summary);
- Ministry will carry out ecological expertise of the submitted documentation, upon which the ecological expertise conclusion is done. The permit will be issued within 15 days after the registration of the application, only in case of positive conclusion of ecological examination.

Law of Georgia on Ecological Expertise (adopted in 2007 by the parliament of Georgia. Final version - 25/03/2013). The law makes an ecological expertise obligatory for issuance of environmental impact or construction permits. An objective of the ecological expertise is to preserve ecological balance through incorporation of environmental requirements, sound use of natural resources and sustainable development principles. A positive conclusion of the ecological expertise is mandatory to obtain an environmental and/or construction permit. Ecological assessments are regulated by the Ministry of Environment Protection and Natural Resources.

Environmental permit for Tskaltubo WWTP subproject will be issued on the basis of positive conclusion of ecological expertise. Environmental assessment process is regulated by the Ministry of Environment Protection and Natural Resources. According to the law, ecological expertise of EIA report will be conducted by independent experts invited by the Ministry.

Law of Georgia on the Protection of Ambient Air (adopted in 1999 by the parliament of Georgia. Final version - 05/02/2014) regulates protection of the atmospheric air from adverse anthropogenic impact

within whole Georgian territory. Adverse anthropogenic impact is any human induced effect on atmospheric air causing or capable of causing a negative impact on human health and environment.

Since one of the most significant negative impact expected during the operation of WWTP is the emission of harmful substances in the air (spread of odor), the law will be significantly reflected on the implementation of the project, namely:

Based on the requirements of the law, maximum permissible emission of harmful substances during the operation phase of the WWTP will be determined within the framework of EIA and will be updated every 5 years. In addition, emissions from stationary sources of pollution should be recorded during the operation phase of the wastewater treatment plant (self-monitoring of emissions).

Law of Georgia on Water (adopted in 1997 by the parliament of Georgia. Final version - 06/09/2013). Consistent with the legislation, water within the territory of Georgia is in the state ownership and is protected by the state. Every citizen of Georgia is obliged to ensure rational and sustainable use and protection of water, to prevent its pollution, littering and depletion.

The main goal of the law is to ensure: Holistic State Policy in the field of protection and use of water; Protection of water bodies and rational use of water resources; sustainability and sustainable use of water related animals; prevention of harmful effects of water and effective liquidation of the impacts; protection of natural or legal persons rights and interests in the field of water protection and consumption, etc.

The law defines state control on water protection and consumption. Among other issues, state control includes the protection of water discharge standards and norms, as well as established regime of water consumption.

According to the law, the responsibility falls on those individuals who will hide or distort information about accidents, salvo water discharges and other particular situations that affect water condition.

Based on the requirements of the law, standards for maximum permissible discharges of pollutant concentrations (MPCs), discharged with wastewater into surface water body, will be determined within the framework of EIA and will be updated every 5 years. Maximum permissible discharge standard is established amount, which is allowed to be discharged into the river during certain period of time. The project implementing organization (in this case WWTP operator company) is obliged to follow MPC standards.

Law of Georgia on the Protection of Soil (adopted in 1994 by the parliament of Georgia. Final version - 14/06/2011) aims at ensuring preservation of integrity and improve fertility of soil. It defines obligation and responsibility of land users and the state regarding provision of soil protection conditions and ecologically safe production. The law sets the maximum permissible concentrations of hazardous matter in soil.

The law restricts: the use of fertile soil for non-agricultural purposes; execution of any activity without striping and preservation of top soil; open quarry processing without subsequent recultivation of the site; terracing without preliminary survey of the area and approved design; overgrazing; wood cutting; damage of soil protection facilities; any activity deteriorating soil quality (e.g. unauthorized chemicals/fertilizers, etc.).

Although, the area selected for the arrangement of the proposed treatment plant is of high anthropogenic load, there are certain risks associated with direct or indirect impact on soil. Based on the requirements of the law, it is necessary to implement topsoil removal-storage works during the preparatory stage. In addition, according to the requirements of the law, any activity during the construction and operation phases should be carried out so as to minimize the possible contamination of soil within the inner and outer perimeter of the area.

Waste Management Code (adopted in 2014 by the parliament of Georgia. Final version - 12/01/2015). The Code aims at creating legal grounds in the field of waste management for the implementation of such measures, which would promote the prevention of generation of wastes and increase their reuse, processing of wastes in a safe for the environment manner (recycling and separation of salvage, generation of power from wastes, safe disposal of wastes). According to the Law the purpose should be attained through means, which do not endanger human health and environment, especially the protected territories and cultural heritage.

Under the Waste Management Code, "the individuals and legal entities, whose activities result in the generation of over 200 tons of non-hazardous wastes or over 1000 tons of inert wastes or any amount of hazardous wastes during a year, are liable to develop company waste management plan." Waste Management Plan is updated every 3 years, or in case of any substantial changes in waste types, volumes and treatment processes.

Since generation of significant amount of waste (including construction waste generated during the dismantling of existing infrastructure and excessive sludge, as well as hazardous waste generated during the operation phase) is expected during the implementation of the planned activities, Waste Management Plan should be developed. Waste Management Plan should include information on preventive and recovery measures; description of the method of waste separation; methods and conditions for temporary storage of waste; waste transportation conditions; waste treatment methods; waste-handling requirements; waste monitoring methods.

Environmental Impact Assessment Code (Approved by the parliament of Georgia. Date for enactment of the code is January 1, 2018)

The reason for the adoption of the draft law is to fulfill the obligation of Georgia to improve environmental legislation and bring it into line with EU Directives through EU-Georgia Association Agreement and other international agreements.

According to the draft law, the objectives of the Code is to establish proper environmental governance in the country and improve environmental assessment system. The Code will promote the protection of environment, public health, cultural heritage and material values, while implementing various types of activities; provide public participation in decision making processes on environmental issues. According to the draft Code, the rights and duties of the state agencies, the executor company and the public representatives in the decision-making process on environmental issues are highlighted. According to the draft Code, the procedures to be implemented in case of transboundary impacts are also determined.

In accordance with the Annex I of the draft code, along with other activities, urban wastewater treatment plants for the equivalent of 50,000 and more population are subject to the EIA procedure. EIA procedure for Tskaltubo Wastewater Treatment Plant subproject, in accordance with the applicable legislation, will be initiated before enacting of the Code. Therefore, new regulations will not apply to the implementation of the activity.

General Environmental Standards of Georgia, related to the Project:

- Technical Regulation – on "Methods for Calculation of the Standards for Pollutants Discharged with Wastewater into Surface Water Bodies ", approved by the order №414 of the Government of Georgia; According to requirements of the technical regulation, for activities subjected to ecological examination, which discharge wastewater into water bodies, it is necessary to determine maximum permissible discharges (MPDs) of pollutants into water bodies. Accordingly, MPD project will be developed for the subproject of Tskaltubo WWTP and will be submitted for approval to the Ministry of Environment and Natural Resource Protection of Georgia.

- Technical Regulation – on "the protection of surface waters against pollution", approved by the order №425 of the Government of Georgia; The present technical regulation determines maximum permissible concentrations of pollutants according to water consumption categories. During MPD standard development for Tskaltubo WWTP subproject, requirements of the given technical regulation will be applied;
- Technical Regulation – "Methods of calculation of maximum permissible emission of hazardous substances into ambient air", approved by the order №408 of the Government of Georgia; The objective of this technical regulation is identification and normalizing of qualitative and quantitative features of hazardous substance emissions, emitted into ambient air from stationary sources of air pollution. During determination of quantitative features of hazardous substance emissions into ambient air for the subproject of Tskaltubo WWTP, requirements of the technical regulation have been applied. Besides, Maximum Permissible Emissions (MPEs) project will be developed in accordance with requirements of the technical regulation, in addition to the EIA report version, prepared for ecological examination, and will be submitted for approval to the Ministry of Environment and Natural Resources Protection of Georgia;
- Technical Regulation – "on water protection zones", approved by the order №440 of the Government of Georgia; Technical regulation determines the rule of establishing borders for water protection zones of surface water bodies, regulates activity mode within these zones in order to avoid contamination, pollution, siltation and draining of water resources;
- Technical Regulation – "on the removal, storage, use and cultivation of topsoil", approved by the order №424 of the Government of Georgia; The present technical regulation defines rules for removal and disposal of topsoil, productive layers and rocks during implementation of earth works, as well as rules for disposal of above-mentioned material to the specially allocated areas for further usage. In the construction phase of Tskaltubo WWTP, it will be required to provide topsoil removal-storage on separate sections of the project area;
- Technical Regulation – "sanitary rules for water sampling", approved by the order №26 of the Government of Georgia; the technical regulation defines requirements for water sampling, transportation, storage and conservation of water samples.

2.2 World Bank Safeguard Policies

All projects funded by the World Bank should follow the World Bank's environmental guidelines. The aims of these principles is to establish environmental expertise in order to ensure that the funded projects are environmentally sustainable, implemented under the current regulatory requirements and are not posing a significant threat to the environment, health and safety.

SWMP triggers the following safeguard policies of the World Bank:

OP/BP 4.01 Environmental Assessment;

OP/BP 4.11 Physical Cultural Resources;

OP/BP 4.12 Involuntary Resettlement;

OP/BP 7.50 Projects on International Waterways.

For the Construction and Operation subproject of Tskaltubo WWTP, WB Operational Policy - OP/BP 4.01 Environmental Assessment, is crucial. It considers examination of each proposed project from environmental point of view in order to determine scale and type, corresponding to the required environmental impact assessment. WB grants the only Category B to the proposed projects, considering the project type, location, sensitivity and scale, as well as the nature and volume of the environmental impact. Based on the principles of the OP/BP 4.01, considering the subproject specification, it is

classified as environmental Category B. Accordingly, the subproject will require examination of environmental risks, development of subproject-specific sets of risk mitigation measures, and planning of environmental monitoring of works. This will be carried out through the Environmental Impact Assessment (EIA) of individual subprojects and development of site-specific Environmental Management Plans (EMPs).

WB operational policy - OP/BP 7.50 Projects on International Waterways - is triggered if any measurable qualitative and/or quantitative positive or negative changes may be caused to water flow of the international waterways. Water from WWTP will be discharged into Tskaltubostskali river, which is not transboundary river. Accordingly, WB operational policy - OP/BP 7.50 will not be triggered.

WB operational policy OP/BP 4.11 - Physical Cultural Resources - is triggered if construction works are to be undertaken in the proximity to cultural and historic heritage sites; the subproject will be checked if it has any impact on historical and aesthetic value of cultural heritage sites. This safeguard policy also applies to handling of chance finds in case they are encountered in the course of earth works. There are no visible historical-cultural heritage monuments recorded within and near the area, selected for the construction of Tskaltubo WWTP. The area is under heavy anthropogenic load, where old WWTP had been operated for decades. Accordingly, during earth works the likelihood of late chance finds is at minimum. Consequently, WB OP/BP 4.11 – Physical Cultural Resources - will not be triggered within the subproject.

WB operational policy - OP/BP 4.12 Involuntary Resettlement - is triggered to address the cases of possible involuntary land acquisition under the targeted investments. The land selected for Tskaltubo WWTP construction is in the ownership of State company – United Water Supply Company of Georgia LLC. The subproject does not consider acquisition of private land plots and involuntary resettlement. Therefore, WB operational policy OP/BP 4.12 Involuntary Resettlement will not be triggered within the given subproject.

The World Bank operational policies also require that all investment projects reflect results of public participation and integrate governmental interests along with those of private businesses and civil society.

According to requirements of WB Performance Policies, IFC Environmental, Health and Safety Guidelines should be met. General EHS Guidelines are designed to be used together with the relevant Industry Sector EHS Guidelines which provide guidance to users on EHS issues in specific industry sectors. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment.

2.3 Comparison of the National Environmental Legislation and WB Requirements:

- **Screening of the project:** The Bank's guidelines provide detailed description of procedures for screening, scoping and conducting ESIA and explain a complete list of stages, which are not envisaged under the national legislation.
- **Classification:** Considering ecological risk, cultural heritage, resettlement and other factors, the Bank classifies projects supported by them under categories A, B and C. As mentioned, in the Georgian national legislation, EIA is carried out only if a developer seeks to implement projects listed in the Governmental Decree on the Procedure and Terms of the Environmental Impact Permit. This list is compatible with the category A projects of the Bank classification. According

to the Georgian legislation EIA is not required in other instances, while the World Bank guidelines may require limited EA or Environmental Reviews for B category activities, as well.

- **Environmental Management Plans:** The Georgian legislation does not request EMPs for the projects not requiring EIAs. The World Bank guidelines require EMPs for Category A and B projects and provide detailed instructions on the content.
- **Involuntary Resettlement:** The national legislation does not take into account the issue of involuntary resettlement at any stage of environmental permit issuance. The Georgian legislation considers social factor only with regard to life and health safety (e.g. if a project contains a risk of triggering landslide, or emission/discharge of harmful substances or any other anthropogenic impact). Thus, the national legislation does not consider resettlement as an issue in the process of issuing environmental permits, unlike the Bank who takes a comprehensive approach to this subject. Also, the national legislation, in difference from the World Bank policy, does not provide for any compensation to informal users of land and other property.
- **Responsibility for the EIA:** While the Bank's policy establishes the responsibility of a Borrower for conducting the environmental assessment, the national legislation provides for the responsibility of a project implementation unit to prepare the ESIA and ensure its consultation. According to the Georgian legislation, the MENRP is responsible for monitoring of project implementation and compliance with the standards and commitments provided in the ESIA and conditions of the permit with a less clearly defined role in relation to EMPs. The "Project Proponent" is responsible for implementing "self-monitoring" programs for the projects subject to the EIA. The WB guidelines stress the role of EMPs, which are important for all categories of projects and the Project Proponent is requested to ensure inclusion of monitoring schemes and plans in the EMPs. Monitoring of performance compliance against the EMPs is an important element of the WB requirements.
- **Involvement of the public and consultations:** Based on the requirements of the Bank, public consultations should be implemented for A and B category projects (not less than 2 consultations should be provided for A category projects). The schedule of these consultations should be developed by the borrower. According to the national legislation, executor of the project is obliged to: (1) organize public discussion of EIA report; (2) publish information on the project; (3) receive comments on EIA report; (4) organize public discussion of EIA report within not less than 60 days after publication of the information and invite all interested parties.

The present EIA was carried out with consideration of both the national and the WB requirements on the complementary basis. Project implementation will comply with the requirements of both – the national legislation and the World Bank policies. If the two have differing requirements for a particular activity or procedure, more stringent requirements will apply.

3 Project Alternatives

Based on the requirements of Article 5 of the Environmental Legislation of Georgia, project alternatives should be considered in EIA report. Due to the specifics of the planned activities, the following alternatives were deemed to be considered:

- No action alternative;
- Alternatives for the location of the treatment plant;
- Technological alternatives.

3.1 No Action Alternative

No action, or zero alternative implies refusal to the project execution that means the wastewater management issue of Tskaltubo will remain unresolved.

With the assistance of international financial organizations, the government of Georgia is planning to improve the wastewater drainage system and to construct wastewater treatment plants in significant settlements of Georgia. Creating the adequate wastewater treatment and drainage infrastructure will have positive effect in terms of further development of the settlements, attracting investments, increasing the tourism potential and the living standards of the local society. Consequently the implementation of such projects will be a significant contribution to social-economic development of the country.

The construction and operation project of Tskaltubo wastewater treatment plant is the most important component of the program. Currently there is practically no organized wastewater management in Tskaltubo. Sometimes the society uses sanitation pits, more frequently the wastewater is discharged directly into nearby surface water body (Tskaltubostskali River). This causes a rather unsatisfactory situation in terms of ecology and sanitation; there are high risks of adverse impacts upon human health and biological environment, which has a negative effect on tourism development.

The project implementation, which can be considered as an important regional environmental activity, can practically fix the existing unsatisfactory situation. In addition, the implementation of WWTP construction and operation project will have a certain contribution to the social-economic development.

Finally, following conclusion can be made: If the project will not be implemented, neither organized treatment of the wastewater in the mentioned settlement, nor minimization of surface water pollution risks will be possible. Considering the reasonable design decisions and appropriate mitigation measures the construction and operation of the wastewater treatment plant will bring more important environmental and economic profit, than in case of project failure. Therefore, no action alternative was rejected.

3.2 Alternatives for the Location of the Treatment Plant

Two alternative areas are discussed for Tskaltubo wastewater treatment plant location, namely:

- The first version considers the arrangement of wastewater treatment plant in the south part of the village Gvishtibi, on the old treatment plant area, with the following coordinates: X – 300297; Y - 4686249. The non-agricultural plots are the state property and the treatment plant operated on the area for many years. Today, the infrastructure of the plant is destroyed and devastated. The territory suffers a high technological load. The nearest residential house (village Gvishtibi) is located to the north-west, about 300m away;
- The second version considers the plant arrangement to the south-west of village Gvishtibi, on the right bank of Tskaltubostskali River, with following coordinates are: X – 299236; Y -

4686116. The area is agricultural land, with no vegetation cover/trees. There are no infrastructural facilities identified on the area. The nearest residential house is about 550m away.

The situational scheme for the alternative locations is given in Figure 3.2.1.

Through the comparative analysis of alternatives, the first thing to note is the distances between the main impact receptors – local community. At this point, the second alternative is preferable, as the distance is almost twice as long.

The secondary vegetation cover (almost no trees spotted) is represented on both alternative areas. However, the preference is given to the first alternative in terms of biological environment impact, as it has higher man-made load.

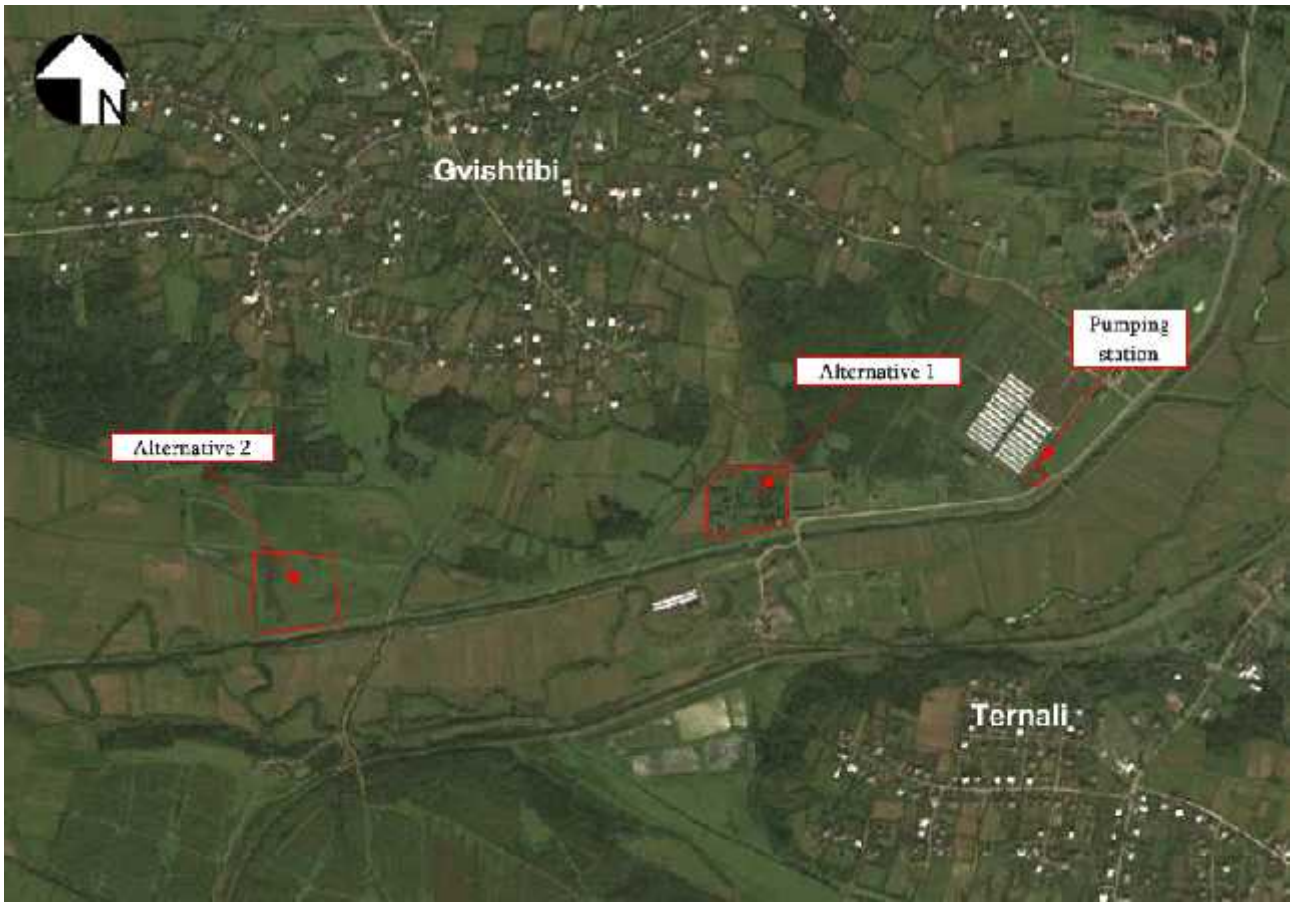
The second alternative area is agricultural land and correspondingly, there are relatively high risks of the impact on the humus layer quality and stability during the construction. Accordingly considering the impact on humus layer quality and stability the preference is given to the alternative-1.

In terms of the impact on the social environment the first alternative is preferred, as the land is in state ownership, where the similar infrastructure already exists. Thus there is no necessity of involuntary resettlement.

Another environmental and social advantage of the first alternative is: As a consequence of the project implementation, current infrastructural facilities (reservoirs and etc.) will be dismantled on the area of old treatment plant, the waste will be removed from the site, and the fence will be renewed around the area. Accordingly, existing unsatisfactory sanitary-ecological conditions will be improved and impact sources on the separate receptors (including human health and safety) –will be liquidated.

Based on the above mentioned and considering the scale of the negative impacts on various receptors, the first alternative is assumed to be more suitable for WWTP location. According to the given alternative WWTP will be closer to the residential houses. However, according to calculations, given in EIA report, exceedence of maximum permissible concentrations of pollutants at the border of residential zone is not expected in normal operation conditions.

Figure 3.2.1 Layout scheme of alternative areas discussed within the framework of EIA



3.3 Technological Alternatives for Wastewater Treatment

While discussing the technological alternatives for the wastewater treatment, the required parameters of the treatment plant were considered, along with the conditions of its operation, the technological accessibility. Three basic alternatives for the wastewater treatment might be discussed:

I. The arrangement of the individual treatment system;
II. Biological treatment using the phytodepuration method. Before the preliminary sedimentation the mentioned method considers water treatment in the canal and pond systems, where the water plants and algae grow.
III. The biological treatment with the treatment plant equipped with the modern technology.

The installation and operation of the individual treatment plant requires quite significant financial expenses. Furthermore, the maintenance of the plant and the wastewater treatment quality control will be rather complicated in the operation phase.

The use of phytodepuration method is rather difficult technically and it has some important negative issues, namely: The method is basically used for the wastewater treatment in small settlements, making it practically impossible to use in Tskaltubo. Besides, the method requires flooding of a large area, the treatment system operation will relate to important technical complications and systematic training of a large number of personnel. The following circumstances are considerable: Quite a large scale artificial reservoir of contaminated water would be formed. An open reservoir would support the increase of the disease carrier insects, smell, etc.

Based on the above mentioned, The III version was preferred, which is the collective treatment of wastewater with the biological treatment plant. This method is quite successfully applied in various settlements of Georgia.

The feasibility study was provided for 3, technically feasible alternatives:

- Alternative 1 – The wastewater treatment using the primary sedimentation and trickling filter;
- Alternative 2 – The wastewater treatment using the anaerobic tanks and trickling filter;
- Alternative 3 – The wastewater treatment using primary sedimentation and activated sludge.

Feasibility study provided an overview of the alternatives on the basis of pricing and analysis of other multiple criteria.

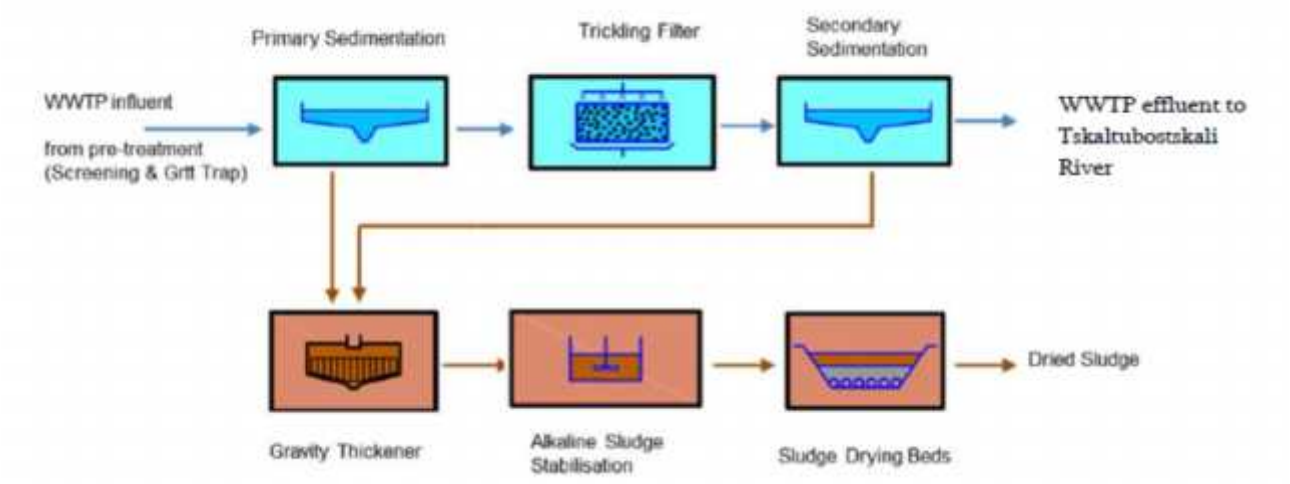
Alternative 1 - Primary settler + trickling filter

	Water Line	Sludge Line
Phase 1	• Screen • Grit Trap • Primary sedimentation • Trickling filter pumping station • Trickling filter • Secondary sedimentation	• Sludge thickener ; • Alkaline sludge stabilization (liquid lime stabilization process); • Drying beds .
Phase 2	• Activated sludge tank; • Intermediate sedimentation; • Return Sludge/Surplus activated sludge pumping	

The alternative 1 is designed to achieve organics removal. A significant part of the particular organics will be removed by the primary sedimentation tanks. The biological treatment in the trickling filters will degrade the dissolved organic compounds.

The sludge must be extracted every day from the primary settlers and the secondary clarifiers respectively. After thickening, the sludge will be stabilized by means of liquid alkaline sludge stabilization (lime addition will lead to a pH increase to 12, suppressing all biological activity in the sludge, killing pathogens and improving the sludge dewatering characteristics). The sludge drying beds dewater the sludge depending on the processing time and climatic conditions.

Figure 3.3.1. The Alternative 1 of WWTP – Phase 1

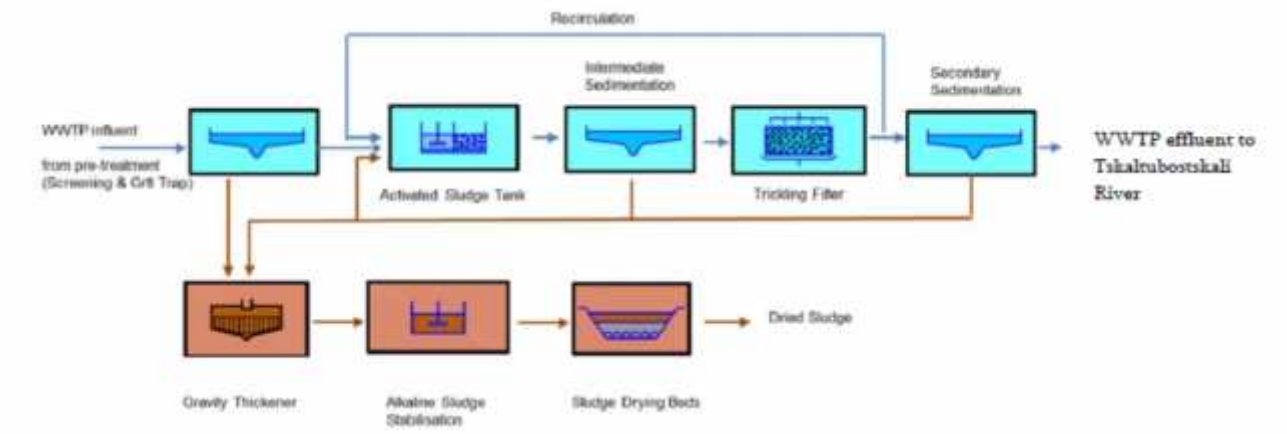


The technological scheme to be implemented in phase 2 considers nitrogen and phosphorous removal from wastewater. While phosphorous removal can be easily implemented by means of chemical precipitation, nitrogen removal from wastewater is a biological process which generally requires higher

efforts.

For implementation of nitrogen and phosphorous removal in phase 2, an approach is proposed that allows full utilization of all units previously implemented in phase 1 and another treatment line is added.

Figure 3.3.2. The Alternative 1 of WWTP – Phase 2



An activated sludge stage is foreseen downstream of the primary sedimentation tanks. The activated sludge tanks will primarily serve for denitrification and carbon removal. The activated sludge will be separated from the clear effluent in intermediate sedimentation tanks and recycled back to the activated sludge tank. The trickling filters will serve as main-stream trickling filter providing the bulk part of nitrification, half of the nitrate rich trickling filter effluent will be returned to the activated sludge tank for denitrification. By proceeding this way, the main nitrification process is separated from the activated sludge tank and the major part of nitrification is achieved externally by the trickling filters. However as nitrifiers are constantly flushed out from the trickling filters and recycled back to the activated sludge tank, nitrification will also take place in the activated sludge tank.

In addition to full utilization of all phase 1 process units, the nitrogen and phosphorus removal approach, proposed for the Phase 2, has the following advantages:

- Reduction of the age of age of the activated sludge system (from 10-15 to 5-8 days);
- the anaerobic mass fraction can be increased to 70% for improvement of denitrification;
- the oxygen demand of the activated sludge tank is decreased, thus reduced electricity cost;
- the sludge settle ability is significantly improved (leading to smaller intermediate sedimentation tanks).

Arrangement of additional sludge thickening, alkaline sludge stabilization and sludge drying beds is considered for the Phase 2.

The proposed nitrogen and phosphorus removal process has been proven to provide effective and cost efficient nutrient removal in various German wastewater treatment plants (e.g. in WWTP Kempten, Design Load 400,000 PE_{60}, Bavaria, Germany).

Alternative 2 - Anaerobic pond + trickling filter

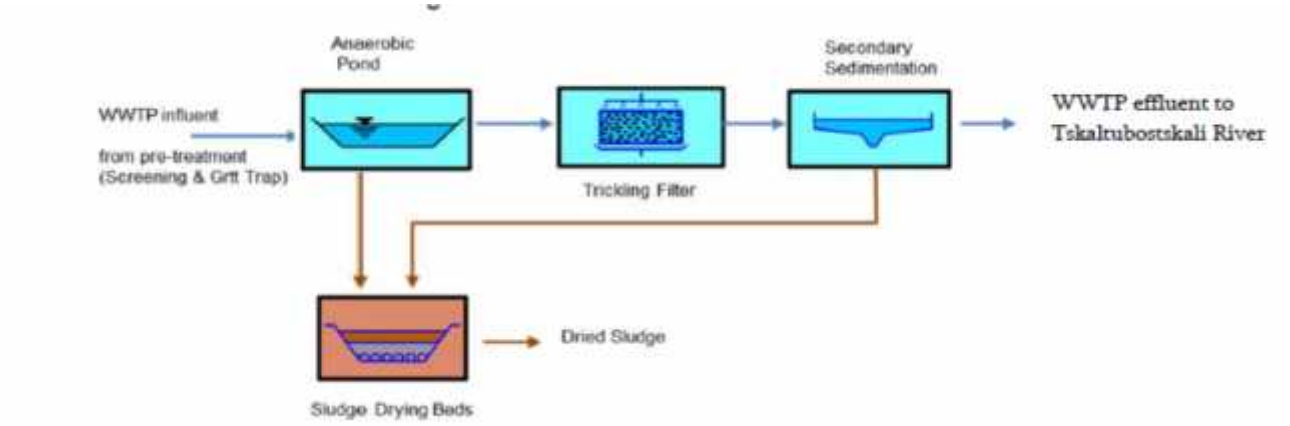
	Water Line	Sludge Line
Phase 1	• Screen • Sand trap • Anaerobic ponds • Intermediate pumping station • Trickling filter	• Sludge Drying Beds

Phase 2	• Activated sludge tank • Intermediate sedimentation • Return Sludge/Surplus activated sludge pumping	

The alternative 2 is designed to achieve carbon (organics) removal on Phase 1. A large part of the particular organics will be removed by the anaerobic ponds. The biological treatment in the trickling filters will degrade the dissolved organic compounds and in addition provide partial nitrification in summertime when the anaerobic pond performance is highest.

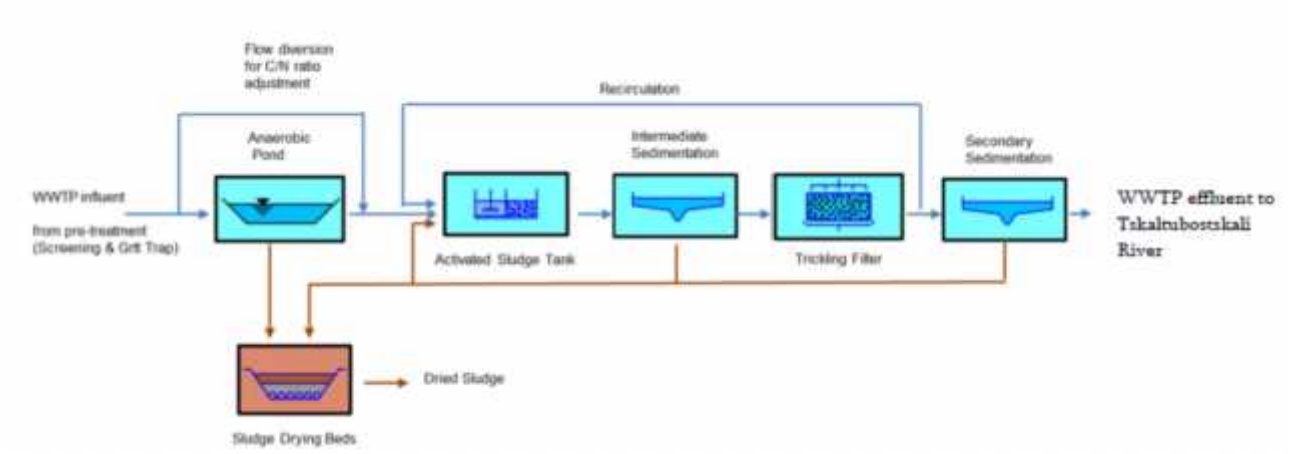
The sludge that will be extracted every day will be fed to the anaerobic ponds, where it will be stabilized by anaerobic digestion. The sludge has to be removed from the anaerobic ponds in long term intervals (approx. every 1-2 years). The sludge withdrawn from the anaerobic ponds can be effectively dewatered on the sludge drying beds.

Figure 3.3.3. The Alternative 2– Phase 1



For implementation of nitrogen and phosphorous removal in phase 2, an approach is proposed that allows full utilization of all units previously implemented in phase 1 and another treatment line is added.

Figure 3.3.4. The Alternative 2 of WWTP Upgrade– Phase 2



In principle the biological treatment process is similar to alternative 1, but the activated sludge stage will be arranged downstream of the anaerobic ponds and the surplus activated sludge will be fed to the anaerobic ponds.

A key process consideration is maintenance of a favorable C/N (Carbon to Nitrogen) ratio for effective nitrogen removal in the activated sludge process. Therefore diversion of a fraction of raw (carbon-rich) wastewater to the anoxic zone (Denitrification Stage) of the activated sludge tank is expected to be

required.

The combination of activated sludge tanks and trickling filters has the same benefits as already described for Phase 2 of Alternative 1.

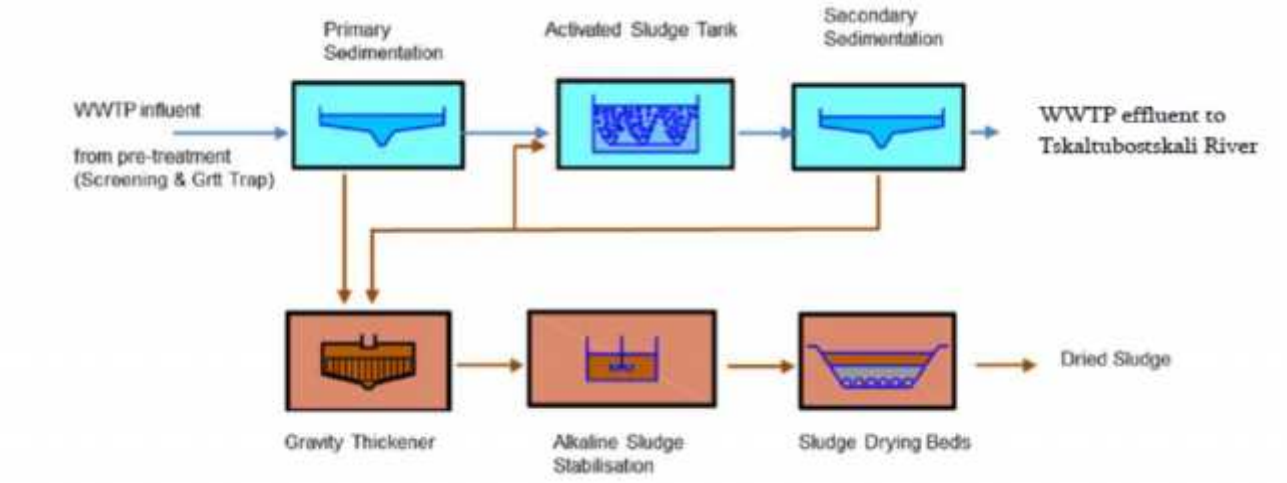
Alternative 3 - Primary settling + activated sludge

	Water Line	Sludge Line
Phase 1 and Phase 2	• Screen • Sand trap • Primary sedimentation • Activated sludge tank • Secondary sedimentation • Return Sludge/Surplus activated sludge pumping	• Sludge thickening • Alkaline sludge stabilization (liquid lime stabilization process) • Drying beds

WWTP process of Alternative 3 - Phase 1 is designed to achieve organics removal. A significant part of the particular organics will be removed by the primary sedimentation tanks. The activated sludge stage is designed for carbon removal. The secondary clarifier will separate the biomass from the clear effluent. The biomass is returned to the activated sludge tank via the sludge pumping station. A part of the return sludge has to be separated as the biomass is constantly growing. This sludge, the surplus activated sludge, together with the primary sludge must be extracted every day and fed to the gravity thickener.

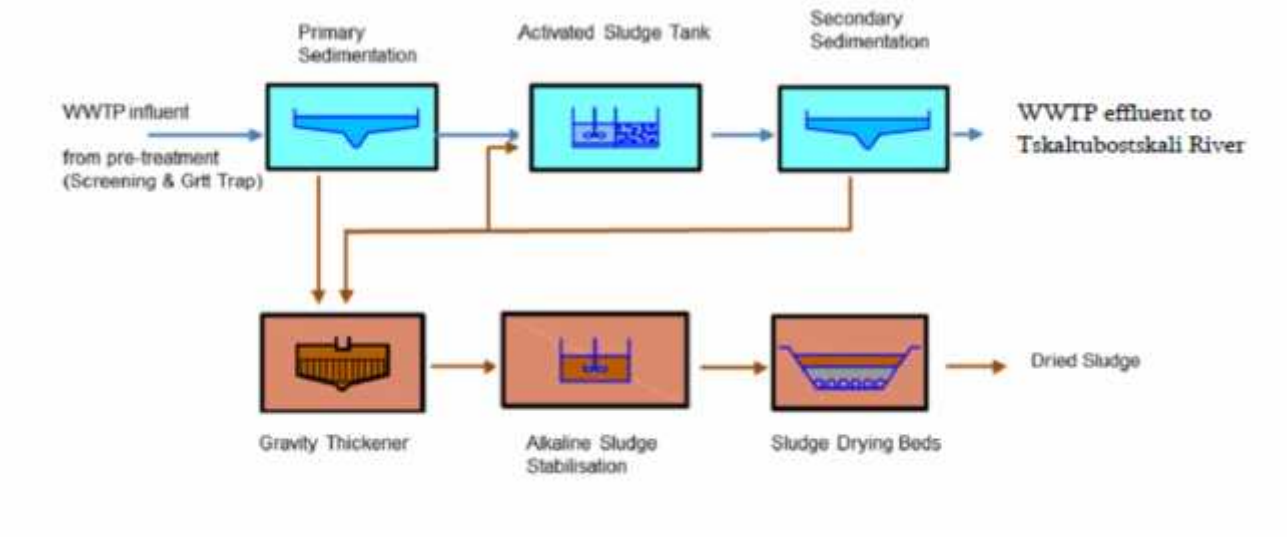
After sludge thickening, the sludge will be stabilized by means of liquid alkaline sludge stabilization (lime addition will lead to a pH increase to 12, suppressing all biological activity in the sludge, killing pathogens and improving the sludge dewatering characteristics). The sludge drying beds dewater the sludge depending on the processing time and climatic conditions.

Figure 3.3.5. The Alternative 3 of WWTP – Phase 1



Implementation of nitrogen and phosphorus removal can be easily managed by a significant increase of the activated sludge tank volume – with an increased aerobic compartment for nitrification and a further addition of anoxic zones for denitrification. In principle the plant configuration is nearly identical to Phase 1, with full utilization of all units previously implemented in phase 1

Figure 3.3.6. The Alternative 3 of WWTP – Phase 2



Conclusion:

In regard to operation, as well as investment costs, financially the most suitable alternative is the alternative 2 – usage of anaerobic ponds and trickling filter. It is followed by the first alternative and then comes the last, alternative 3. The second alternative of the wastewater treatment plant was preferred, due to the following reasons:

- The alternative has the advantage in terms of removal of BOD. The amount of produced sludge is significantly reduced and the improved quality of the final sludge is ensured;
- The alternative has the operation-related advantages – relatively simple way to develop the sludge, less pumping, large interval between extractions of sludge from anaerobic tanks and accordingly, reduced amount of sludge;
- The capital investment and operation related costs are low.

4 Description of Selected Alternative

4.1 General Overview

Area selected for the construction of WWTP, non-agricultural land (cadastral code: 29.07.35.021) is located to south-west of Tskaltubo city, on the right bank of Tskaltubostskali River at 86-90 m a.s.l.. Project area is about 31 827 m^2 (3.2 ha). Geographic coordinates of the project area: (zone - 38T): X - 300288; Y=4686250. The land plot is the property of United Water Supply Company of Georgia.

The wastewater treatment plant of Tskaltubo Municipality operated on this area in the past years, which is out of order now and has been inactive during decades. There are damaged structures of old plant.

The outer perimeter of the area is fenced by the wire-fence. On the inner space artificially grown tree-plants both decorative and cultural species, are presented. The increase number of thorns and bards is presented within the area of sedimentation tanks and sludge drying beds. In the North of the area there is small section of swamped land (up to 40 m^2), which is dried out during summer season.

The views of the projected area are given on the picture 4.1.1.

Picture 4.1.1 Views of the project area

Tskaltubostskali river flows in the South of the project area (in the distance of 20-25 m), which has the deep riverbed. The project area is bordered by business yard to the East, and by agricultural land to the West, which in private ownership.

The nearest residential zone (village Gvishtibi) is about 300 m away from the border of the project area in the North.

6 kV electric transmission line goes near the project area, which can serve as a power supply source both on construction and operation phases.

The arrangement of the design pumping station is envisaged on the area of old pumping station (with approximate coordinates X= 301017; Y= 4686290), where the damaged infrastructure remains are still presented. The infrastructure of old pumping station is out of order and cannot be re-used.

The pumping station area is bordered by the greenhouse area in the North. The nearest residential zone is situated in the North, in the distance of 400 m. To the South-West it is bordered by highway, and the trunk main and natural gas pipeline are between the highway and the Tskaltubostskali riverbed.

In the adjacent territory of the pumping station the sewers of the right and left banks are joined. Due to the inactivity of the pumping station, the accidental discharge of wastewaters take place on this very place (coordinates: X= 301068; Y= 4686266.) The view of the project area of the pumping station and accidental discharge point is given on the picture 4.1.2.

Picture 4.1.2 Untreated Wastewater Discharge Point

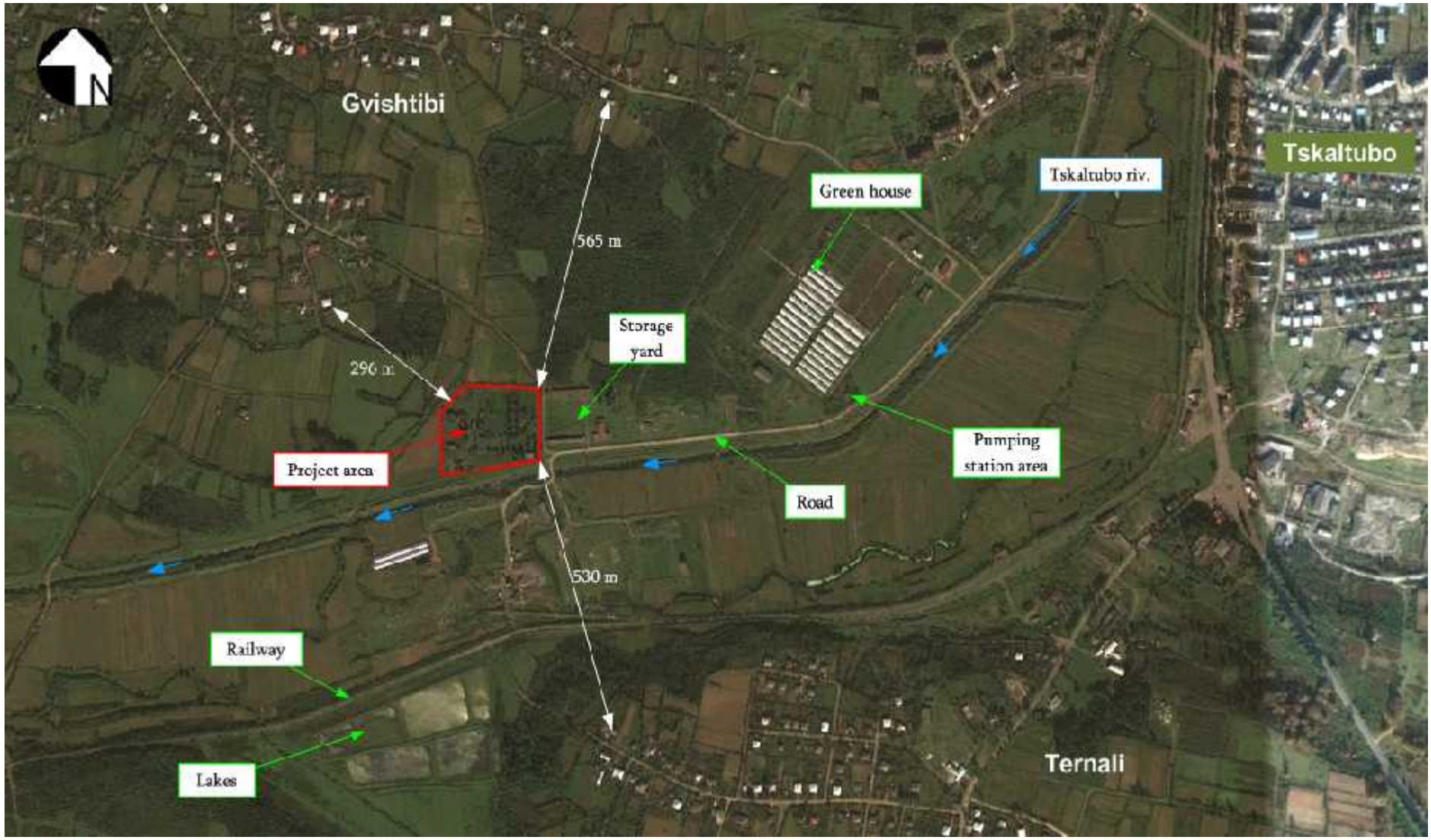
The arrangement of the pressure sewer is planned from the pumping station to the WWTP area, and its corridor will be across the highway (see Picture 4.1.3.). It should be mentioned, that the water trunk main and natural gas pipeline pass in the same corridor on the river side. Supports for 6kW power

transmission line are located across the highway. The vegetation cover is not presented within the project area and neither any artificial or natural barrier is placed.

Picture 4.1.3 Pressurized Sewer Corridor

The layout plan of the project is given in Figure 4.1.1. See also Figure 4.3.2.3.1.

Figure 4.1.1 Layout scheme of the project area



4.2 Description of Tskaltubo WWTP Project

In consideration of the current environmental situation with no wastewater treatment at all and stringent financial situation, a two-phase strategy for Tskaltubo WWTP subproject is well justified. Namely:

- On the first phase, the infrastructure facilities, that provide wastewater treatment in the amount expected for 2028, will be arranged (Population Equivalent PE_{60} - 18500). The mechanical cleaning and BOD and COD removal will be achieved. The design daily flow will be 6171 m^3/d, peak flow – 483 m^3/h;
- On the second phase, the infrastructure facilities, that provide wastewater treatment in the amount expected for 2038, will be arranged (Population Equivalent PE_{60} – 25500). It is planned to update the treatment plant for total nitrogen and total phosphorus removal. The design daily flow will be 6477 m^3/d, peak flow – 483 m^3/h;

The effluent quality requirements for phase 1 and phase 2 are given in table 4.2.1.

Table 4.2.1 Quality requirements for the treated wastewater

Parameter	Parameter	
	Phase 1	Phase 2
Biochemical oxygen demand (BOD_5 at 20 °C) without nitrification	25 mg/l	25 mg/l
Chemical oxygen demand (COD)	125 mg/l	125 mg/l
Total suspended solids (TSS)	35 mg/l	35 mg/l
Total Nitrogen (TN)	-	15 mg/l
Total Phosphorous (TP)	-	2 mg/l

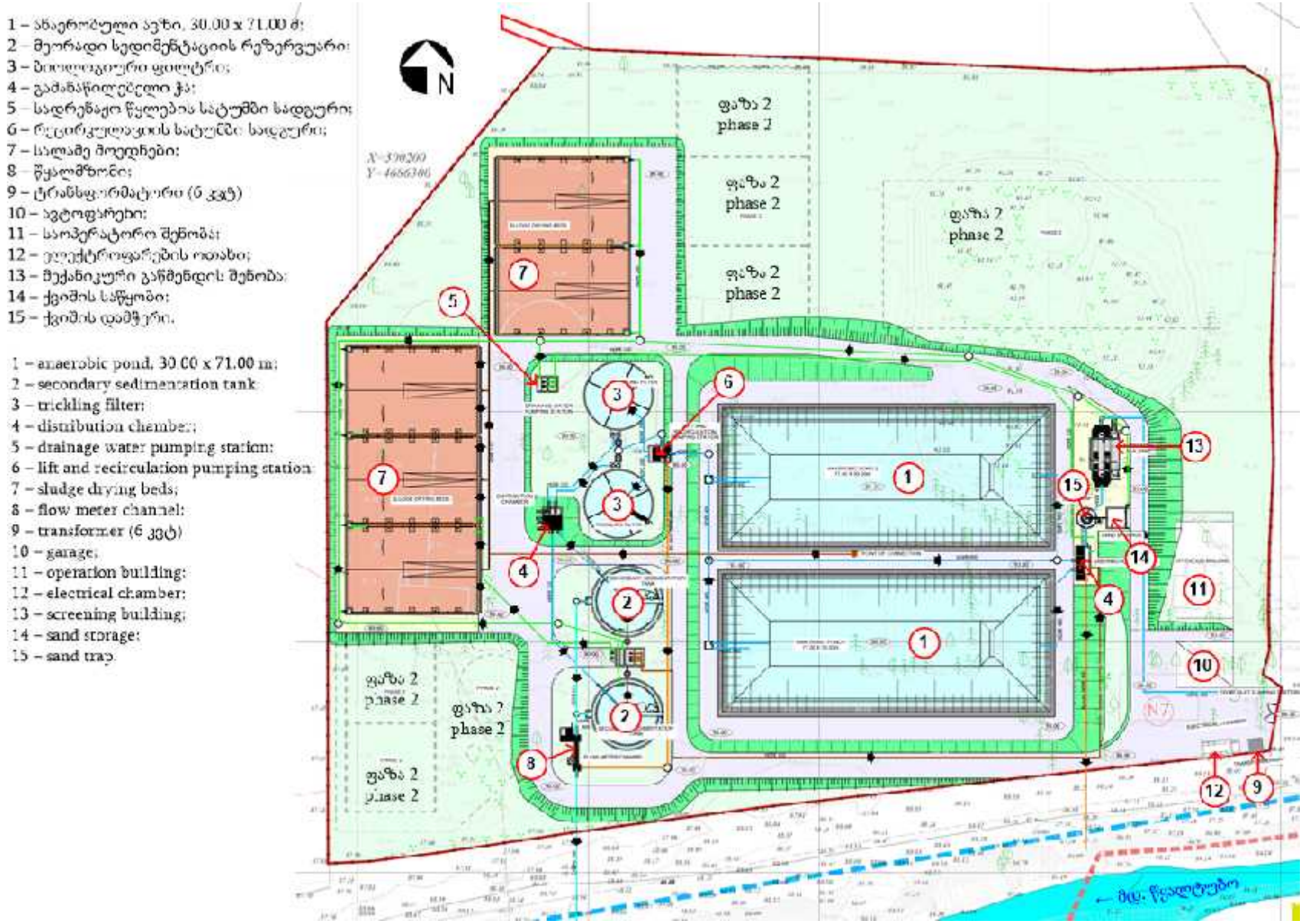
The Phase 1 of the project envisages the installation of the following main infrastructural units and equipment:

- Inlet pumping station of WWTP;
- Coarse screen (so called screening system);
- Grit Trap and Distribution Chamber;
- Anaerobic tanks;
- Trickling filter pumping station;
- Trickling filter;
- Secondary sedimentation tanks;
- sludge drying beds.

According to the project, it is planned to dismantle the pumping station, located in about 800 m upstream from the project area and arrange new one instead. Pumping station will be equipped wth 4 pumps (3 operation and one reserve) and it will be considered for pumping of maximum wastewater flow, expected for Phase-2 to the treatment plant. Inlet sewer will be arranged between pumping station and WWTP, which will pass across existing road.

The WWTP general plan, depicting all main infrastructural units is given in Figure 4.2.1.

Figure 4.2.1. General plan of WWTP with infrastructure facilities considered for the Phase 2



4.3 Brief Description of WWTP Operation Process

For Phase 1 the operational scheme of WWTP envisages BOD and COD reduction. Anaerobic ponds, trickling filters, secondary settlers and sludge drying beds are involved in the treatment process. Treatment process is suitable considering low investment costs, low power consumption and low operational costs to achieve the wastewater treatment.
At initial stage wastewater entered the WWTP is undergone the mechanical treatment on fine screens and sand trap. Screens are automated. Stop log rabbets are installed upstream and downstream of screens, and one set of stop-logs is provided. Wastewater will be discharged into channel through this grit chamber with relatively low speed so that heavy inorganic grit will be silted on the bottom, from where it can be removed. Grit, silted on the bottom of the cesspool, is transferred to the grit disposal site through air pump.

After pre-treatment (mechanical treatment), the water undergoes biological treatment, involving anaerobic tanks in the process. The anaerobic tanks provide primary wastewater treatment by anaerobic degradation of dissolved organic compounds, sedimentation of settable solids and subsequent anaerobic digestion. When the accumulated digested sludge on the bottom of the tank reaches a threshold level, a removal of the settled sludge is required.

After anaerobic tanks, the water undergoes biological treatment by trickling filters. The purpose of this treatment is to allow sewage water to be in contact with biological population. Organic matters degradation occurs when biological population is growing. Pre-settled wastewater is continuously 'trickled' or sprayed over the filter. As the water migrates through the filter surface, soluble organics are aerobically degraded by the microorganisms, growing on the filter material. Once the soluble organic material concentration falls below a threshold value, also nitrification takes place. The microorganisms are steadily replicating. Trickling filter generally operates in aerobic conditions. Raw water goes down through through perforated floor and then is led on the bottom slope to drainage ring-channel, then goes out to secondary settler. To allow recirculation of organic matters and treated water, a valve is installed on this pipe and when it is shut water overflows to recirculation pit.

The outflow of the trickling filters contains biofilm fragments that have been sloughed off from the trickling filter media. The secondary sedimentation tank separates the sludge particles from the clear effluent. Flow enters through the central diffuser drum and is forced downward, ensuring a proper settling time in the clarifier to allow for the settling of the solids. The water then rises and exits through a wall mounted weir placed on the inner circumference of the clarifier. A surface skimmer sweeps over the surface of the clarifier to collect the floatable solids and removes them. The collected scum will be intermittently pumped to the sludge drying beds.

From secondary sedimentation tank the treated water will go through about 35 m long underground pipeline to Tskaltubostskali river direction. Discharge pipeline will cross existing road. Approximate discharge coordinates are as follows: X – 300223; Y – 4686118.

Sludge will be stabilized in anaerobic ponds. Sludge dewatering using sludge drying beds will be provided. For optimal drying a maximum height of 200 mm of sludge will be stored at a time. This process is repeated until 600 mm of sludge is stored on the drying bed; after that dewatered sludge will be removed.

Sludge Treatment/Drying

Sludge drying beds are equipped with two intake pipes, which are connected to the sludge piping system, which is directly fed by the float-mounted sludge suction device.

WWTP will generate 263 000 kg SS/a of sewage sludge – once the full capacity level of the 2028 Phase 1 facility is attained; this means sludge production levels will likely be lower in the first years of operation, until greater numbers of inhabitants are connected to the sewer network. The "wet" sludge will be removed every 1-2 years from the Anaerobic Ponds to the sludge drying beds, via a floating sludge removal device. According to this detention time, the anaerobic "fermentation" will thoroughly stabilize the sludge to ensure minimal odor levels upon removal. From the anaerobic ponds, the sludge will be transferred to the onsite Sludge Drying Beds to remove moisture and solidify the sludge.

As it was mentioned above, sludge with 200 mm thick layers will be stored at a time. This process is repeated until 600 mm of sludge is stored on the drying bed; Sludge drying beds contain 5 sections. (each section with following dimensions: 28,3 x 19,1 m). Accordingly, total storage volume of sludge drying beds is 28.3 x 19.1 x 5 x 0.6 = 1621 m^3. According to the project annual production of sludge is 1406 m^3. Thus the capacity of sludge drying beds will be sufficient for storage of sludge generated during a year. Removal of sludge from sludge drying beds to the permanent disposal area should be carried out once in 421 days at minimum (sludge removal from sludge drying beds to permanent disposal areas is given in paragraph 7.9).
Drainage water from sludge drying beds will be collected in an organized way by drain channels and will be discharged into distribution chamber.

The Phase 2 WWTP technological scheme involves nitrogen and phosphorus removal from wastewater. While phosphorus can easily be provided by chemical precipitation, nitrogen removal from wastewater is the process, which requires large effort. Nitrogenous compounds will be removed biologically from wastewater: nitrification and denitrification. Phosphorus removal will be achieved by chemical settling. Main changes to be made on Phase 2: for nitrogen removal it will be required to arrange activated sludge tank, blower station and supplementary clarifier on the next stage after trickling filters.

Wastewater treatment process for Phase 1 and Phase 2 is reflected in figures below.

Figure 4.2.3.1 Technical scheme of wastewater treatment –Phase 1.

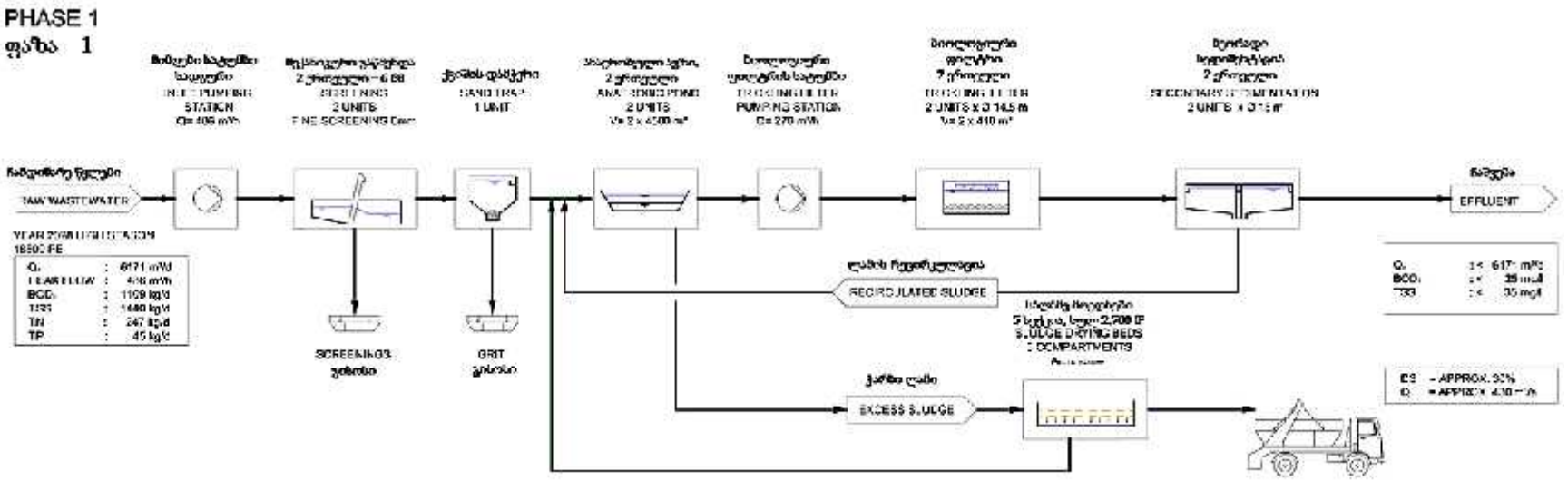
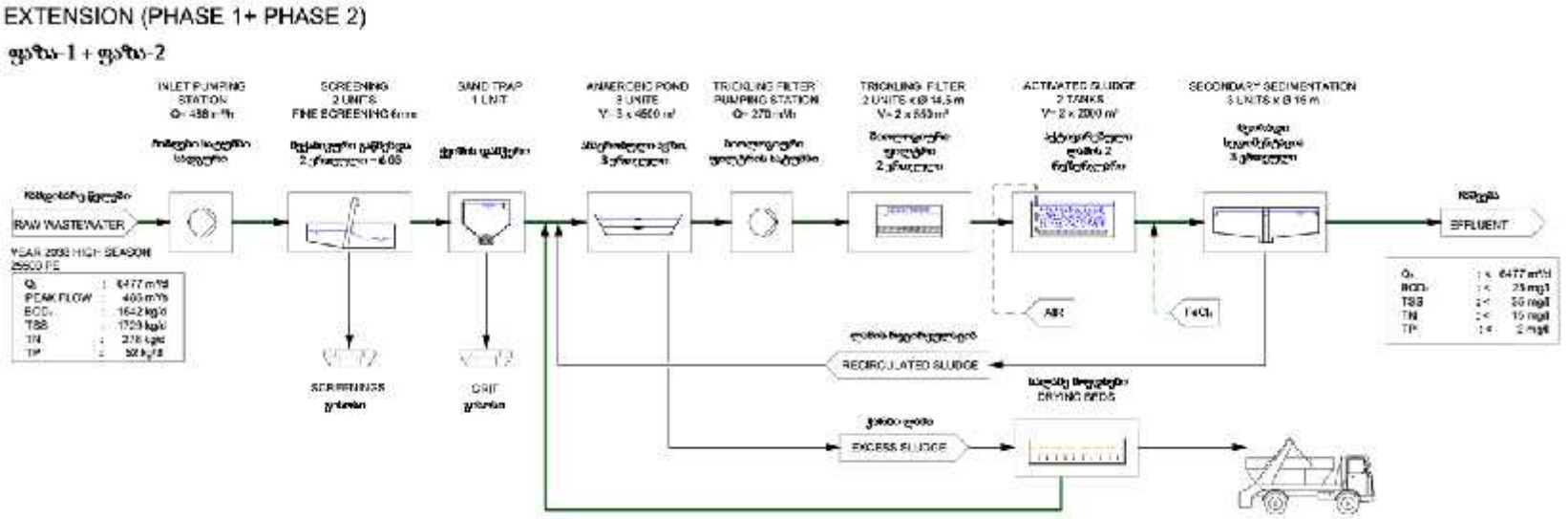


Figure 4.2.3.2 Technical scheme of wastewater treatment –Phase 2.



Supportive Infrastructure

Potable and Technical Water Supply

Water supply of WWTP will be provided from the water main pipeline, bordering the project area. The diameter of the pipeline is 400 mm. The pipeline with the approximate length of 10 m and diameter of 100 mm will be arranged to access WWTP project infrastructure.

Sewerage and Drainage System of the Facility

Proposed sewerage and drainage system will collect water drained from the Screening Building, the Operation Building, the Grit Storage Area, the Sludge Loading/Storage Area, as well as liquors from the Sludge Drying Beds. All of the a.m. flows (contaminated water) will be directed to the distribution chamber. All other paved areas and maintenance roads, where no surface pollution occurs, will be drained to the adjacent green areas. The respective roads and areas will be designed with a sufficient surface inclination.

Fire-Fighting System

Appropriate fire detection and alarm facilities will be provided on the WWTP site. Manual alarm buttons, smoke and heat sensing detectors will be installed in all buildings, plant operation areas, storage areas, etc. A master alarm annunciator will be located in the control room. The system will be manufactured in accordance with current IEC standards and installed in accordance with local regulations. All buildings and structures, where required, will be provided with lightning protection equipment.

4.4 Organization of Construction Works

According to the project, planned works can be provisionally divided into several stages. Below the description of each stage is given. In total, the duration of the construction works is 1 year, including dismantling of existing buildings.

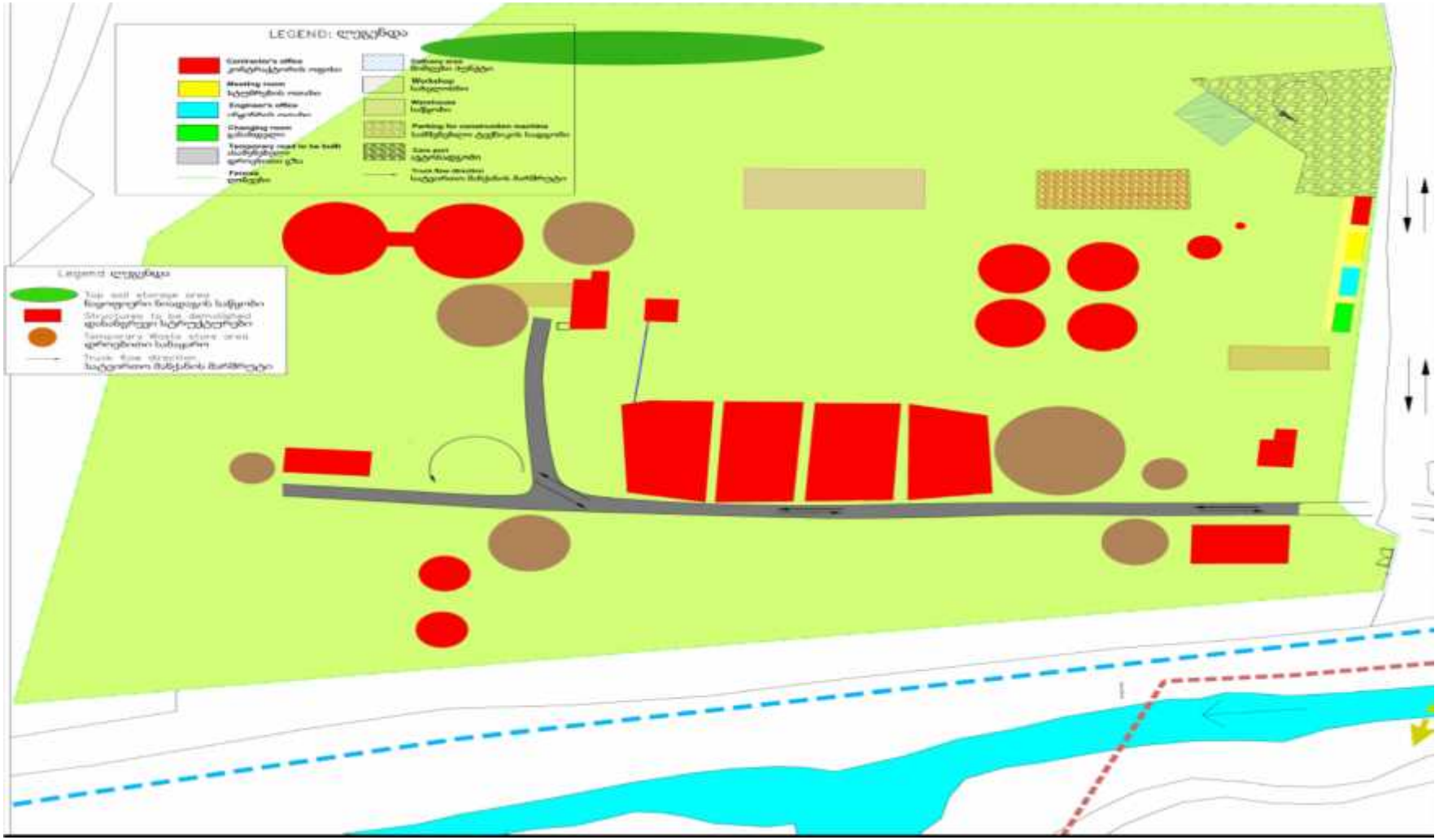
Construction Camp

According to the construction organization plan, it is not considered to arrange the construction camp. Within the inner perimeter of the allocated area, owned by UWSC, following infrastructural facilities will be arranged: Container type offices, changing room for workers, meeting room. Parking for construction machine and vehicles, mechanical processing site, storage areas for waste and construction material disposal also will also be arranged. Such location of temporary infrastructure will be suitable in terms of transport operations – distance for daily movement of equipment and vehicles will be short. The area is highly anthropogenic and accordingly, the arrangement/operation of temporary infrastructure will not cause additional impact on vegetation cover, topsoil and wildlife.

The inert materials and ready concrete mixture will be delivered from natural and legal persons' facilities acting in the region. Arrangement of concrete plant and crushing and sorting plant on the site is not required. Majority of employed people (35 people) on construction phase will be from local population (80%) and accordingly arrangement of permanent living containers for working personnel is not considered.

Layout of temporary infrastructure is given in figure 4.4.1.

Figure 4.4.1. Layout of temporary infrastructure



Dismantling Works

As it was mentioned initially, infrastructural facilities of old WWTP are remained on the project area. Development of the new infrastructure is planned on the east perimeter of the area, owned by United Water Supply Company of Georgia LLC. Accordingly, it is projected to dismantle old buildings, located on this section. According to approximate evaluation, about 2500-2700 m^3 concrete and 60-70 t metal structures will be dismantled. The figure above also shows those buildings, which will be dismantled on the Phase I.

Inert material, generated in the result of dismantling works will be disposed in compliance with par. 51, Article 21 of the Waste Management Code, namely: "Inert waste that is suitable for backfilling operations or for construction purposes does not need to be disposed of in landfills, if agreed with state or municipal bodies, they will be used for backfilling operations or project considered construction purposes". Accordingly, under agreement with Tskaltubo Municipality Administration, inert construction materials will be used for backfilling of such areas, which requires vertical planning in order to avoid further negative processes (erosion, etc.). Dismantled construction material will be removed by trucks.

Metal waste generated in the result of dismantling works will be handed over to contractor (scrap receiving facilities).

Removal of Vegetation cover

Area selected for the arrangement of the treatment plant is strongly anthropogenous and modified habitat. It is floristically poor.

The vegetation cover removal works will be implemented with the agreement of local self-governing body, under the supervision of qualified personnel. The cut trees will be stored on the separated area. The trees that can be re-used with the allowance of local self-governing body can be transferred to the local population, and unusable part will be disposed to the landfill.

Removal/Storage of Topsoil

Considering the specificity of the area, it will be possible to remove topsoil only on lateral sections, on about 30% of the total area (≈30000 m^2) that is ≈9000 m^2. Considering the average topsoil depth (15 cm), approximate volume of removed topsoil will be 9000 x 0,15 = 1350 m^3.

Considering existing situation, topsoil removal-storage works will not be carried out on pumping station site, within the corridor of inlet and outlet collectors (actually, the whole area of the pumping station is free from soil cover, and collector will be arranged on the area bordering to the existing road).

Removed topsoil will be temporarily stored on the separated section (on the north periphery of the project area), which will be protected from external impact factors. Height of the stored topsoil stockpile doesn't exceed 1.5 m, while slope angle will be inclined by 33°.

Special structures will be arranged to prevent the soil erosion and occurrence of polluted surface waters on the project territory. These structures will divert the runoff and trap the sediments.

After completion of construction works, the topsoil will be used for recultivation of the territory.

Power Supply

Power supply of the construction camp is assumed from the existing network, using temporary scheme (to the south of the area there is the power transmission line).

Power system of WWTP includes:

- MV system: 6kV, 50Hz
- LV system 400 V, 50Hz, TN-C-S
- Control: 24VDC

Two power stations will be arranged for WWTP operation: one for inlet pumping station, which will be equipped with 160 kVA power transformer; one – for WWTP, equipped with 630 kVA power transformer. Emergency power supply will be provided using UPS. 3 kVA 2 units of UPS is considered in electrical room. 2 pcs. of 3 kVA for the SCADA equipment installed in the Dispatcher room. They will provide a 30 min. autonomy for the supplied equipment. Approximate maximum demand of WWTP on power is 105 kV.

Water Supply and Wastewater

Construction works will need as potable-industrial, so technical water supply.

The potable-industrial water will periodically delivered by tankers. The water storage reservoir will be installed on construction camp site, from where the separate units of the camp will be supplied by means of internal water supply system.

On the construction phase consumption of potable and industrial water depends on number of workers employed for the construction and water consumption per person. Every working day approximately 60 people will work and potable-industrial water consumption per working day comprises 25 liters.

If calculate this for 300 work days per annum and considering single-shift working schedule, potable and industrial water requirement should comprise:**1,5 m³/day** and **450 m³/y.**

In addition, it is possible to arrange showers, two points, on the construction camp. The average water flow for one shower point per day will be 500 l. The necessary water amount will be **1 m³/day and 300 m³/y.**

Total amount of potable-industrial water used will be about **750 m³/a.**

The technical water will be needed for fire-fighting purposes. The approximate amount of the water necessary for fire-fighting water storage and for the training of the personnel will be **1000-1500 m³/a.**

For collection of fecal wastewater pressurized cesspool with the capacity of 20-25 m^3 is considered, which will be treated periodically by sanitation machine, about thrice a month.

The volume of household-fecal wastewater is determined according to the volume of potable- household water consumed, considering 5% loss. Therefore, the approximate volume of household-fecal water during construction works shall be **712.5 m³/a.**

Recultivation Works

After completion of the construction works, recultivation works will be implemented following the requirements of the regulation, approved by the decree No 424 of Georgian Government on "Removal, Storage, Usage and Recultivation of Topsoil", dated by December 31, 2013, namely:

All types of damaged and deteriorated soil, as well as the area adjacent to it, which partially or fully lost productivity under the negative impact of damaged and deteriorated soils are subject to recultivation.

According to the same technical regulation, the recultivation works should be implemented according to the recultivation project. The recultivation project of WWTP will be developed after revealing the contractor constructor. The project will cover technical and biological recultivation stages.

Work Mode and Staff

WWTP construction works will last about 12 months. 35 people will be employed on construction works, 80% out of them will be locals. Private residential houses adjacent to the project area will be rented for the rest 20% of worker. Accordingly, arrangement of construction camp is not envisaged.

Taking into account the specification of the works, the WWTP will be operated during the whole year, with 24-hour work mode. At operation phase about 15-20 people will be employed.

5 Description of Environmental Baseline

5.1 General Overview

Construction Of wastewater treatment plant is planned near Gvishtibi village in Tskaltubo Municipality, on the right bank of Tskaltubostskali River.

Tskaltubo Municipality is located in Imereti region, to the East of the Kolkheti Lowland, within the Basin of Rioni River and Gubistskali River. It is bordered by Kutaisi city from the East, Samtredia and Khoni Municipalities from the West, Tsageri and Ambrolauri Municipalities from the North, and Baghdati and Vani Municipalities from the South (see Figure 5.1.1.).

Tskhaltubo Resort is located in western Georgia, to the East of the Kolkheti Lowland, in the Valley of Tskaltubostskali River; the city is on 7 km from Kutaisi, 70 km from the Black Sea. It is located at 95-120 m a.s.l.

Figure 5.1.1 Administrative division of Imereti region

5.2 Physical-Geographical Environment

5.2.1 Climate and Meteorological Conditions, Ambient Air Quality

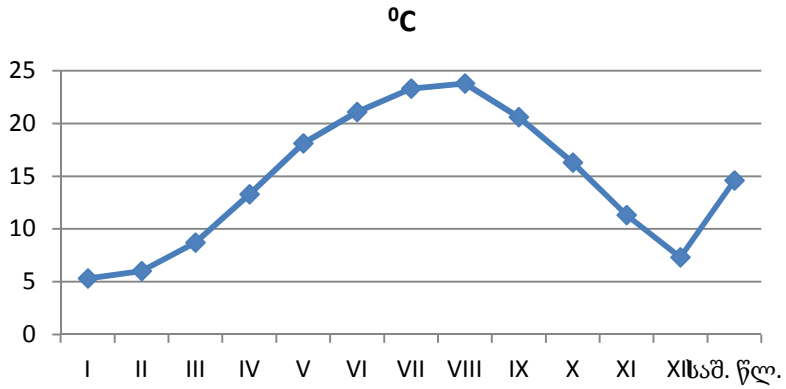
The climate of Imereti region is humid subtropical. Imereti plain is characterized by an extensively humid subtropical climate.

Climate in Tskaltubo is subtropical, which is characterized by short winters and hot summers. Tskhaltubo is one of the warmest regions of Georgia.

Tables and diagrams below provide specific characteristics of the climate within the study area and parameters describing their recurrence, according to the data obtained from Tskaltubo meteorological station (source: Construction Climatology PN 01.05-08).

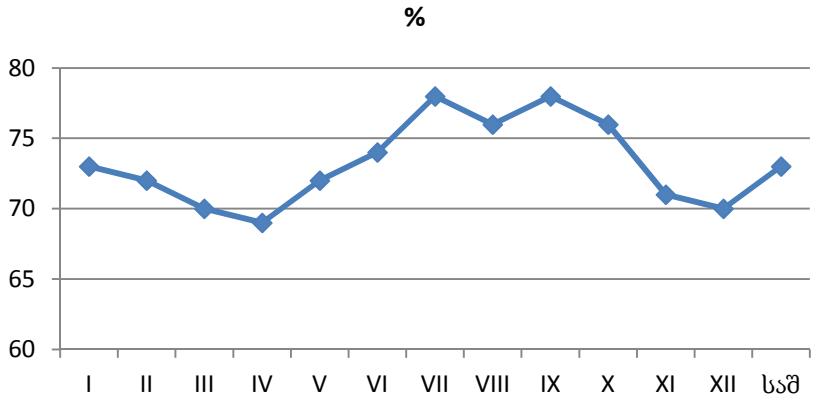
Ambient air temperature

Month Average	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average annual	Abs. min. annual	Abs. max. annual
^{0}C	5,3	6,0	8,7	13,3	18,1	21,1	23,3	23,8	20,6	16,3	11,3	7,3	14,6	-19	42



Relative humidity

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
%	73	72	70	69	72	74	78	76	78	76	71	70	73



Average relative humidity at 13:00		Average daily amplitude of relative humidity	
The coldest month	The hottest month	The coldest month	The hottest month
61	62	18	30

Precipitation

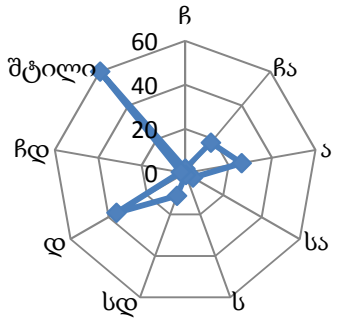
Annual precipitation, mm	Daily maximum of precipitation, mm
1818	131

Wind characteristics

Highest wind speed, possible once in 1,5,10,15,20 years. m/s				
1	5	10	15	20
18	23	25	26	27

Average highest and lowest wind speed, m/s	
January	July
3,9/0,5	2,5/0,4

Annual repeatability of wind direction and calm (%)								
North	Northeast	East	Southeast	South	Southwest	West	Northwest	Calm
2	18	26	4	1	11	36	2	60



Baseline Condition of the Ambient Air Quality:

Comprehensive observation on ambient air quality in Tskaltubo municipality is not available, accordingly it was not possible to obtain data on background concentrations of pollutants from existing stations. Therefore, approach, determined by Technical Regulation – "Methods of calculation of maximum permissible emission of hazardous substances into ambient air" (approved by the order №408 of the Government of Georgia), has been assumed as background concentrations of pollutants, in particular: in case of absence of data, assumed values will be taken from the table below.

Orientation values of background concentrations (mg / m^3)

Population (thousand people)	Dust	Carbon Dioxide	Nitrogen Dioxide	Carbon Monoxide
250-125	0,2	0,05	0,03	1,5
125-50	0,15	0,05	0,015	0,8

50-10	0,1	0,02	0,008	0,4
<10	0	0	0	0

Ambient air background data are obtained from data, available for settlements with less than 10 thousand people (according to 2014 Census, 1249 peoples live in Gvishtibi village). Accordingly, it can be assumed that background pollution of ambient air with various pollutants is not observed in the surroundings of the project WWTP.

5.2.2 Geological Environment

Geomorphology

From geomorphological point of view, there are 3 main types of terrain within the lower reaches of Rioni River basin:

- Anthropogenic-accumulative terrain;
- Anthropogenic-erosion terrain of northern Kolkheti;
- Foothill terrain of southern Imereti.

From geomorphological point of view, Tskaltubo Municipality is located in low mountain region of West part of big Caucasus South slope fold system. It covers extreme South periphery part of Okriba-Lechkhumi anticlinorium. Relief is hilly-terraced.

The area selected for the construction of treatment plant is located on the right terrace of Tskaltubostskali River. It is located at 86-90 m a.s.l. (4-5 m above the riverbed). Surface of the area has technogenic nature – due to a dumped soil and infrastructure, terrain surface is wavy-stepped. Overall the surface is flat, slightly tilted to the south.

Geological Structure

According to geotechnical zoning of Georgia, the study area (downstream of Rioni River basin) is included within the western molasse subsiding zone (Rioni intermountain cavity). Mainly Neogene-Quaternary molasse sediments are formed on the surface, which are developed on weakly deployed Palaeogene and Cretaceous rocks.

Geologically, the study area is formed by Cretaceous rocky and semi-rocky sediments. It is lithologically represented by reddish, brown and yellow, grayish-greenish tuffs, tuff sandstones, tuffbreccias and albitofines. They are covered with plastic clays. The study area has been investigated by boreholes and trial pits. Engineering-geological survey results are given in the following paragraph.

Results of Engineering-Geological Survey Conducted within the WWTP and New Pumping Station Project Area

Engineering-Geological Survey has been conducted in two stages.

- Initial surveys have been conducted by GeoTechservice Ltd under the agreement signed with ILF CONSULTING ENGINEERS on November, 2014.
- Additional surveys have been conducted by BEVRIS DA ARA KOVLIS LTD under the agreement signed with SADE GE LTD. Works necessary for examination of foundation conditions for project structures were carried out within the period of March 1, 2017 and March 30, 2017.

Description of engineering-geological conditions of the study area is given in the present paragraph according to the recent survey results.

As a result of processing the data obtained in the course of the field survey, visual examination and laboratory testing, 4 soil layers and 2 engineering geological element (EGE) have been identified in the geological section of the area, within the surveyed depth (8.0-9.5 m):

- Layer 1: topsoil penetrated with plant roots; this layer was found in all of the boreholes drilled both on the site intended for the pumping station and the one of the sewage disposal system, except Borehole 1. The thickness of the layer makes 0.1-0.5 m;
- Layer 1ı: Filled ground/made land representing construction debris (concrete and brick fragments) stuffed with yellowish-grayish clay serving as a filling agent. The thickness of the layer discovered in Borehole 1 makes 0.30 m;
- Layer 2 - EGE I (QIV): clay of tight-plastic consistency and yellowish colour; the layer was discovered in all the boreholes. Thickness of the layer will vary within 1.20 and 4.50 m;
- Layer 3 - EGE I (QIV): sandy loam, yellow, with pebblestone inclusions, water-bearing; the layer was present in all the boreholes drilled throughout the area. Surveyed thickness of the layer that serves as an interlayer for watertight clays (of gumbrine type) will vary within 0.30 and 0.90 m;
- Layer 4 - EGE II (P3): wackle sandstone, strongly weathered, representing sedimentary bedrock, grey-rusty with black spots. Thickness of the layer will vary within 1.80 and 3.590 m; the layer is not water-bearing.

Laboratory study of the soil samples was undertaken by the Geotechnical Laboratory of the Engineering Survey Department of the Akhali Sakkalakmshenproekti Ltd, based at 10a Gotua Lane,Tbilisi.

In the course of the field survey (March 1-10, 2017), within the surveyed depth (8-9.5 m), groundwater occurences were revealed on different sites, at different depths - from 1.5 m up to 4.5 m. The statistical groundwater level was recorded within a depth of 0.5 m up to 1.4 m below ground sirface.

Lithological columns of boreholes, drilled within the project area, as well as engineering-geological logs and laboratory examination summarizing table is given in Annex 8.

Conclusions and Recommendations Developed on the Basis of Engineering-Geological Survey

The conclusions concerning the geotechnical status of the area allotted for construction of pumping station and sewage disposal system in the city of Tskaltubo, to be drawn proceeding from the findings of the field investigation and results of visual and laboratory examination (physical properties) of the soil sampled from the boreholes as well as from the study of the literary sources compiling the previous scientific effort, are as follows:

1. Reasoning from the findings of the above engineering geological survey and in view of the fact that no perilous geological processes (such as land slides, karst, supposia, land falls etc.), are to be either observed within the area under discussion or expected during operation of the plant, the geotechnical condition of the the area allotted for construction of pumping station and sewage disposal system in the city of Tskaltubo shall be believed satisfactory.

2. As specified by Compulsory Addendum 10 to SNiP 1.02.07-87, from the point of view of its geotechnical conditions, the area under investigation shall be classified as Category II one (of average complicity).

3. As a result of processing the data obtained in the course of the field survey, visual examination and laboratory testing, 4 soil layers and 2 engineering geological element (EGE) have been identified in the geological section of the area: These are:

- Layer 1: topsoil penetrated with plant roots; this layer was found in all of the boreholes drilled both on the site intended for the pumping station and the one of the sewage disposal system, except Borehole 1. The thickness of the layer makes 0.1-0.5 m;
- Layer 1I: Filled ground/made land representing construction debris (concrete and brick fragments) stuffed with yellowish-grayish clay serving as a filling agent. The thickness of the layer discovered in Borehole 1 makes 0.30 m;
- Layer 2 - EGE I (QIV): clay of tight-plastic consistency and yellowish colour; the layer was discovered in all the boreholes. Thickness of the layer will vary within 1.20 and 4.50 m
- Layer 3 - EGE I (QIV): sandy loam, yellow, with pebblestone inclusions, water-bearing; the layer was present in all the boreholes drilled throughout the area. Surveyed thickness of the layer that serves as an interlayer for watertight clays (of gumbrine type) will vary within 0.30 and 0.90 m.
- Layer 4 - EGE II (P3): wackled sandstone, strongly weathered, representing sedimentary bedrock, grey-rusty with black spots/frecles. Thickness of the layer will vary within 1.80 and 3.590 m; the layer is not water-bearing.

4. Proceeding from the geological structure of the area allotted for construction, the material to be used as foundation soil for one or two-storey buildings or structures intended for accommodation of sewage disposal system and pumping station should be Layer 2 – clay of tight-plastic consistency and yellowish colour, with gypsum content; according to Table 3a in Article 4 of Addendum 2 to the Georgian Design Norms PN 02.01-08, if the voids ratio is e=0.85 while the liquidity index makes $0 \leq 1_I < 0.25$, then the modulus of deformation will be E=18 MPa (180 kgf/cm^2).

5. As per the same normative document (Table 3g in Article 4 of Addendum 3), if the voids ratio is e=0.8 while the liquidity index makes IL=0.01,then the conditional design resistance will be R0 = 3.0 kgf/cm^2 or 300 kPa.

6. For foundation design, the table below gives the design values of the physical and mechanical characteristics of the Layer 2 (clay of tightplastic consistency, yellowish, with gypsum content) obtained as a result of the laboratory examination of the material and derived from relevant normative documents, archival files and reference bibliographic sources (the "Designer's Computation-Theoretical Reference Book").

Item No	Soil Characteristics	Design Values
1	Density, ρ g/cm^3	1,84
2	Specific cohesion C kPa	63
3	Angle of internal friction φ°	21
4	Conditional design resistance Ro kgf/cm^2	3,0
5	Deformation modulus E kgf/cm^2	18
6	Poisson's ratio μ	0,42
7	Coefficient of subgrade reaction k kg/sm^3	2,0
8	Coefficient of friction b/w concrete and soil *f*	0,2

7. As supposed by the design requirements specified above, foundation type to be selected for the structure to house the sewage disposal plant may be either in-situ reinforced concrete intermittent

footing/pad foundation tied by foundation beams or combined strip-intermittent foundation to be cast in situ.

8. It is advisable to install the foundation at a depth of at least 0.5 m below the present-day ground level/grade. To have the foundation depth reduced, we would advise to replace the existing clay soil (Layer 2) with a cushion made of detrital material (crushed stones or pebblestones) and rammed layer by layer. Depth of the foundation shall be determined very accurately so that resting the latter upon heterogeneous material could be avoided. Therefore, depth of the foundation and engineering parameters (thickness, area) of the artificial bed, or crushed stone-pebblestone cusion should be specified based on structural design solutions and corresponding design calculations.

9. As to hydrogeological conditions of the site we should state that ground water was found within a depth interval of 0.5-5.5 m in all the boreholes (in March , 2017). Th ground water stabilization level is 0.5-1.5 m.

10. Due to sulfate aggressiveness of the clay soil (Layer 2) participating in the geology of the area, underground structures shall be made of the concrete prepared with sulfate-resistant cement

11. Maximum inclination of the slopes of walls of the foundation pit or trenches should be determined in accordance with the provisions specified in Para 3.11, 3.12 and 3.15 of SNiP 3.02.01–87 and in Chapter 9 of SNiP III-4-80.

12. As per Design Norms “Antiseismic Construction” (PN 01.01-09), the earthquake proneness of settlement No 1033 (Gvishtiba village) under the Tskaltubo Municipality is 8 points by MSK64 scale with inestimable seismic and peak horizontal acceleration coefficient A=0.15 (P.63 of the above normative document in force from January 1, 2010).

13. As to the seismic characteristics of the material, we should state that according to Table 1 Design Norms PN 01.01-09 “Antisesmic Construction”, the soils participating in the geological structure of the site, by their seismic characteristics should be classified as Class II ones. The design seismicity of the site shall be considered as 8 points.

14. By their complexity for excavation (Refer to Table 1 of SNiP IV-5-82), the soils prevailing within the site shall be attributed to:

a) Topsoil layer penetrated with plant roots (Layer 1), No 9b - to Category II;
b) Filled ground/made land, heterogeneous, containing construction debris (brisk and concrete fragments) (Layer 1), No.24b – Category II
c) Clay soil of tight plastic consistency (Layer 2), No Bd - to Category II;
d) Wacked sandstone - strongly weathered grey-rusty sedimentary rock with its mean in-situ density making 2200 kg/m^3.

15. Excavation and the substructure construction cycle shall be performed under supervision of the geological engineer.

Hydrogeology

According to the hydrogeological zoning of Georgia, the study area is included into Tskaltubo porous, fractured, fractured-karstic and karstic artesian basin. Artesian Basin includes most of Imereti lowland and Sagurali ridge. Following major artesian horizons are observed in this basin, as in the neighboring regions: Lower Cretaceous limestone, Upper Cretaceous-Paleogene and Quaternary sandy-gravel.

Lower Cretaceous limestone consists of fissured and fissured-karst pressurized groundwater, including - low- radioactive thermal waters of Tskaltubo.

Upper Cretaceous-Palaeogene limestone aquifer has a limited distribution and minor capacity.

Quaternary sand-pebble horizon is saturated with porous groundwater.

Jurassic sediments revealed by unit boreholes (Bajocian porphyritic series and Bathonian sandstones) contain highly mineralized waters with sodium chloride or calcium chloride.

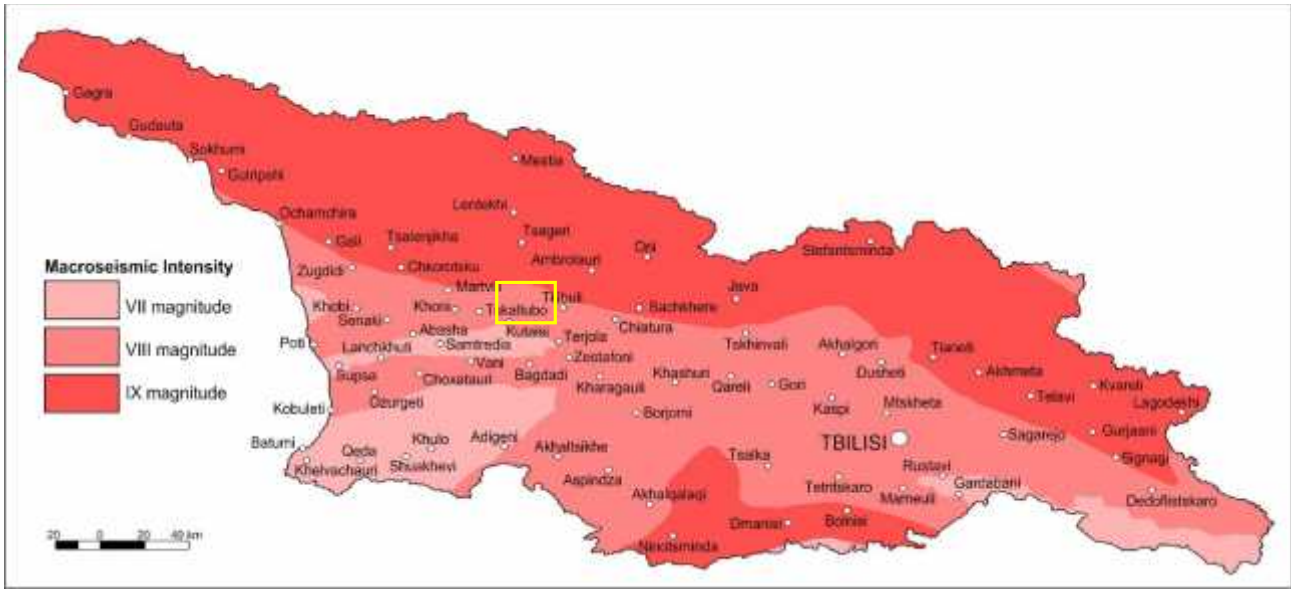
The underground natural resources of the region are 15 m^3/s.

According to the engineering-geological studies, conducted within the study area, the groundwater level is 1.5-3.8 m.

Seismic Conditions

According to the corrected scheme of seismic zoning of Georgia, the investigation territory Tskaltubo and its surrounding areas are located in 8 scale seismic region (Order №1-1/2284 of the Minister of Economic Development, October 7, 2009 Tbilisi, on the approval of the construction norms and rules "Seismic Resistance Construction" (pn 01.01-09) (see Figure 5.2.2.1.).

Figure 5.2.2.1 Seismic hazard map of Georgia



Unidimensional coefficient of seismicity for the nearest settlement (village Gvishtibi) is 0.14.

Engineering-Geological Hazards, Risks of Flooding

Geomorphologically, the study area has almost horizontal surface. It is slightly wavy due to old dumped soils. Based on the results of engineering-geological studies, the study area is suitable for implementation of the project and further complications are not expected.

According to the calculations given in the following paragraph, Tskaltubostskali River water level may be increased by 3.49 m during the maximum flows. As it is mentioned in Paragraph 4.1., altitude difference between the project area and the active riverbed is 4-5 meters. Based on this, the risk of flooding the area is minimal. Besides, it should be considered that the project includes raising heights of the proposed structures by 25 m and more.

Considering the above mentioned no significant measures (protective structures, etc.) will be required to implement in order to prevent activation of hazardous-geodynamic processes and to protect area from flooding.

5.2.3 Hydrology

The main river of Tskaltubo Municipality is Rioni with its tributaries – Tskaltubo and Gubistskali. Their annual runoff is 1690 million/m^3. Tavshava Lake is within the municipality, while artificially created "Tsivi Tba" ("Cold Lake") is within the city.

Due to the proximity to the project area, a brief hydrological description of Tskaltubostskali River is given in Table 5.2.3.1. Hydrology of Tskaltubostskali River has never been studied. Therefore, hydrological characteristics of Tskaltubostskali River have been determined through interpolation of hydrological characteristics of Gubistskali River.

Table 5.2.3.1 Hydrological characteristics of Tskaltubostskali River near the project area

Catchment area, km^2	94
Average height of basin, m	230
Average annual flow, m^3/s:	
Average multiannual	3.25
75% dependable flow	2.84
97% dependable flow	2.25
Minimum flow, m^3/s:	
Average multiannual	-
75% dependable flow	0.40
97% dependable flow	0.27

Calculated values of maximum water flows for the project area are determined through the method, which is presented in "Technical reference for calculating maximum discharge rate of a river in Caucasian conditions".

According to this method, maximum flow for rivers and groves, the catchment area of which is not more than 400 km^2, is calculated by the following:

$$Q = R\left[\frac{F^{2/3} * K^{1.35} * \tau^{0.38} i^{0.125}}{(L*10)^{0.44}}\right] * \Pi * \lambda * \delta \quad \text{m}^3/\text{s}$$

Where,

- R- regional parameter;
- F – catchment area in the project section, km^2;
- K – climatic factor, the value of which is taken from special map;
- τ – repeatability in years;
- i – balanced slope of river stream or grove in units from river source to reporting section;
- L – length of the river or grove from source to the reporting section;
- Π – coefficient of soil surface characteristic in river or gorge basin; its value is taken from special map and Table;
- λ – forest cover factor, the value of which is calculated by the following equation:

$$\lambda = \frac{1}{1+0.2*\frac{F_1}{F}}$$ Here,

F_1 – area of basin covered by forest in %;

- δ - Basin shape factor, the value of which is calculated by the following equation:

$$\delta = 0{,}25 * \frac{B_{max}}{B_{sas}} + 0{,}75$$

Where,

B_{max} - maximum width of the basin in km;

B_{sas} – average width of the basin in km, the value of which is calculated by the following equation: $B_{sas} = \frac{F}{L}$;

by inserting given values in the formula presented above, reconciliation maximum discharge rates for design area of Tskhaltubo River is calculated. Results are presented below, in Table 5.2.3.2.

Table 5.2.3.2 Maximum flows of Tskaltubostskali River within the project area in m^3/s

F km^2	L km.	i slope	K	Π	λ	δ	Maximum flows τ=100 years
13,0	5,5	0,0089	7	1,19	0,91	1,23	132.11

In order to calculate Tskhaltubo-tskhali levels corresponding to maximum flows rates, crosscut segment of the river-bed was extracted from 1:1000 scale topographic plan of the design area. Average flow speed in the segment is determined by the following formula:

$$V = \frac{h^{2/3} i^{0.5}}{n}$$

Where,

- h – average depth of the flow in meters;
- i - hydraulic gradient of the flow between the cross section;
- n - roughness factor;

Tskaltubostskali River – levels relevant to maximum flows within the design section are given in Table 5.2.3.3.

Table 5.2.3.3 Tskaltubostskali riv. calculation provision river-level values corresponding to maximum discharge rates

Design section	provision P%	H m
	Q 132,11 m^3/s	87,90

According to the given data, river level rises by 3.49 m from the existing level during the maximum water flows.

Water Quality of Tskaltubostskali River:

During the ecological audit water samples were taken for the assessment of Tskaltubostskali river water baseline quality. Water samples were taken near the discharge point of the design WWTP. Lab surveys were conducted in the accredited laboratory of the scientific-research firm - "Gamma". Results of the analysis are given in the table 5.2.3.3.

Table 5.2.3.3. Lab survey results of Tskaltubostskali River water quality

№	Defined component	Unit	Received values	MPCs based on ND
1.	BOD	mg/l	2,3	6,0 mg/02dm3
2.	BOD	mg/l	<15	30
3.	Common N	mg/l	3,1	12,2[2]
4.	Common P	mg/l	0,2	1,2[3]
5.	Suspended particles	mg/l	68	-

5.2.4 Soils

Brown humus, red, yellow, yellow-podzolic and alluvial meadow soils are mostly spread throughout the Imereti region. As for Tskaltubo municipality, mostly red, organic and humus soils are represented.

Due to a high anthropogenic loading of the area selected for the arrangement of wastewater treatment plant, the soil cover here is of low value. Average thickness of soil cover in some places is 0.15 m.

5.3 Description of Biological Environment

5.3.1 Vegetation Cover

General Description of Vegetation Cover in the Region

The natural vegetation cover of Imereti plain is hardly preserved, - the former oak-hornbeam forests are almost completely destroyed by anthropogenic influence, and cultural vegetation takes their place.

The dominated type of vegetation in the western part of Imereti plain is the broadleaf flora, which in the lower zone is presented by Oak, Hornbeam, Chestnut, and in the upper zone – by Beech. The sub-forest is well-developed, (including ever-greens) and lianas. In the major part of settled area the mentioned vegetation cover is devastated and modified by shrubs, meadows and crops and plantations.

Results of Botanical Research Conducted Within the Study Area

Project area study group carried out qualitative and quantitative recording of plants, which will be cut within the WWTP project area in June, 2017.

The project area is plain on the right bank of Tskaltubostskali river (distance from riverbed is 50 m). The plot is fenced. It is highly anthropogenic and modified.

Major part of the project area is free from trees. Some sections of the land plot is swamped, where aquatic plants grow. Majority of plants represented within the area is artificially grown, where most of them are semi-dried or dried specimens.

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[2], [2] According to the active normative documents in Georgia, maximum permissible concentrations of common nitrogen and common phosphorus in surface water are not determined. MPC values are determined according to the method, given in par. 6.6.

There are naturally grown trees with low productivity, sparsely scattered across Tskaltubostskali river banks, which become more sparsely in the downstream. The yard is fenced by the rows of cypress (*Cupresus* sp.) and privet (*Ligustrum vulgare)*. The significant part of the land is covered by lianas: blackberry (*Rubus),* dog-rose (*Rosa canina)*, Goat-leaf Honeysuckle *(Lonicera caprifolium*). The rest of the territory represents meadows with weed population, of low pastoral value, where scarce and low-productive grass grows.

The marsh plant- rush (*Juncus*) was identified in some parts of the area. Plants mainly form evergreen coniferous and deciduous trees and shrubs. The pine (*Pinus* sp.), Himalayan cedar (*Cedrus deodora)* and other types of cypress (*Cupressus* sp.) are presented here from coniferous plants; As for evergreen deciduous trees and shrubs: cherry laurel (*Laurocerasus officinalis)*, laurel (*Laurus nobilis)* and privet (*Ligustrum vulgare)*; Decorative flowering plant - Chinese wisteria *(Wistaria chinensis);* Cypress and privet shrubs form the rows on the area and their number prevails other trees and shrubs here.

Only one units of Red List Species middle aged Imeretian Oak *Quercus imeretina* (VU) (GPS coordinates: X –0300288; Y –4686250) and 2 bushes of Sweet bay *Laurus nobilis* (VU) was identified here.

In general, forest massif within the project area is low conservative value habitat.

According to Tskaltubo WWTP project, the area of the territory, which is subject to vegetation clearance is 25 000 m^2. The perimeter of this area is marked on figure 5.3.1.1.

The species of trees and shrubs presented on WWTP area and their quantitative indicators are given in the table 5.3.1.1.

Figure 5.3.1.1. Borders of the Area for Vegetation Clearance

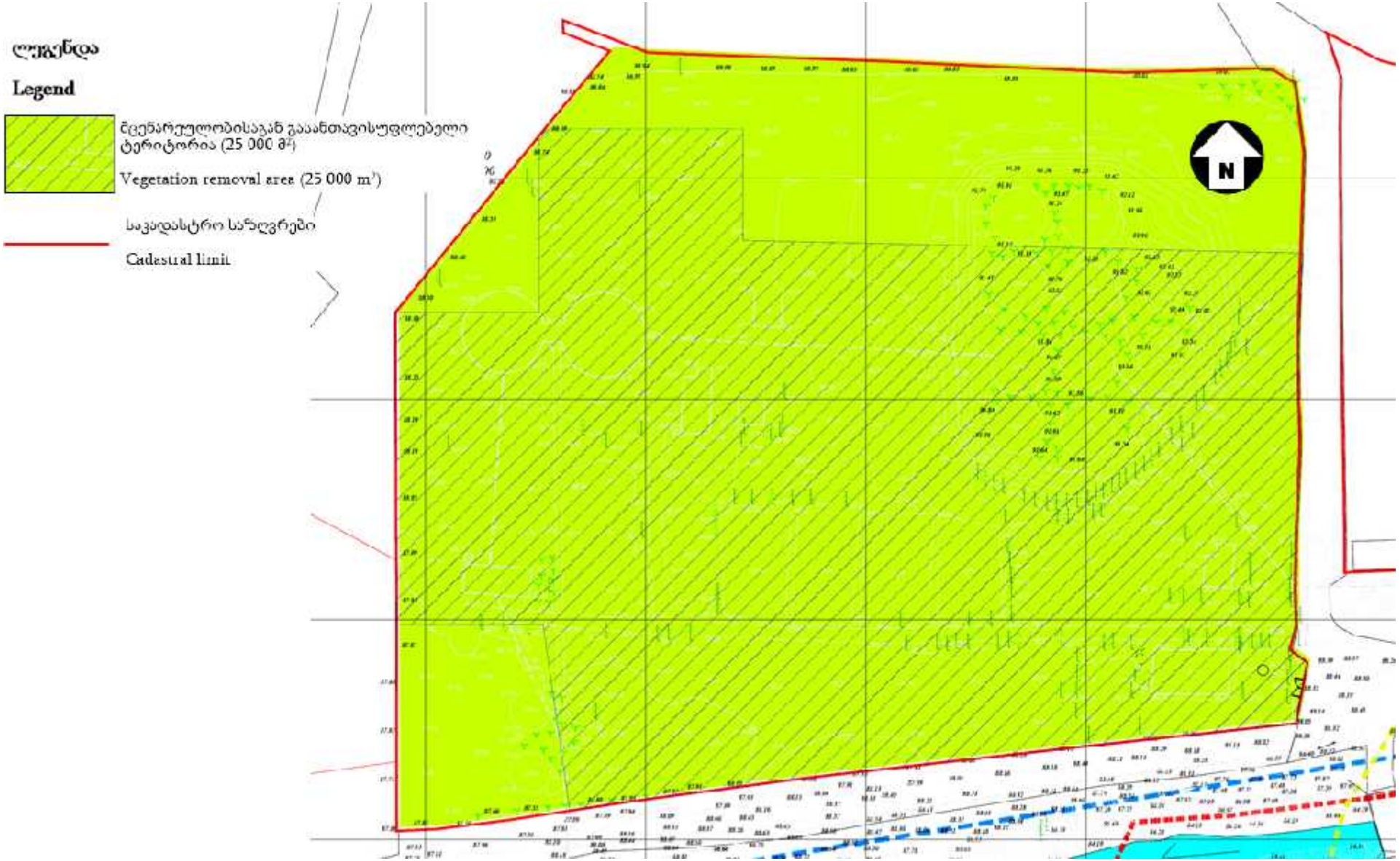

Table 5.3.1.1. Qualitative and Quantitative indicators of trees and shrubs within the project area

English name	Latin name	Quantity	English name	Latin name	Quantity
Deodar cedar (middle-age)	*Cedrus deodora*	12	Cherry Laurel	*Laurocerasus officinalis*	3
Pine (middle-age)	*Pinus* sp.	9	Fan palm	*Trachycarus excelsa*	2
Cypress (various)	*Cupressus* sp.	40	Mulberries (young)	*Morus alba*	2
Willow (various)	*Salix babilonica*	8	Cherry plum	*Prunus divaricata*	1
Imeretian Oak (middle-age) **VU** (Vulnerable)	*Quercus imeretina*	1	Quince	*Cydonia oblonga*	1
Ash	*Fraxinus*	1	Quince	*Cydonia oblonga*	1
Pear (middle-age)	*Pyrus*	2	Privet	*Ligustrum vulgare*.	20
Common fig	*Ficus carica*	4	Pomegranate	*Punica granatum*	4
Sweet bay **VU** (Vulnerable)	*Laurus nobilis*	2			

The total number of species of trees and shrubs presented on WWTP area is 122.

The photo material describing vegetation presented in the study area corridor is given below

Marsh meadow, with dilapidated buildings

Swamped area with dry Cyprus

Imeretian Oak

Dry Cedars

Hawthorn, goat-leaf honeysuckle and privet

5.3.2 Wildlife

The selected WWTP area was the former active WWTP, surrounded by the settlements and the major part of the area is developed by the man; therefore, only small number of wild animals is remained on the study area and the approaches of nearest villages.

Prey animals may often visit the environs of study area, such as golden jackal *(Canis aureus)*, least weasel *(Mustela nivalis)*. From marten family - beech marten (*Martes foina*) and European badger (*Meles meles)*. More or less the favorable conditions are for following rodents: social vole (*Microtus socialis),*

Common vole (*Microtus arvalis)*, broad-toothed field mouse (*Apodemus mystacinus)* and European hare (*Lerus europaeus)*.

As for birds, the following species are common: Hooded crow (*Corvus cornix) ,* Eurasian tree sparrow (*Passer montanus)*, common chaffinch (*Fringilla coelebs)*, red-back shrike (*Lanius collurio)*, white wagtail (*Motacilla alba)*, common blackbird (*Turdus merula)*, mistle thrush (*Turbus viscivorus),* European green woodpecker (*Picus viridis)* , common quail (*Coturnix coturnix)*, European bee-eater *(Meprops ariaster),* common cuckoo (*Cuculus canorus)*, Northern Goshawk *(Accipiter gentilis),* and others. Deforestation change habitat for many birds that leads to the reduction of their number on the area. During spring-summer season many other birds visit the area of interest, the variety of which is more than dozens.

From reptiles the following species are distributed: Sand lizard (*Lacerta agalis)*, sheltopusik (*Poseudopus apodus)*, grass snake (*Natrix natrix)*, and Greek tortoise (*Testudo pontica); While studying the area, dice snake (Natrix tesselata) was identified.*

The main part of the area is swamped and marsh plant – rush is distributed, which creates favorable environment for development of hydrophilous animals. From amphibian fauna European green toad *(Bufo vitatus)*, water frog (*Rana rididunda)*, European tree frog (*Hylidae arborea)* are distributed on the area.

Study area is bounded by the river Tskaltubostskali, according to local population, various types of fish are common in the river, which flows in from the river Gubistskali, such as: European chub (*Leuciscus cephalus)*, Danube bleak *(Chalcalburnus chalcoides)*, common barbell (*Barbus barbus)*, Colkhic nase (*Chondrostoma colchicum)*, and round goby (*Gobius cephalarges)*, zander (*Lucioperca lucioperca).* After talking with local population, it is revealed that the electric device is often used for fishing that significantly reduced the number of fish in the river.

The invertebrate fauna is diverse; especially the number of following species is big: insects (insecta*)*, arachnids (*Araxnida)*, arthropod (Arthropoda*),* Molluscs (*mollusca),* gastropods (*Gastropoda)* and others.

During field surveys, there were no trails of Red List species identified within the area. Due to the proximity to population and low landscape value, presence of favorable habitats for animal species of special significance on the project area is actually excluded. In total, the project area is very poor from wildlife diversity viewpoint. Surroundings also are not habitats of critical significance.

5.3.3 Protected Areas

The nearest recreational area from the wastewater treatment plant location is Tskaltubo mineral water park (located to the north-east, ≈2 km distance from the area). Apart from the significant distance, it is considerable to nota that between the park and the research area, there is a part of densely populated area of the town. Thus, there are practically no risks of the direct impacts on Mineral Water Park during the project implementation.

5.4 Description of the Socio-Economic Environment

5.4.1 Population

Based on the data of the National Statistics Office, the approximate population of Tskaltubo Municipality is 56 200 people and the majority lives in villages.

Table 5.4.1.1 displays the number of population in Imereti region, including the Tskaltubo Municipality (2009-2017).

Table 5.4.1.1 Number of population in Georgia, in a research region and municipality (thousand persons)

	2009	2010	2011	2012	2013	2014	2015*	2016	2017	2009	2010
Georgia	**4385.4**	**4436.4**	**4469.2**	**4497.6**	**4483.8**	**4490.5**	**3,713.7**	**3,720.4**	**3,718.2**	**4385.4**	**4436.4**
Imereti Region	693.5	700.4	704.5	707.5	703.9	703.3	533.6	532.9	529.7	693.5	700.4
Tskaltubo Municipality	73.0	73.6	73.8	74.1	73.6	73.5	56.9	56.6	56.2	73.0	73.6

Note: * 2015-2017 data are based on General Census of Population for November 5, 2014.

Ethnic origins in Tskaltubo municipality:

- Georgians 96.7%
- Greeks 2.3%
- Russians 0.7%
- Armenians 0.2%
- Azerbaijanis 0.1%
- Ukrainians 0.1%

The majority of Tskaltubo population belongs to 7-17 and 46-55 age groups, about 59% are economically active.

From the year 2002 till 2008 the birth rate has decreased to 14.2% (53 born) and the mortality rate decreased as well, by 43.8% (344 dead). For the comparison purposes, at that time the birth rate decreased by 0.5% and mortality by – 7.5% throughout the country. In 2008, the number of emigrants was 816.

According to General Census results 11 281 people love in Tskaltubo city, which is 33% less than 2002 data.

5.4.2 Employment Rate

The economic activity level of Imereti region is listed in a table below. The given data are collected are received from the integrated researches of the households.

Table 5.4.2.1 The economic activity rate in Imereti region (2016)

Total active population (workforce)	376.7
Employed	335.9
Hired	108.9
Self-hired	225.4
Unknown	1.6
Unemployed	40.8
Population except the workforce	155.1
Unemployment rate (in percentage)	**10.8**
Activity rate (in percentage)	**70.8**
Employment rate (in percentage)	**63.2**

5.4.3 Agriculture

Tskaltubo is an agricultural region. The agriculture is one of the leading sectors of the municipality. The following agricultural crops are produced in the municipality: Corn; Grapes; Vegetables.

The agricultural lands occupy 29k ha, the arable areas - 13k ha, perennial plants - 2.6k ha, pasture lands - 13.2k ha. In 2013, within the project supporting the farmers owning small lands in their spring works 8 772 ha land was plowed. In a current year 9 979 ha land is plowed and seeded.

The specialized agricultural fields are: horticulture, corn production, livestock farming, beekeeping, fishery, and viticulture and tea production. The horticulture is distinguished among others.

It is notable that there are agricultural plots adjacent to the treatment plant site, mostly owned by the residents of the village Gvishtibi. There is greenhouse farming in the north of the design pumping station.

5.4.4 Enterprises

There are cold storage facilities functional at Tkachiri, Geguti and Maglaki, where the export green is kept and packed. The greenhouse farming is functional in the villages. About 6 000 greenhouses of various kinds and sizes are accounted throughout the municipality territory. There are 301 large-scale farmers, 289 of them produce the vegetables in closed soil, three of them are occupied with sheep breeding, and four farmers with poultry farming, and five of them produce milk and milk products.

5.4.5 Tourism

Tskaltubo is one of the most important municipalities of Georgia from touristic point of view. Especially, Tskaltubo resort and its balneal specifications should be necessarily mentioned.

Tskaltubo Resort. Tskaltubo is diverse resort and is famous for its warm radon mineral waters. The water is mild, limpid and without odor, and its temperature is 33-35°.

Tskaltubo mineral water cures following diseases: it helps the patients who have the joint disease, the disease of the peripheral nervous system, the cardiovascular system disease, skin disease, metabolism, the disease of endocrine glands, gynecological disorders. People with rheumatism, cerebral paralysis and poliomyelitis also take treatment in Tskaltubo. Karst caves with their microclimate provide natural treatment for the patents who suffer from bronchial asthma, steno cardia, high blood pressure, neurosis and chronic pneumonia. The treatment period is 20-24 days.

In 90-s, the demand was significantly decreased in the resort Tskaltubo, as well as in the other touristic places of Georgia. The number of touristic visits was reduced and the condition of local infrastructure was deteriorated. But due to private investments, made in the improvement of infrastructure and hotel sector, the attraction of the resort has significantly improved. The growth in the number of local and foreign tourist visits is mentioned. Tourists mainly arrive from Israel, Russia, Germany, Spain, Italy and Ukraine.

Apart from the balneal-characteristics, the accommodation of the caves, and implementation of the planned infrastructural projects have become an important factors for tourism popularization. The existing natural and geographic conditions allow the therapeutic and recreational functions, arrangement of the phytol; speleo and paleontological tours are available as well.

The project WWTP site is in significant distance (2 km and more) from main important touristic zones. Areas adjacent to WWTP site do not have any touristic value.

5.4.6 Transport and Communication

The geological location of Imereti region must be considered as a potential of significant resources, which is reflected in a role of being the transit corridor for Europe and Asia. The distance from Kutaisi to the nearest sea port - Poti is 102 kilometers, and 236 km to the capital.

The main means of transport in Imereti are the motor transport, railway and air transportations. According to the experts, the total length of Imereti highways is 2754.8 km, while the railways total

229,285 km. Two airports operate in Kutaisi; the international flights are performed in one of the airports (Kopitnari).

There are 60k telephone customers in Imereti region (30 in Kutaisi alone), that gives 87 customers per 1000 residents (161 customers in Kutaisi). GSM branch offices operate in every large town.

Condition of the motorway leading to the design wastewater treatment plant is satisfactory. The other noteworthy infrastructural facilities include the natural gas pipeline, a water pipeline and 6 kW volt transmission line.

5.4.7 Local Media

There are 12 towns and regional centers in the Imereti region, with 37 functional media organizations. The most media organizations operate in Kutaisi, out of which 13 are printing and 4 electronic. There are four media-organizations both in Samtredia and Chiatura, three in both Zestaponi and Tkibuli. There are two Medias in Vani, Bagdati and Kharagauli and one in Khoni, Terjola, Sachkhere and Tskaltubo. The proportion between printing and electronic media organizations is as follows: Out of 36 organizations in Imereti region, 27 are print medias and 10 – electronic medias. It seems, there is no significant disproportion between the two types of Medias. There is only 1 print media organization in Tskaltubo.

5.5 Waste Management

In Tskaltubo municipality household waste management is provided by municipal cleaning service. Waste is disposed on landfill near Kutaisi (so-called Nikea landfill), which is operated by Solid Waste Management Company of Georgia LLC. Landfill does not meet technical and environmental requirements. According to the available information, it is planned to close the landfill and construct new regional landfill in the east of Kutaisi.
There are many illegal landfills in the municipality, because the majority of the villages do not have the official landfill, and the population disposes waste in so-called ravines.

5.6 Historical and Cultural Heritage Sites

There are four functional museums in Tskaltubo Municipality territory. Those are: Giorgi Akhvlediani Local History Museum – Tskaltubo, Niko Lortkipanidze House-Museum (named after Georgian writer) in village Chuneshi, Giorgi Akhvlediani House-Museum in village Derchi and House-Museum of Soldier in village Opshkviti.

Tskaltubo municipality and its surroundings attract special attention with the historical-archeological monuments. Along with the mentioned monuments there are speleological sites (crystal caves and gaps), which often synthesize with the historical monument and create natural and artificial complexes.

There are no historical-architectural monuments located in the wastewater treatment plant and its surrounding areas. Based on the characteristics of the area, there are small chances for the archeological monuments to appear later on.

6 Environmental Impact Assessment Methodology

6.1 General Principles of EIA Methodology

Approaches used for the environmental impact assessment, as well as the quantitative and qualitative criteria have been developed for unification and standardization of assessment system, which ensures the objectivity of the assessment. Impact assessment methodology has been developed based on the recommendations of the World Bank and other international financial institutions (EBRD, IFC, ADB).

Values, established by regulatory documents of Georgia, EU and the International Financial Corporation / World Bank on quality indicators of environment (air, water, soil, etc.) are used for quantitative criteria; In case of those factors of the impact with no quality indicators (e.g. impacts on ecosystems and population), quantitative criteria are defined on the basis of baseline data analysis, considering the value and sensitivity of the impact.

The following scheme has been used during the assessment of the environmental and social impact caused by planned activities:

Stage I: Determination of the major types of the impact and analysis format

Determination of those impacts that may be significant for these types of projects based on general analysis of the activities.

Stage II: Environmental Baseline study

Identification of those receptors, which are expected to be impacted by the planned activities; determination of sensitivity of the receptors;

Stage III: Characterization and assessment of the impact

Determination of the nature, probability, significance and other characteristics of the impact, taking into account the sensitivity of the receptor; Description of the expected changes in the environment and evaluation of their significance.

Stage IV: Identification of mitigation measures

Determination of mitigation, prevention or compensating measures for significant impact.

Stage V: Assessment of the residual impact

Identification of the magnitude of the expected changes in the environment after the implementation of mitigation measures;

Stage VI: Processing of monitoring and management strategies

Monitoring of the effectiveness of mitigation measures is needed to ensure that the impact does not exceed predetermined values, to verify the effectiveness of mitigation measures, or to identify the necessity of corrective measures.

6.2 Impact Receptors and their Sensitivity

The project may lead to a change in the qualitative and quantitative characteristics of physical and biological resources of the area of influence, such as:

- Ambient air quality and acoustic environment;
- Soil stability and quality;
- Surface and ground water quality;
- Visual changes in landscape;
- The quantity of habitats, flora and fauna;
- and others;

The population, which may be affected by the planned activities include people living in the vicinity of the project area, workers and others (e.g. tourists, passengers). The staff is considered as potentially sensitive receptors.

Sensitivity of a receptor is related to the magnitude of the impact and to the ability of a receptor to resist change or recover after changes, as well as to its relative ecological, social or economic value.

6.3 Characterization of the Impact

The major influence factors have been identified for the environmental impact assessment during the construction and operation phase. Assessment of the expected impact has been implemented in accordance with the following classification:

- Nature - positive or negative, direct or indirect;
- Magnitude - very low, low, medium, high or very high;
- Probability of influence - low, medium or high risk;
- Impact area - district, area or region of activities;
- Duration - Short and long term;
- Reversibility - reversible or irreversible.

Expected changes in the environment and their nature, area of the influence and duration, reversibility and probability of risk realization have been determined for both phases of the project, based on which the significance of the impact has been assessed.

The impact is mainly determined according to the quantity. For those environmental objects, having qualitative standards stated, assessment has been implemented based on these very standards. When quantitative assessment was impossible, the impact has been evaluated qualitatively, taking into account its characteristics and pre-established criteria.

Below are the criteria established for the assessment of the impact on environmental and social receptors; Characterization of the impact; List of relevant mitigation measures; Using established criteria for determining significance and scope of the impact before and after the implementation of mitigation measures.

In the following paragraphs methods and calculations used for determining the impact quality for each natural and social receptors, as well as criteria introduced for impact quality assessment are described.

6.4 Methods and Assessment Criteria Used for Calculation of Emissions in Ambient Air

Methods Used for Emission Calculation

The approach, where the typical construction equipment operation is considered, has been used for the assessment of ambient air contamination quality.

Impact of emissions on ambient air quality expected from such technological processes, such as earth works have been estimated and calculated. Implementation of these operations requires the exploitation of a number of machinery and use of other necessary material resources, including welding electrodes.

Given that, the following sources of pollution have been identified: Excavator and bulldozer. These machinery works using fuel and their exhaust is assessed according to operation capacity, and emissions from diesel reservoir, welding operations are assessed considering to the material expenses based on regulatory and reference documentation.

Usually, degradation of organic matter in the wastewater treatment process is accompanied by a large amount of hydrogen sulfide (H_2S) emissions, which is the source of foul odor spread. Hydrogen sulfide is generated mainly during anaerobic treatment of wastewater.

In accordance with national legislation, the quantitative and qualitative calculation of emission can be carried out in two ways: 1. Through instrumental measurements; 2. Through calculation method. In the present report the calculation is performed according to calculation method.
The report on harmful substance emissions during WWTP construction and operation is presented in Annex 2. Software printout of harmful substance emissions for operation phase is also given in this annex.

Baseline condition of ambient air quality has been considered during emission calculations (se par. 5.2.1.)

Impact Assessment Methodology

For the assessment of impact on ambient air quality normative documents of Georgia have been used, which determine the air quality standards. Standards are defined for the protection of health. As the impact on health depends on the concentration of harmful substances, as well as on the duration of the impact, evaluation criteria considers these two parameters.

Table 6.4.1. Assessment criteria for the impact on ambient air quality

Ranking	Category	Short-term concentration (< 24 h)	Unpleasant odor distribution (long-term, or frequent)	Dust distribution (long-term, or frequent)
1	Very low	C <0.5 MPC	10% of < OU_E/m^3	Unnoticeable increase
2	Low	0.5 MPC < C < 0.75 MPC	10-20% of OUE/m3 standard	Noticeable increase
3	Medium	0.75 MPC < C <1 MPC	20-50% of OUE/m3 standard	Slightly disturbs the population, though has no negative impact on health
4	High	1 MPC < C <1.5 MPC	50-100% of OUE/m3 standard	Quite disturbs the population, especially the sensitive individuals
5	Very high	C > 1.5 MPC	> 100% of OUE/m3 standard	Population is very disturbed, has negative impact on health

Note: C - Estimated concentrations in the environment, considering the baseline

6.5 Assessment Criteria and Methods Used during Calculations of Noise Propagation

Noise Propagation Calculation Methods

Acoustic calculations on industrial and construction sites are implemented according the following sequence:

- Determination of noise sources and their characteristics;
- Selection of reference points on the border of protected areas;

- Determination of noise direction from noise source to the reference point and calculation of acoustic of the environmental elements, affecting the distribution of noise;
- Determination of expected noise levels at reference points and its comparison to allowable levels of noise;
- Determination of noise level reduction measures, if necessary.

Noise propagation calculation for WWTP construction and operation phases is given in Annex 3.

Impact Assessment Methodology

Noise levels in Georgia are regulated by normative document – sanitary norms 2.2.4/2.1.8 003/004-01 "noise in workplace, in housing, public buildings and residential areas". The noise level should not exceed the values set by these standards.

Impact Assessment Methodology

Noise levels in Georgia are regulated by regulatory document – sanitary norms 2.2.4/2.1.8 003/004-01 "Noise at the workplace, residential, public buildings and residential areas". The noise level should not exceed the values set by these standards.

Table 6.5.1 Assessment Criteria Relating to the Noise Impact

Ranking	Category	Residential zone	Working, industrial or commercial zone
1	Very low	Acoustic background will increase by less than 3 dBA, at residential zone, during the daytime up to <50 dBA, while during night hours up to <45 dBA	Acoustic background will increase by less than 3 dBA and up to <70 dBA
2	Low	Acoustic background will increase by 3 – 5 dBA, at residential zone, during the daytime up to <55 dBA, while during night hours up to <45 dBA	Acoustic background will increase by 3 – 5 dBA and up to <70 dBA
3	Medium	Acoustic background with sensitive receptors will increase by 6-10 dBA, at residential zone, during the daytime up to <55 dBA, while during night hours up to <45 dBA	up to <70 dBA, Acoustic background with sensitive receptors will increase by 6-10 dBA
4	High	Acoustic background with sensitive receptors will increase by more than 10 dBA, at residential zone, during the daytime up to >70 dBA, while during night hours up to <45 dBA	up to >70 dBA, Acoustic background with sensitive receptors will increase by more than 10 dBA
5	Very high	Acoustic background with sensitive receptors will increase by more than 10 dBA, at residential zone, during the daytime up to <70 dBA and accompanied by a tonal or impulsive noise, while during night hours up to <45 dBA	up to >70 dBA, accompanied by a tonal or impulsive noise

6.6 Tskaltubostskali River Water Quality Impact Assessment Methodology and Criteria

Method used for assessment of harmful substance concentrations in the surface water bodies during operation phase:

From WWTP wastewater will be discharged in Tskaltubostskali river. For assessment of impact on water quality the methodology is used, which is given in the technical regulation – on "Methods for Calculation of the Standards for Pollutants Discharged with Wastewater into Surface Water Bodies", approved by the decree №414 of the Government of Georgia on December 31, 2013.

Based on the mentioned methodology maximum permissible concentrations for various pollutants has been determined, allowable to be discharge within the project section, considering the baseline concentration of recipient water body, MPCs in water and their assimilation ability. The results have been compared with WWTP efficiency.

Results of calculation of water quality impact, after mixing effluents with Tskaltubostskali river are given in Annex 4.

Surface Water Impact Assessment Methodology

With regard to the impact on the surface waters only the risks related to the deterioration of water quality is discussed in this document. Due to the specifics of the planned activities, impacts, such as changes in water debit, limited movement of river sediment, violation of stability of river-bed and river banks and so on are not discussed.

Table 6.6.1 Assessment criteria of the impact on the surface waters

Ranking	Category	Water quality deterioration
1	Very low	Background concentrations of substances and water turbidity has changed unnoticeably
2	Low	Concentrations of substances or water turbidity have increased by less than 50%, though it does not exceed MPC.
3	Medium	Concentrations of substances or water turbidity have increased by 50-100%, though it does not exceed MPC.
4	High	Concentrations of substances or water turbidity have increased by more than 100%, or have exceeded MPC.
5	Very high	Concentrations of substances or water turbidity have increased by more than 200% and have exceeded MPC.

6.7 Groundwater Impact Assessment Methodology

Table 6.7.1 Assessment Criteria of the Impact on Underground/Ground Water

Ranking	Category	Changes in groundwater debit	Deterioration of groundwater [4] quality
1	Very low	Debit has changed invisibly	The background concentration of substances have changed invisibly
2	Low	Ground-water levels has declined markedly, though, it has not affected water levels in wells or flow of water	Concentration of substances of the II group[5] is below the permissible limits for drinking water
3	Medium	Ground-water levels and water extraction from wells has declined markedly.	Concentration of substances of the II group is more than the permissible limits for drinking water
4	High	Wells are not working temporarily; discharge of water has reduced in surface	Hazardous substances of I group is observed

[4] Groundwater quality is not regulated by the law of Georgia. Therefore, drinking water standard is used for the assessment
[5] EU Directive 80/68/EEC, December 17, 1979, "Protection of groundwater from contamination by certain hazardous substances"

		water bodies, which will cause a seasonal drought.	
5	**Very high**	Wells are drying, water is not discharging in surface water bodies, and there is a great risk of drought and ecological impact.	Concentration of substances of the I group is more than the permissible limits for drinking water

6.8 Soil Impact Assessment Methodology

Negative impacts on soil during the construction and operation of wastewater treatment plant may be related to:

- Impact on soil integrity and stability. Topsoil loss and damage;
- Soil contamination.

Impact values on soil have been assessed by the following parameters:

- Intensity, scope and duration of the impact;
- Their sensitivity to the changes;
- Their ability to recover.

Table 6.8.1 Impact Assessment Criteria

Ranking	Category	Topsoil destruction	Soil contamination
1	Very low	Eternal destruction of less than 3% of the project area	Baseline of soil is changed invisibly
2	Low	Eternal destruction of 3-10% of the project area	Concentrations of pollutants is increased by less than 25%, though it is less than the allowable value; Soil / ground quality restoration could take up to 6 months
3	Medium	Eternal destruction of 10-30% of the project area	Concentrations of pollutants is increased by 25–100%, though it is less than the allowable value; Soil / ground quality restoration could take up to 6-12 months
4	High	Eternal destruction of 30-50% of the project area; small sections are damaged even outside the project area, recultivation of which is possible after completion of construction works	Concentrations of pollutants is increased by 100%, or exceeds the maximum permitable value; Soil / ground quality restoration could take up to 1-2 year
5	Very high	More than 50% of the project area is damaged or destructed; small sections are damaged even outside the project area, recultivation of which is possible after completion of construction works	Concentrations of pollutants is increased by more than 100% or exceeds the maximum permitable value; Soil / ground quality restoration could take up to 2 year

6.9 Assessment Methodology for Engineering-geological Hazards

Number of geodynamic processes are discussed such as landslide, erosion, gullying, as well as flooding of the area, etc. which can be activated in the result of project implementation. Risks are assessed considering receptors and project activities.

Table 6.9.1 Assessment Criteria for the Development of Engineering-geological Hazards

Ranking	Category	Geohazards
1	**Very low**	The project does not consider providing any type of work within the area/zone of

		geohazards; Project activities are not connected to the risks of development of geological hazards.
2	**Low**	During implementation of the project activities within the area/zone of geohazards, preventive measures are considered, that will effectively eliminate geohazards. The project activities provided on geologically safe area will not cause erosion or other changes that can provoke geohazards; Effective geohazards management/ mitigation plan is developed and implemented.
3	**Medium**	During implementation of the project activities within the area/zone of geohazards, preventive measures are considered, that will effectively eliminate geohazards While working on geologically safe area, there is a risk of such process development (e.g. erosion) that can cause geohazard production unless provision of effective management, Effective geohazards management/ mitigation plan is developed and implemented.
4	**High**	Despite providing preventive measures within geohazard area/zone, the significant geological hazard is developed, or due to the previously implementation of the works on geologically safe sites, significant geological processes are developed. There is no geohazards management/ mitigation plan or it is ineffective.
5	**Very high**	Despite providing preventive measures within geohazard area/zone, the significant geological hazard is develop, or due to the previously implementation of the works on geologically safe sites, significant geological processes are developed. There is no geohazards management/ mitigation plan or it is ineffective.

6.10 Visual-landscape Alteration Assessment Methodology

Visual-landscape impact assessment is more or less subjective. Impact area and duration, as well as the relative ecological value of the landscape is taken as an assessment criteria.

Table 6.10.1 Assessment Criteria for the Visual-Landscape Impact

Ranking	Category	Impact on visual receptors	Duration of landscape changes and spatial boundaries / landscape quality and value
1	Very low	Invisible change in the view	Invisible change in the landscape, or landscape is not valuable
2	Low	Some slight change of view is observed from certain points, which is easily adaptable	Insignificant change in the landscape, or landscape restoration takes 1-2 years
3	Medium	The view has changed noticeably from many points of view, though it is easily adaptable	Some sites of the natural landscape have changed, or landscape restoration takes 2-5 years
4	High	The view has changed noticeably from most of the points, though it is easily adaptable	A large area of natural or high-value landscape has changed, or landscape restoration takes 5-10 years
5	Very high	The view has completely changed from every place, hardly adaptable impact on receptors is expected.	A large area of natural or high-value landscape has changed, or landscape restoration is not possible

6.11 Assessment Methodology for Biological Environment Impact

For the assessment of the impact on biological environment qualitative criteria are introduced for the following categories:

- Integrity of the habitat, where the possible loss or fragmentation of habitats, reduction of the potential capacity of ecosystem and the impact on natural corridors are assessed;

- The loss of species. Impact on species behavior, where the assessment is implemented about changes in their behavior that are caused due to the physical changes, including visual impact, noise and atmospheric emissions, as well as about the impact on breeding, nesting, spawning, daily and seasonal migration, activity, and mortality;
- Protected habitats, protected areas, protected landscapes and monuments of nature.

The criteria used to assess the environmental impact significance:

- The probability of the impact, intensity, scope and duration, which is used to determine the magnitude of the impact;
- Sensitivity of the habitat or species to the direct impact, or the impact caused by the change;
- Restoration capabilities of species and habitats;
- Ecological value of impact receptors, including species, populations, communities, habitats, landscapes and ecosystems;
- Impact on protected receptors is assumed as a high impact.

Criteria established for assessment of the impact on ecological systems are given in Table 6.11.1.

Table 6.11.1 Assessment Criteria of the Impact on Biological Environment

Category	Impact on habitat integrity	Loss of species. Impact on species behavior	Impact on protected habitats
Very low	Negligible impact on the integrity of the habitat. After the completion of recultivation works, recovery of the habitat in a short period of time (<1 year)	Changes in behavior are invisible; death of not valuable species of small mammals / fish is expected; there is no risk of spreading invasive species.	No impact is observed throughout the areas protected by country's legislation or international conventions
Low	Noticeable impact on the integrity of low-value habitat, including the loss of less valuable habitat of 10-20 acres of land. After the completion of recultivation works, recovery of the habitat in two years.	Changes in behavior may be revealed by standard methods; death of not valuable species of small mammals / fish is expected; there is no risk of spreading invasive species.	A temporary, short-term, minor impact is expected throughout the areas protected by country's legislation or international conventions, which will not cause a long-term violation of ecological integrity
Medium	Significant impact on the integrity of locally valuable habitat, its reduction, reduction of valuable habitats, or less valuable 20 - 50 ha of terrestrial habitat loss. After the completion of recultivation works, recovery of the habitat in 2-5 years	Changes in behavior of endemic and other valuable species may be revealed by standard methods; death of less valuable animal species is to be expected; appearance of invasive species is expected.	A minor impact is expected throughout the areas protected by country's legislation or international conventions, though ecosystem will be restored within 3 years.
High	Reduction of locally valuable habitats, or less valuable 50-100 ha of terrestrial habitat loss. After the completion of recultivation works, recovery of the habitat in 5-10 years.	Changes in behavior of protected species may be revealed by standard methods. The death and reduction of protected and valuable animal species is expected; Spread of invasive species	Impact is expected throughout the areas protected by country's legislation or international conventions. Mitigation measures are to be implemented in order to restore the ecosystem. It will need 5 years to be restored.
Very high	Reduction of locally valuable habitats, or less valuable more than 100 ha of habitats loss. After the completion of recultivation works, recovery of the habitat in more than 10 years.	Changes in behavior of an internationally protected species may be revealed by standard methods. Protected or valuable species of animals die and there is a probability of disappearing these species. Spread of invasive species	There is an impact on the areas protected by country's legislation or international conventions.

6.12 Assessment Methodology for the Socio-economic Environment Impact

Negative as well as positive aspects of the project implementation have been discussed during the assessment of the impact on socio-economic environment. Impact is assessed according to three categories - **low impact, medium impact and high impact** (see, the table 6.13.1.).

Table 6.13.1 Assessment Criteria for the Impact on Socio-economic Environment

Ranking	Category	Impact on socio – economic environment
Positive		
1	**Low**	– Employment rate in region has increased by less than 0.1%. – Average income of the local population has increased by 10%. – Budget revenues of the region have increased by 1%. – Local infrastructure / power supply has been slightly improved, resulting in improved local population living / subsistence and economic environment.
2	**Medium**	– Employment rate in region has increased by 0.1%-1%. – Average income of the local population has increased by 10-50%. – Budget revenues of the region have increased by 1-5%. – Local infrastructure / power supply has been significantly improved, resulting in significantly improved local population living / subsistence and economic environment, which contributes to the economic development of the region.
3	**High**	– Employment rate in region has increased by 1%. – Average income of the local population has increased by more than 50%. – Budget revenues of the region have increased by more than 5%. – Local infrastructure / power supply has been significantly improved, resulting in significantly improved local population living / subsistence and economic environment, which contributes to the economic development of the region.
Negative		
1	**Low**	– A short time delay in the availability of resources or infrastructure is expected, though it will not affect the income of the local population. In addition, it will not be followed by long-term negative impacts on the economic activity of the local population. – Quality of life of the local population will be lowered for a short period of time, though it will not be followed by long-term negative results. – Health will not be affected. – Impact on safety is negligible. – A long-term, but easily adaptable impact on environment is expected. – Local population will increase by 10% due to migration.
2	**Medium**	– A short time delay in the availability of resources or infrastructure is expected, due to which the local population will have to change their lifestyle for a short period of time. However, it will not have any long-term negative impact on the economic activities of the local population. – Quality of life of the local population will be lowered for a short period of time, though it will not be followed by long-term negative results. – A certain impact on health is expected, but there is no increased mortality risk. – There are some risks related to safety. – Complaints from citizens are expected about some of the impacts. – Local population will increase by 10-30% due to migration.
3	**High**	– A short time delay in the availability of resources or infrastructure is expected, due to which the local population will have to change their lifestyle for a short period of time, which will have a long-term negative impact on their economic activities. – Quality of life of the local population will be significantly lowered. – There is a significant impact on health. There is a high risk of increasing mortality rate. – There are some risks related to safety. – Corrupt deals related to employment or nepotism. – People are constantly complaining about the influence of certain factors. In this regard, conflicts arise between residents and staff. – Local population will increase by 30% due to migration. Cultural environment for the local population is significantly changed. Creation of new settlements is expected.

6.13 Assessment Methodology for the Impact on Cultural Heritage Monuments

Table 6.14.1 Assessment Criteria for the Impact on Cultural Heritage

Ranking	Category	Damage/destruction of Cultural Heritage
1	Very low	The impact risk is insignificant due to the distance from the site or the method used during construction/operation.
2	Low	1-10 % of insignificant site can be damaged/ destroyed.
3	Medium	10-25 % of site, bearing local importance, can be damaged/ destroyed.
4	High	25-50 % of site, bearing local importance or the site having regional value, can be damaged/ destroyed
5	Very high	50-100% of the site bearing local importance can be damaged/ destroyed, the site of regional importance can be seriously damaged, and the site of national or international value can be seriously damaged.

7 Environmental Impact Assessment and Analysis

Information submitted above has been summed up in this paragraph, on the basis of which the sources, types and objects of the impact, caused by the planned activities, have been defined. Changes in quantitative and qualitative characteristics of the environmental condition have been predicted. Environmental impact has been assessed as for the construction (construction phase) so for the operation (operation phase) processes.

7.1 Impact on Ambient Air Quality

Construction Phase

During WWTP construction process ambient air quality deterioration is expected due to the propagation of inorganic dust and burning products. The main sources of pollution are construction equipment, earth works and transport movement. The nearest residential house is assumed to be the impact receptor.

The calculations carried out showed that ambient air pollutants emitted by pollution sources during the construction phase do not exceed maximum permissible concentrations of harmful substances established by Georgia's Normative Document. Considering the distance to the nearest residential house (300 m), concentrations of harmful substances as a result of the construction work will be much less than the maximum permissible values. MACs will not be exceeded in standardized area of 500 meters.

Hence, on construction phase, the negative impact on the ambient air quality, caused by the burning products, can be assessed as "low. In terms of spreading the dust, sometimes (intensive transport movement and earth works) "medium" impact is expected.

On construction phase, the corresponding mitigation measures will be considered that will reduce possible negative impact up to the "very low" rate.

Results of Emission Calculation for the Operation Phase and Analysis

Burning products and dust emission risks into the ambient air will not be high on operation phase. The risks are connected to the odor nuisance caused by technological process on this stage of the project.

Corresponding calculations are carried out in relation with odor nuisance within EIA report (see Annex 2).The main receptor of the impact is assumed the nearest residential house. Considering the requirement of regulatory document of Georgia (№ 408 Decree of the Government of Georgia, dated as December 31, 2013, on approval of the technical regulations for calculating standards of maximum permissible emissions of harmful substances in the ambient air), the 500 m radius is also used as reference point[6].

Calculation results – or maximum concentrations of pollutants in the control points per MPC shares are given in the table 7.1.1, and graphic reflection of harmful substance emission is given on the figures below.

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[6]. According to technical regulation on ,, Calculation of Standards for Maximum Permissible Emissions of Pollutants into Ambient Air", maximum permissible emissions (MPEs) into ambient air is determined for:"the nearest residential zone from the facility, preschools, schools, higher educational institutions, sport complexes, parks, public health recovery institutions, food industry objects, airports, aerodromes and railway stations, but not for the distance, more than 500 m radius from the facility". According to the mentioned requirements, we could carry out the calculation only for the border of 300 m radius. However, according to the practice, introduced in Georgia, MPE standards should be determined for the border of residential zone, as well as for the border of 500 m radius (even in case if the nearest residential zone is within 500 m radius). The mentioned note of the regulatory document does not consider that there should be no population within the 500 m radius.

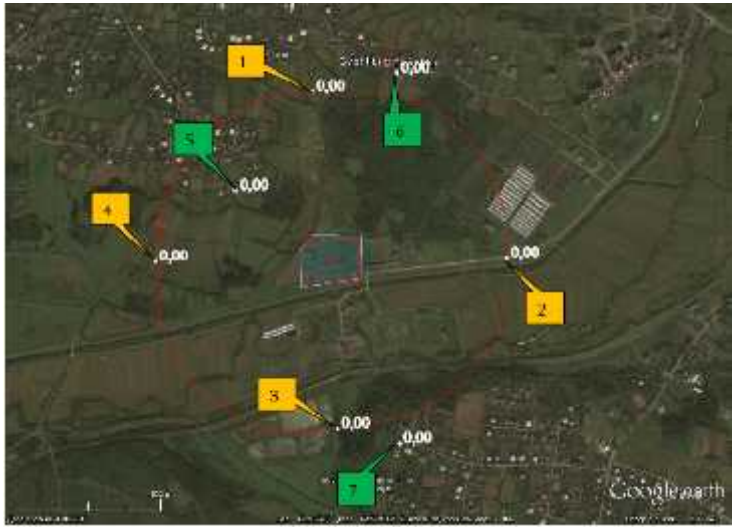
Table 7.1.1 Maximum Concentrations of Contaminants within Control Points

Name of harmful substances	MPC of harmful substances from the object	
	On the border of the nearest residential area	On the border of 500 m radius
1	2	3
Nitrogen dioxide	0,00	0,00
Ammonia	0,01	0,00
Hydrogen sulphide	0,01	0,01
Carbon oxide	0,00	0,00
Methane	0,00	0,00
Methyl mercaptan	0,00	0,00
Ethyl mercaptan	0,00	0,00
Total Impact Group 6003	0,02	0,01

Calculation results shows that during the operation of the treatment plant, air quality of the adjacent areas on the borders of 500 meters radius and residential zone will not exceed the limits prescribed by the law, namely: Concentration of pollutants in the 500 meters radius and near the residential zone is less than 0.1 MPC. Therefore, the operation of the plant in regular mode will not cause the deterioration of air quality. Emissions can be classified as maximum allowable emission. In normal operation condition the impact can be assessed as “medium”.

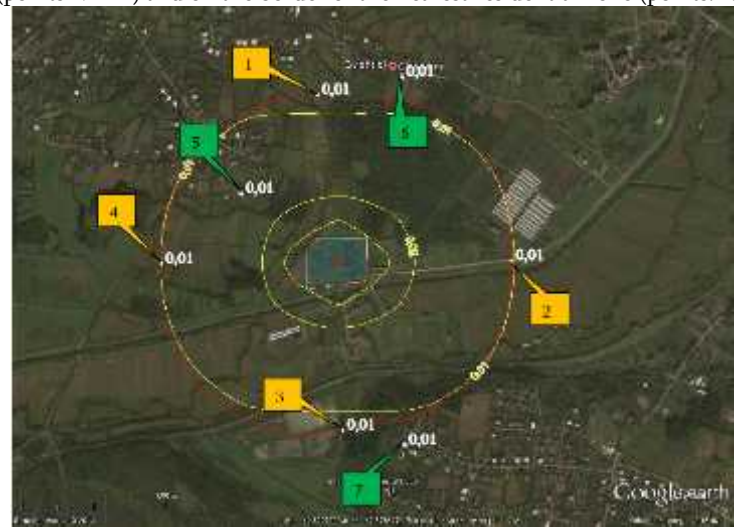
However, in order to prevent odor nuisance to the nearest settlements, appropriate mitigation measures may be taken (which are described in the following paragraph), that will reduce negative impact rate and propagation scope. The necessity of implementation of above-mentioned mitigation measures will be determined according to corresponding monitoring results.

Figure 7.1.1 Graphic Reflection of Harmful Substance Emission

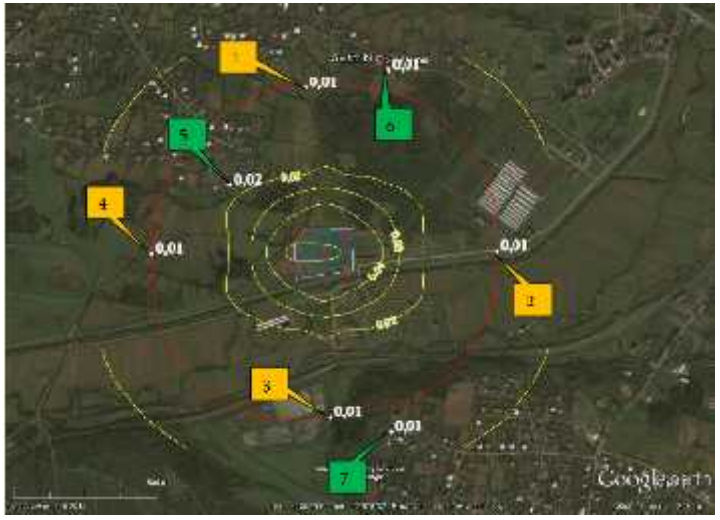


The maximum concentrations of Nitrogen dioxide (code 301), carbon oxide (code 337), methane (code 410), Methyl mercaptan (code 1715), Ethyl mercaptan (code 1728) on the border of 500 meters zone (points № 1-4) and on the border of the nearest residential zone (points. № 5-7).

The maximum concentrations of Ammonia (code 303) on the border of 500 meters zone (points № 1-4) and on the border of the nearest residential zone (points. № 5-7).



The maximum concentrations of Hydrogen sulphide (code 333) on the border of 500 meters zone (points № 1-4) and on the border of the nearest residential zone (points. № 5-7).



Maximum concentrations of total impact of the 6003 group (codes 303 +333) on the border of 500 meters zone (points № 1-4) and on the border of the nearest residential zone (points.№5-7).

7.1.1 Mitigation Measures

Mitigation measures for air pollution have been developed for the construction and operation phases.

- Construction phase:
  - To ensure proper maintenance of the machinery;
  - To extinguish engines or working with a minimum rotation when they are not used;
  - To protect the optimal speed of the traffic (especially on earth roads);
  - Maximum limited use of roads in populated areas;
  - Precautionary measures (e.g. restriction of material dropping from height during the loading and unloading);
  - To cover properly the vehicles while transporting materials from which dust is expected to be easily spread;
  - In the storage areas for such materials from which dust is expected to be easily spread, a special pavemnet or watering is required in order to prevent windblown dust from spreading;
  - To locate generators and other equipments away from sensitive receptors;
  - Ensure personnel with an appropriate protection equipment (Respirators);
  - Instruction of the personnel;
  - Recording of complaints and relevant response to them.

- Operation phase
  - Mitigation measures for air pollution during the repair and maintenance work are identical of measures considered for the construction phase;
  - Planting of trees within the perimeter of the project area should be considered at the construction stage;
  - In order to prevent the spread of unpleasant odor, a systematic control of a proper operation of the plant is required;
  - The spread of unpleasant odors should be monitored. If necessary, appropriate measures should be implemented, which are described below.

Monitoring of the Odor Nuisance and Mitigation Measures

During the operation phase of WWTP, monitoring of the spread of unpleasant odor from anaerobic tanks, sludge beds and other structures can be implemented through two types of equipments, namely:

- For periodic measurements - field olfactometer;
- For constant monitoring - 2 units of measurement device (so-called "electronic noses"), which will be permanently connected to the automatic control system used within the treatment facility – so called SCADA system. One device will be installed near the borders of the treatment plant, while the second – near inlet pumping station.

Field olfactometer is financially advantageous mean for measuring the spread of odor. Through calibrated field olfactometer it is possible to monitor the spread of odors inside and outside the boundaries of the treatment facility (border of the settlement). Nitrogen filtered air is used in the device. The volume of fresh air, as well as of air containing odor emissions is determined through this device. Example of use of the device in field conditions is shown in the picture 7.1.1.1.

So called "electronic noses" is composed of many detectors. The device performs continuous monitoring of the parameters associated with odors. An alarm signal will be activated if the level of odor will exceed the parameters pre-entered in the device. Signal will be transmitted to the operator. Limits will be preliminarily determined in accordance to the distance to the targeted objects (e.g. private houses, villages, etc.). Usage and operation of “electronic noses" is very simple: filter should be changed and the device should be re-calibrated twice a year. Sensors should be changed within the predetermined

intervals, depending on the type of sensor. "Electronic noses" are used in many treatment plants. Picture is given in figure 7.1.1.2.

Picture 7.1.1.1 Field olfactometer

Type of the device - Nasal Range

Type of the device - Scentroid SM100

Picture 7.1.1.2 "Electronic Nose"

Type of the device - Alpha MOS - RQ Box

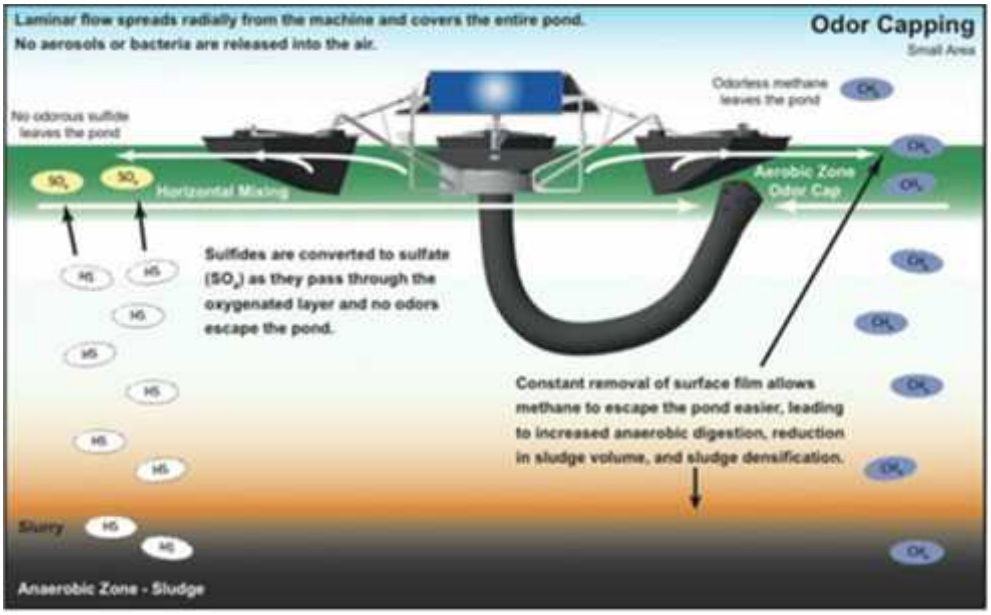
Type of the device - PCA Technologies – Olfo Sense

Although, according to the performed calculations the spread unpleasant odors is less likely expected near residential houses, in practice, it is still possible to have a negative impact, which will be revealed on the basis of the monitoring. Plant performance requirements (functional guarantees) require limits below community-level threshold for 95% of time. After this, appropriate mitigation measures will be considered and implemented in practice.

One of such mitigation measure can be the covering of anaerobic tanks. However, the design organization has proposed a more efficient measure, namely, using of floating aerator devices on each anaerobic tank.

Suppression of odors arising from anaerobic tanks through floating aerator device is reflected on Figure 7.2.3.1.3. Floating aerator device is formatting oxygenated layer (odor control vent valve - so called „odor cap“) in the top section of the pond. The intake hose can be arranged where the depth is not great. One unit will circulate towards the pond edge in all directions. Floating circulators are characterized by minimal costs of electricity and maintenance.

Figure 7.2.3.1.3 Suppression of odors arising from anaerobic tanks through floating aerator device



Through appropriate monitoring and if necessary, through additional mitigation measures, the risks of spreading unpleasant odors towards the settlements will be even more reduced. The staff will be equipped with individual respirators.

7.1.2 Impact Assessment

Description of impacts and impact sources	Impact receptors	Residual Impact Assessment					
		Nature	**Probability of influence**	**Influence area**	**Duration**	**Reversibility**	**Residual impact**
Construction Phase:							
Combustion products, welding aerosols and other harmful substances emitted into ambient air – Combustion products sources - activities requiring construction and special machinery. These include earth works, transportation of building materials, construction/arrangement of infrastructural units, diesel generators, etc. – Welding aerosols source - Installation of metal structures. – Other sources of harmful substances - Gaseous emissions of chemical substances (fuel - lubricants, fuel tanks, etc.).	Residents of nearby settlements, staff, biological environment	Direct, Negative	Medium risk	Construction site and adjacent areas	Medium term (Depends on the duration of construction works	Reversible	**Low,** Taking into account the mitigation measures - **very low**
Dust emissions – Source – earth works, transportation, storage and usage of bulk construction materials, movement of equipment and vehicles, and others.		Direct, Negative	High risk	Construction site and adjacent areas	Medium term	Reversible	**Medium or low,** Taking into account the mitigation measures - **very low.**
Foul odor emission – Source - painting works.		Direct, Negative	Medium risk	Construction site and adjacent areas	Short term	Reversible	**Very low**
Operation phase:							
Combustion products, welding aerosols and other harmful substances emitted into ambient air during the maintenance works.	Population, technical staff, biological environment	Direct, Negative	Low risk	Construction site and adjacent areas	Short term	Reversible	**Very low**
Foul odor emission - Degradation process of organic matter in treatment plant.		Direct, Negative	Medium risk	Construction site and adjacent areas	Permanent	Irreversible	**Medium or low,** Taking into account the mitigation measures - **very low.**

7.2 Impact of Noise Propagation

Construction Phase

The main sources of noise is assumed to be the machinery and transport equipment working in the center of allocated area. The impact receptor is the nearest residential house.

Calculation was conducted within EIA report (see Annex 3.), according to which the emission propagation levels, produced during machinery working process, were defined toward calculation points. Calculation results are given in the table 7.2.1., where they are compared to the allowable level.

Table 7.2.1 Noise Propagation Calculation Results on Construction Phase

Area	Main Machinery	Equivalent Noise Level at Generation Point [dBA]	Distance to the Nearest Receptor [m]	Equivalent Noise Level at Nearest Receptors [dBA]	Allowable Norm [7]
Construction camp and construction site	o Bulldozer o Dump truck o Crane	94,6	300	**49,4**	During the day - 70 dBA. During the night time – 60 dBA

Based on the results of calculation, noise levels adjacent to the referance points may exceed only during the night time. However, construction works (especially intense noise generating works) will be conducted only in daytime. Therefore, noise will not exceed allowable limits near the residential house.

A number of circumstances should be considered that makes it possible to conclude that the construction activities will not cause a significant negative impact on residents, namely:

- Construction works will be implemented only during daytime;
- The main sources of noise are less likely to work simultaneously. Even then it will not be a long lasting process;
- During the calculation the shortest distance has been considered. Major construction works will be conducted in the central and southern part of the area. Therefore, the distance between the noise sources and the reference point is even greater;
- Impacts caused by noise propagation during the construction phase will be of short term.

Noise propagation will cause negative impact on construction stuff. The noise level at the construction site may reach 95 dBA. Personnel employed on the construction (especially when working near the equipment causing significant noise), will be equipped with safety equipment (ear-flaps).

Noise propagation may have negative impact on local wildlife as well, which will be connected to the migration of animal species (especially birds). However, construction site and surrounding areas are not distinguished with diversity of animal species. Animal species, adapted to the intensive activities of humans, are spread within this area. The impact is temporary and after completion of the construction works, the majority of species will be returned to old habitats.

Noise propagation mitigations measures will be carried out during construction phase., through which noise level, classified as “medium” will be reduced to “”low” impact.

Operation Phase

The main source of noise propagation during the operation of treatment plant will be pumping stations and transformers.The main receptor of noise impact will remain the same- the nearest residential house.

[7] sanitary norms on “noise in workplace, in housing, public buildings and residential areas”.

On operation phase calculation of noise propagation is conducted using the same method, as on construction phase. Calculation results are given in the table 7.2.2.

Table 7.2.2. Noise Propagation Calculation Results on Operation Phase

Area	Main Machinery	Equivalent Noise Level at Generation Point [dBA]	Distance to the Nearest Receptor [m]	Equivalent Noise Level at Nearest Receptors [dBA]	Norm[8]
WWTP area	o Pumping Devices o Transformers	95,6 – 25 ≈ 70	400	**22**	During daytime hours - 70 dBA. During night hours- 60 dBA

The obtained results are consistent with the calculation of the day as well as night time established standards. Consequently there will be no significant noise impact (expected "low" impact). However, certain mitigation measures should be carried out on operation phase.

7.2.1 Mitigation Measures

It is recommended to implement the following mitigation measures in order to minimize noise levels during the construction phase:

- To ensure proper maintenance of the machinery;
- To implement works that cause noise during the daytime only;
- To limit implementation of noisy works simultaneously;
- To identify the period for the construction works causing the noise, taking into account social (Sunday and holidays) issues;
- Prior to implementing noisy works, warning and the corresponding explanations (if necessary) should to be done with the population living adjacent to the construction camp;
- Generators and other noisy equipments should to be alocated away from sensitive receptors (residential houses) (to the south of the construction site, which is relatively far from sensitive receptors);
- Temporary barriers (screens) should to be arranged between a significant noise source and the houses, if necessary. The screens can be arranged by using a variety of structures (e.g. shields made from wood materials). The quality of noise protection depends on on the material type and thickness of the boards. For instance:
  - Fencing by pine boards (with thickness of 30mm – 12 Dba);
  - Fencing by oak boards (with thickness of 45mm - 27 Dba);
- If necessary, equip personnel with proper protective equipment;
- Frequent change of personnel that are employed for noisy works;
- Instruction of the personnel prior to the beginning of construction works and then, after every six month;
- In case of complaints, they should be recorded and appropriate action should be taken.

Though, exceedance of noise levels near the sensitive receptors is not expected during the operation phase, following mitigation measures will be implemented:

- High-quality pump installations will be arranged within the territory of the treatment plant. Much less noise is generated from pumps, which are made of stainless steel or cast iron. Low-cost pumps, which are made of thin steel sheets produce more noise;
- During the installation of pumps, noise-insulating material such as foam plastic will be used as far as possible;

[8] sanitary norms on “noise in workplace, in housing, public buildings and residential areas”.

- Pumps will be arranged on vibration isolation platforms, for which thick rubber sheets can be used;
- If necessary, equip personnel with proper protective equipment;
- Frequent change of personnel that are employed for noisy works;
- Instruction of the personnel prior to the beginning of construction works and then, after every six month;
- In case of complaints, they should be recorded and appropriate action should be taken.

7.2.2 Impact Assessment

Table 7.2.2.1 Summary of the noise impact

Description of impacts and impact sources	Impact receptors	Residual Impact Assessment					
		Nature	**Probability of influence**	**Influence area**	**Duration**	**Reversibility**	**residual impact**
Construction phase:							
Noise Propagation in the Air – Noise propagation from construction equipment and construction operations; – Noise caused by construction/installation works; – Noise caused by vehicles.	Population, project stuff, animals inhabiting in adjacent areas.	Direct, negative	Adjacent to the populated area – medium risk. Area of activities – high risk.	About 0.3 - 0.5 km radius adjacent to construction site and construction camp.	Medium term (depending on the duration of the construction works)	Reversible	**Low or Medium.** Taking into account the mitigation measures - **low or very low**
Operation phase:							
Noise Propagation in the Air – Exploitation of electric engines; – During the maintenance / repair works - used vehicles and spec. technology	Population, project stuff, animals inhabiting in adjacent areas.	Direct, negative	Low risk	The are aadjacent to the treatment plant	Long term	Reversible	**Very low**

7.3 Impact on Surface Waters

Construction Phase

The major impact receptor during the construction works will be Tskaltubostskali River, which flows in the vicinity of the project area.

Constamination of Tskaltubostskali River water during the construction phase is possible in the following cases:

- Oil spill in case of violating the rules of their storage or the rules of construction equipment and vehicles maintenance;
- In case of contaminated water discharge during the earth works;
- In case of discharging vehicles or equipment wash down water;
- In case of improper management of construction waste;
- In case of improper management of agricultural-fecal and storm waters, etc.

Discharge pipeline corridor is the most significant site in the regard with water contamination potential. This corridor will be located in the shortest distance to Tskaltubostskali river. However it should be noted that pipeline arrangement works will be carried out in the shortest terms and accordingly risks will not be high.

Surface water contamination risk on construction phase is considerably depended on implementation of environmental management measures by building contractor as well as waste management and machinery maintenance quality. Soil protection from contamination is important as well.

According to the project, industrial- fecal wastewater generated from the construction camp area will be collected through sanitation pits. Potentially contaminating areas will be protected from atmospheric precipitation.

Based on the above mentioned, impact on the surface water during the construction phase will not be significant.

Operation Phase

Impact on Tskaltubostskali River Water Quality

During the operation of wastewater treatment plant, purified wastewater is planned to be discharged into one point of Tskaltubostskali River. Effective system of wastewater treatment is proposed in accordance with the project, which provides regular treatment of wastewater in case of the proper operation rules. On the first phase of the project (reference year – 2028) removal of suspended particles, BOD and COD is planned from the wastewaters, while on the second phase (reference year – 2038) reduction of Nitrogen and Phosphorus concentrations is carried out.

In the condition of operation the treatment plant in the nominal mode, normative document applicable in Georgia is used for the impact assessment on Tskaltubostskali River water quality, namely: Technical Regulation on “Calculation of Maximum Permissible Discharge (MPD) of pollutants discharged with wastewaters in the Surface Water Body” (see Annex 4.). The relevant calculation showed that the wastewater considered by the project (I and II phases) won’t have significant negative impact on river water quality.

In this regard, attention should be paid to that design solution, according to which removal of total nitrogen and phosphorus is not planned on the 1st phase of the project and their concentration in the wastewater will be the same as in the sewage water transferred to the plant: total nitrogen - 40 mg/l and total phosphorous - 7,3 mg/l.

According to the relevant calculation, in order to provide proper water quality 830 m below from the discharge section, wastewater with total nitrogen no more than 73,1 mg/l and total phosphorous no more than 7,9 mg/l can be discharged in the river. which is more than the discharge value on phase 1.

It means that hydrological characteristics of Tskaltubostskali river, baseline qualitative condition and other factors considered during the calculation provide such dilution indicators of the wastewater and receiver water that concentration of pollutants in the calculation sections will be less than it is permitted.

Current situation of the wastewater management should be also taken into account. After rehabilitation of the drainage system of sewage water, there will be no uncontrolled discharged points, which will positively impact on the river quality. In its turn, the mentioned factor will increase the dilution indicator as a result of mixture the wastewater and the river water.

As a total, it can be said that the project implementation, including the design solution considered by the 1st phase will positively impact on Tskaltubostskali River water quality.

It should be noted that within the EIA procedures, the project on "Norms of Maximum Permissible Discharge (MPD) of Pollutants Discharged with Wastewaters from the Treatment Plant" will be developed and submitted to the Ministry of Environment and Natural Resources Protection of Georgia for approval.

In addition, impact on water quality may occur during the maintenance works as well. The impact will depend on the type and volume of works. Impact mitigation measure during construction works will be similar to the expected one.

Impact on Hydrology of Tskaltubostskali River

According to the project, peak flow of wastewater is 0,134 m^3/s. In compliance with the information given in the EIA report, paragraph 5.2.3., maximum flow of Tskaltubostskali river for 100 –year return period is 132 m^3/s. Difference between the wastewater flow and natural flow of river is so considerable that practically, no impact is expected on hydrological conditions as a result of wastewater discharge. Increase of flood cases is not expected in the upstream.

7.3.1 Mitigation Measures

Surface water (Tskaltubostskali River) pollution prevention measures during the construction phase are:

- To ensure proper maintenance of vehicles / equipments;
- Vehicles / equipments and potentially polluting materials should be located less than 50 meters away from surface waters (where it is possible). If this is not possible, the permanent control and safety measures should be implemented in order to prevent water pollution (especially within the construction site);
- Prohibition of washing vehicles in river-beds;
- Management of contaminated wastewater generated from construction camps will be implemented in accordance to the conditions determined by the project (sanitation pits will be used, which will be cleaned timely);

- Drainage / water channels should to be arranged throughout the perimeter of potentially polluting sites of wastewater;
- Roofing of potentially polluting sites (arrangement of sheds);
- Proper management of materials and waste;
- All potential pollutants should be removed after the completion of works;
- In case of spillage of oil/lubricants, spilled product should be localized / cleaned;
- Implementation of mitigation measures related to the protection of soil quality;
- Instruction of the staff.

Surface water pollution prevention measures during the operation phase are:

- Maximum permissible discharge of pollutants (MPD) will be adhered. MPD project will be updated once in 5 years;
- Possibility of sampling the wastewater, as well as purified water prior to the discharge into the river will be considered;
- Relevant authorities of the Ministry of Environment and Natural Resources Protection of Georgia will be provided with an accurate information about the volume and composition of wastewater;
- If the monitoring results show that the quality condition of wastewaters and receiver water body doesn't meet the project of MPD norms and the requirements established by corresponding regulatory documents, following measures will be immediately carried out for improvement of the situation:
    - A person in charge of environmental protection should immediately notify the Ministry of Environment and Natural Resources of Georgia about the existing situation. Information should contain the causes and preventive measures that will be implemented in order to eliminate the problem, as well as extreme levels of accidents related to emergency situations and pollution of water bodies;
- Systematic control over implementation of measures considered by the waste management plan;
- Appropriate drainage system will be arranged on the perimeter of the wastewater treatment plant. Atmospheric waters generated on sludge bed will be treated by technological process.
- Systematic supervision on fuel/oil storage and usage rules;
- In case of fuel/oil emergency spill, localization of the pollution and implementation of measures to prevent deterioration of the surface waters;
- According to the monitoring plan, laboratory analysis of wastewater will be carried out periodically;
- Instruction of personnel on environmental and safety issues

7.3.2 Impact Assessment

Table 7.3.2.1. Summary of the impact on surface water quality

Description of impact and its sources	Impact receptors	Residual Impact Assessment					
		Nature	**Probability of influence**	**Influence area**	**Duration**	**Reversibility**	**residual impact**
Construction phase:							
Contamination of Tskaltubostskali River water and related water bodies with suspended particles, hydrocarbons and other substances – Source of contamination with suspended particles - Contaminated surface runoff, construction works close to the river-bed; – Source of contamination with hydrocarbon / Chemical Substances - due to their spillage, inflow of contaminated surface water runoff, or their spillage in the water bodies; – Other pollution sources - Construction or household solid / liquid waste generated form construction camps.	Residents of nearby settlements, river inhabitants.	Direct. In some cases - indirect (e.g. inflow of contaminated surface water runoff in rivers, as a result of spilled pollutants). Negative	Medium risk, taking into account mitigating measures – low risk	Tskaltubostskali River water, section adjacent to the project area and downstream	Medium term (The impact is limited with the construction phase)	Reversible	**Medium,** Taking into account the mitigation measures - **low**
Operation phase:							
Contamination of Tskaltubostskali River water and related water bodies with suspended particles and organic substances – Source of contamination – wastewater discharged into the river from treatment plant	Residents of nearby settlements, river inhabitants.	Direct, Negative	Low risk	Tskaltubostskali River water, downstream from the discharge point	Permanent	Reversible	In case of normal operation mode- **low.** In case of emergency situations **high** impact is expected that

7.4 Impact on Groundwater

Construction Phase

There are certain risks of groundwater pollution at the construction phase (earth works). Engineering - geological survey showed that groundwater level is quite close to the land surface (groundwater levels have been established at a depth of 1.5-3.8 m). Therefore, groundwater level is within the rated depth of the foundation of the proposed structure. Bogging has been observed in some parts of the territory.

Deterioration of groundwater quality may be caused by accidental spillage of oil and movement of pollutants into the deeper layers of the soil, as well as by the excavations.

Due to the specifics of the project, direct impact of the wastewater treatment plant construction on groundwater debit is expected to be minimal. Though, there is a risk of indirect effects (e.g. reduced infiltration). The scale of the impact is very small and can be described as minor.

Operation Phase

Risk of groundwater contamination during the operational phase will be related to the damage of equipments and technological pipeline of the treatment plant, namely: Sewage spill within the territory of the treatment plant. At this phase, risks of negative impact on groundwater will be entirely related to the effectiveness of surface water and soil pollution preventive mitigation measures.

7.4.1 Mitigation Measures

In order to reduce the probability of groundwater pollution it is necessary to implement the measures related to the protection of soil and groundwater quality.

Construction Phase:

- To ensure proper maintenance of vehicles / equipments. In case of damage and fuel / oil spilage, they should be immediately repaired. Damaged vehicles are not allowed on the construction site;
- Strict observance of the boundaries of the corridor in order to prevent "neighboring" areas from possible contamination, topsoil damage and compaction;
- Machinery / equipment and potentially contaminating materials should be at least 50 meters away from surface water body (where possible). If it is not possible, control and safety measures should be taken in order to prevent water pollution;
- Prohibition of washing vehicles in river-beds;
- Proper management of contaminated wastewater generated from construction camps;
- Drainage / water channels should to be arranged throughout the perimeter of potentially polluting sites of wastewater;
- Proper management of materials and waste;
- All potential pollutants should be removed after the completion of works;
- Cleaning and recultivation of the area after the completion of works;

Operation Phase:

- Systematic control over the technical maintenance of equipment and technological pipelines of the treatment plant. If necessary, appropriate corrective measures should be taken;
- Insulating layer (clayey compacted soil) will be arranged within the territory of the treatment plant.

7.4.2 Impact Assessment

Table 7.4.2.1 Summary of the impact on groundwater

Description of impact and its sources	Impact receptors	Residual Impact Assessment					
		Nature	**Probability of influence**	**Influence area**	**Duration**	**Reversibility**	**Residual impact**
Constriction Phase:							
Changes in groundwater debit	Population, animals, surface waters with a hydraulic connection	Indirect	Low risk	Construction camps and construction sites	≈1 year	Reversible	**Very low,** or impact is not expected
Deterioration of groundwater quality – As a result of pollutants movement into the deep layers of soil, or contamination of surface waters; – Earth works	Population, animals, surface waters with a hydraulic connection (Tskaltubostskali River)	Mostly indirect	Medium risk	Construction camps and construction sites	≈1 year	Reversible	**Medium.** Considering the mitigation measures – **low**
Operation Phase:							
– ***Changes in groundwater debit*** Reduced infiltration	Population, animals	Indirect	Low risk	Project area and surroundings	Long-term	Irreversible	**Very low**
Deterioration of groundwater quality – As a result of pollutants movement into the deep layers of soil, or contamination of surface waters	Population, animals, surface waters with a hydraulic connection (Tskaltubostskali River)	Mostly indirect, in some cases direct and negative	Low risk	Project area and surroundings	Short-term	Reversible	**Low or very low**

7.5 Impact on Soil Stability and Quality

Construction Phase

Impact on Soil Stability

As noted in project description, treatment plant is planned to be arranged on the territory of the former treatment facility. There are the remains of old structures on the proposed area, therefore the major part of the area is remained without topsoil, while the thickness of the observed topsoil is minor and less valuable. However, impact on soil stability should be considered during the construction phase. Impact on topsoil and soil stability is mainly expected during the preparatory and construction works, Which will be caused by the arrangement of the construction camp, construction site, replacement of the equipment, earthworks, arrangement of temporary and permanent infrastructures, etc.

Places where topsoil is more or less represented should be marked during the preparatory stage. At these areas, topsoil should be removed and stored on the pre-selected area till the completion of construction works. Due to the specificity of the project area, works related to topsoil removal and storage will not be of large scale at the initial stage of the construction. Topsoil removal is possible only in the remote areas of the territory, throughout about 30% of the area. Capacity of removable topsoil layer will be approximately 1350 m^3.

In process of removal of the fertile soil layer and temporary storage, soil erosion may occur. In addition, fertile soil layer removal and transfer into the bund may cause loss of its certain amount, reduce soil fertility, impoverish seed stock, change pH and chemistry and structure of the surface layer.

Considering the fact that project area is under significant techno genic load, the impact on soil stability and integrity can be classified as “low”.

Soil Contamination Risks

Soil contamination is expected during preparatory and construction works.

The following negative impacts are to be expected on soil quality during the construction phase:

- In case of oil spillage / leakage from vehicles or other equipments used throughout the project area;
- In case of misuse and spillage of such hazardous substances such as paints and other toxic substances;
- In case of improper management of a removed soil layer during the construction phase.
- In case of improper management of industrial-fecal waters generated during the construction phase.

Considering the fact that agricultural lands are presented on adjacent area, soil contamination risks can be assessed as “medium”. After providing mitigation measures the residual impact will be “low”.

Operation Phase

Impact on the integrity and stability of soil or the loss and damage of the topsoil is not expected during the operational phase.

Possible causes of soil contamination during the operational phase are:

- Violation of the rules of storage-usage of fuel and lubricants;
- Improper management of municipal and other solid wastes (contaminated wipes used for equipment cleaning, dirty work gloves);
- Emergency situations (spillage of wastewater in case of damage of pipelines or other infrastructures).

During normal operation mode of WWTP the negative impact significance on soil can be assessed as "low".

The impact is also expected during the maintenance works. During implementation of repairing works mitigation measures and impact avoidance measures should take place during construction phase.

7.5.1 Mitigation Measures

In order to preven the damage and contamination of soil, the construction contractor will be required to take into account the following environmental requirements:

- Surface layer of the soil should be removed and storaged temporarly in pre-selected locations. The soil should be stockpiled separately. Stockpiles should be protected from wind and atmospheric precipitation and should be at least 50 meters away from surface water body;
- Storage for topsoil should be arranged in accordance with the relevant rules: the height of stockpails should not exceed 2 meters; the tilt angles of the slopes of stockpails should be 450; If necessary, water discharge channel should be arranged; after the completion of the construction activities, stored soil should be used for recultivation works;
- Strict protection of the boundaries of construction sites in order to prevent possible contamination of "neighboring" areas, damage and compaction of topsoil;
- Protection of the roads used by the vehicles and techniques (prohibition of turning off from the road), in order to reduce the probability of soil compaction;
- Vehicles and equipment should be checked regularly. In case of damage and fuel / oil leakage, it should be repaired immediately. Damaged Vehicles should not be allowed on the construction sites;
- Waste should be collected and stored in a designated area;
- Materials / waste should be disposed so that to prevent erosion;
- Proper management of industrial and fecal wastewater according to the conditions provided by the project;
- In case of fuel tank arrangement, the tank should be fenced by concrete or clay material, inner volume of which should not be less than 110% the reservoir capacity. In this case it is possible to prevent the oil propagation during the accidental sillage of oil;
- In case of spillage of pollutants, spilled material should be localized and contaminated site should be immediately cleaned; Staff should be provided with appropriate means (adsorbents, shovels, etc.) and with personal protective equipments as well;
- Contaminated soil and ground for further remediation should be taken out from the territory by the contractor equipped with an appropriate permit on these activities;
- Staff should be instructed prior to the construction works;
- Area should be cleaned and recultivated after the completion of works.
- After completion of construction works, all kind of waste (including hazardous waste) will be collected and removed from the area. Hazardous waste should be removed for further management by the licensed contractor.

The following measures must be ensured by the operator company, in order to prevent soil contamination during the operational phase:

- Control of the fuel/oil storage and usage rules;
- Waste management plan provides the systematic supervision of fulfilling the measures;
- In case of fuel/oil spill, cleaning of the territory and withdrawal of the contaminated soil and ground for further remediation;
- Training of the personnel on environmental and safety issues during recruitment and then once a year;
- In process of repair works, implementation of the mitigation measures considered for the construction phase.

7.5.2 Impact Assessment

Table 7.5.2.1 Summary of the impact on soil

Description of impact and its sources	Impact receptors	Residual Impact Assessment					
		Nature	**Probability of influence**	**Influence area**	**Duration**	**Reversibility**	**Residual impact**
Construction Phase:							
Impact on integrity and stability of soil. ***Lose of topsoil*** – Vehicle and construction equipment movement; – Earth works, arrangement of access roads and various facilities; – Waste management.	Vegetation, animals, population	Direct, Negative	High risk, taking into account mitigation measures – low risk	Construction camp, construction sites and corridors of roads for vehicles	Medium or long-term	Reversible. In exceptional cases - irreversible	**Low -** taking into account mitigation measures – **very low**
Soil contamination – Spillage of oil or other chemical substances, pollution by waste.	Vegetation, surface and ground waters, population	Direct (incase of siltation with sediment contaminated water – indirect). Negative	Medium risk	Construction camp, construction sites and corridors of roads for vehicles	Medium-term (Limited to the duration of the construction phase)	Reversible	**Medium,** taking into account mitigation measures – **very low.**
Operation Phase:							
Soil contamination – Spillage of oil or other chemical substances, pollution by waste	Vegetation, surface and ground waters, population	Direct, Negative	Low risk	Areas adjacent to the treatment facility	Long-term	Reversible	**Low or very low**

7.6 Engineering-Geological Hazards, Risk of Flooding

Construction Phase

Relief of the project area is flat, slightly wavy. Based on the results of engineering - geological surveys, the risk of development of dangerous geodynamic processes is not expected.

Based on the above mentioned, impact related to dangerous geodynamic processes during the construction of the treatment plant, pumping station and pipeline can be assessed as “low”.

Operation Phase

As the relevant calculations shows, the risk of flooding the area is minimal even during the flooding period on Tskaltubostskali River. However, the area of the treatment plant will have a vertical layout, namely, elevations of the area will be rised and the infrastructure of the treatment plant will be arranged above the existing elevation of the land surface.

7.7 Landscape and Visual Impact

Construction Phase

There will be some visual and landscape impact during the preparatory and constuction works due to the increased traffic flow, construction sites and working equipments and personnel, structures under construction, construction materials and waste. Implementation of the construction works will partially change the normal view and landscape.

The sensitive receptors will be the population of Gvishtari village and the passengers passing through the road adjacent to the project area.

After completion of construction works, vehicles and equipments, materials and waste will be removed from the construction sites, temporary structures will be dismantled and removed, workers will be withdrawn, the area will be recultivated.

Operation Phase

The major factor of visual and landscape changes during the operational phase will be the existence of the treatment plant, though it should be considered that currently sanitary and environmental conditions of the area is very poor, which cause negative impact on the visual receptors (population, passangers and animals). After the completion of the construction, a new building of treatment plant will be presented instead of old structures. In case of implementing planned recultivation and greening works, significance of a positive impact will be increased. Hence, the project will bring positive effects in terms of visual and landscape impact.

Some impacts are expected due to the maintenance and rehabilitation works. This impact is similar to the one of the construction phase, though much smaller.

7.7.1 Mitigation Measures

Visual and landscape impacts can be mitigated by reasonable selection of colour and design for the structure. In addition, temporary structures, materials, and waste should be disposed so that to be less noticeable for visual receptors. Decorative trees and plants should be planted throughout the treatment plant area and its perimeter.

7.7.2 Impact Assessment

Table 7.7.2.1 Summary of the visual and landscape impact

Description of impact and its sources	Impact receptors	Residual Impact Assessment					
		Nature	**Probability of influence**	**Influence area**	**Duration**	**Reversibility**	**Residual impact**
Construction Phase:							
Visual and landscape impact: – Construction camp and temporary structures; – Waste disposal; – Works related to construction and transportation.	Anumal species inhabiting in the vicinity, population	Direct, Negative	Medium risk	Areas adjacent to construction camps and sites. (Distribution area depends on local landscape, or visibility conditions)	Medium term	Reversible	**Medium.** In some sections **– low**
Operation Phase:							
Positive impact is expected							

7.8 Impact on Biological Environment

7.8.1 Impact on the Integrity of the Habitat and the Destruction of Vegetation

Construction Phase

Botanical survey revealed that the project area is heavily anthropogenous and modified habitat. It is floristically impoverished.

Vegetation cover is no dense. Part of vegetation represented within the project area is partly or totally dried. According to surveys conducted, about 112 trees will be cut during construction works. There are two species under special protection status – Imeretian Oak (*Quercus imeretina) (VU)* and Sweet bay (*Laurus Nobilis)* represented on the area. Their removal from the environment should be made in accordance with the requirements of Georgian legislation (See mitigation measures).

Due to high anthropogenous load, the area is not favorable habitat for wildlife. Part of the area due to swamping creates suitable conditions for amphibians. Due to the proximity of people, occurrence of large animals is actually impossible. Considering aforementioned construction works will not have significant impact on habitat integrity and it is not required to carry out special mitigation measures in this direction.

Impact on habitat integrity and vegetation cove can be assessed as **Low.**

Operation Phase

Considering the specifics of the planned activities, negative impact on vegetation is not expected during the operational phase of the treatment plant. Indirect impact may occure during the performance of the maintenance works (propagation of dust and combustion products), but the impact will be short-term and low intensity.

WWTP site is not located within the significant migration route of animals. The area is bordered from east and south sides by arable lands, which are intensively cultivated. Accordingly, habitat fragmentation impact will be minimal.

Potential impacts on vegetation cover during the operation phase can be assessed as **very low**.

7.8.1.1 Mitigation Measures

Mitigation measures for the impact on vegetation and the integrity of habitat during the construction phase are:

- Prior the works personnel will be instructed on the issues related to vegetation protection;
- In order to protect vegetation from too much damage, the boundaries of construction sites and traffic routes should be strictly defined;
- If required, removal of protected species will be carried out in compliance with the f) subparagraph of the 1st paragraph of the Article 24 of the law on "The Red List and the Red Book of Georgia" and the issue will be agreed with the Ministry of the Environment and Natural Resources Protection of Georgia;
- Compensation measures for the damage of trees-vegetation will be carried out:
    - Compensation measures for the impact on woody Red List species will be determined in accordance with the Decree #242 of the Government of Georgia, on "Rules of Forest Usage" dated as August 20, 2010, which considers money compensation. According to the rule of calculation of compensation fee, given in Annex 7 of the above-mentioned regulatory document, the fee to be paid for extraction of 1 m^3 oak from the environment is 300 GEL (including VAT).

- As for laurel, which is non-woody plant, compensation fee for this specie is not determined by regulatory document. Compensation fee will be defined by permit issuing body (the Ministry of Environment and Natural Resource Protection of Georgia). For orientation, fee for extraction of 1 m^3 laurel from the environment will not be more than 320 GEL (including VAT). After payment of compensation fee, it is recommended to replant the mentioned specie outside the project impact zone, to the analogous environment. Laurel grows quite well on humus-carbonated drained soils and cannot stand its salinity. It loves light. Therefore, it is recommended to replant these plants to the north-eastern periphery of the project area. According to the project, the development of the WWTP infrastructure is not planned on the given site;
- The Ministry of Environment and Natural Resources protection of Georgia makes decision about removal of the red-listed plants from the environment. Compensation measures for the red-listed species are defined by the Decree N242 of the GoG on the "Rule of the Forest Use" dated as August 20, 2010, which implies the cash compensation. According to the rule of calculation the compensation amount given in the Annex №7 of the mentioned normative document, the tax for the red-listed plants on 1 m^3 is as follows: walnut - 320 gel, oak – 300 gel;
- As for the laurel, it is recommended to replant species outside the project impact area, in the same environment. Laurel grows quite well on humus-carbonated drained soils and can not stand its salinity. It loves light. Therefore, it is recommended to replant these plants to the north-eastern periphery of the project area. According to the project, the development of the WWTP infrastructure is not planned on the given site;
- The issue of removal of less valuable plants from environment will be agreed with the local government (administration (Gamgeoba) of Tskaltubo municipality). Proper compensation measures will be determined under agreement with the mentioned body. The cut timber will be transferred to the administration of Tskaltubo municipality for further management;

- In order to reduce impact on habitat integrity, following measures will be carried out:
  - Work sites will be fenced;
  - Earth work period will be limited and excavated ditches will be backfilled in shortest possible time;
  - Ditches, trenches, etc. will be enclosed with any barriers to avoid animal falling in – for large species – bright colored band, and for smaller ones any type flat materials - sheet iron, polyethylene, etc. Will be used. At night long boards and logs will be placed in ditches and trenches to allow small animals to escape from there. Ditches and trenches will be checked prior to backfilling;
  - After completion of the construction works recultivation works will be carried out adjacent to communications and access roads. This will significantly reduce impacts related to habitat fragmentation.

During the repair-maintenance works, mitigation measures for the impact on vegetation cover developed for the construction phase will be carried out on the operation phase too

7.8.2 Impact on Wildlife

Construction Phase

During impact assessment of WWTP construction works on wildlife, baseline conditions of the project area and its surroundings should be highlighted: The construction site itself is under heavy anthropogenic load, dilapidated buildings of old WWTP are presented on major part of the site; density of vegetation cover is low, which cannot create critically significant habitat for large mammals and rare

bird species. It is noteworthy that adjacent agricultural and arable lands are intensively cultivated; the impact of human agricultural activity is high, which is main disturbance source for animals. Considering aforementioned the quantitative and specie composition of animals is low within the project area. It should be highlighted that trails of animal species of special significance (Red List species of Georgia) have not been observed within the project area during surveys. Accordingly, direct damage to animal shelters, as well as indirect impact will not have large scale.

During vegetation cleanup habitat for small mammals such as social vole (*Microtus socialis),* Common vole (*Microtus arvalis)*, broad-toothed field mouse (*Apodemus mystacinus)* can be restricted. Works may have direct impact on following bird species: Hooded crow (*Corvus cornix) ,* Eurasian tree sparrow (*Passer montanus)*, common chaffinch (*Fringilla coelebs)).* red-back shrike (*Lanius collurio)*, common blackbird (*Turdus merula)*, etc. However direct impact on them is minimal, as during surveys, their nests have not been identified on existing trees and vegetation. During chopping of shrubby vegetation, sand lizard *(Lacerta agalis), (Poseudopus apodus),* grass snake (*Natrix natrix)*, should be singled out among other project-impacted species.

During implementation of earth works especially on the side of the swamped areas, shelters of small animals (lizard, turtle, forest frog, etc) can be damaged/destructed or direct impact on species may take place. In addition, trenches/ditches, created in the result of earth works pose a certain threat to small animal species. It can cause their falling into trenches, injury or death.

Noise, vibration, ambient air emissions, as well as changing of lighting background will result animal disturbance. However, it should be noted that majority of animals, identified on the area, are used to intensive activities of people (sparrow, common blackbird, etc.).

Improper waste management can be the reason of direct impact on animals (poisoning, injury, death). Disposal of waste, as well as construction material or other temporary structures in improper areas will limit free movement and cause habitat fragmentation for species, such as Greek Tortoises – (*Testudo pontica)* and various amphibians.

Therefore, the wildlife will be directly (collision / damage, habitat fragmentation) and indirectly (migration due to the noise / vibration, emissions, etc.) impacted. The major sources of the impacts are:

- Traffic movement;
- Vehicles and equipment, as well as the staff working on the construction site;
- Excavation works and construction of temporary structures;
- Artificial lightening system.

Based on the above mentioned, impact on the wildlife during the construction phase can be assessed as a **low**. In case of effective implementation of mitigation measures and constant monitoring, it will be possible to reduce impact even more.

Operation Phase

Among the possible negative impacts on wildlife during the operational phase of the wastewater treatment plant the most noteworthy are:

- Impact related to noise propagation;
- Impact related to odor propagation;
- Impact on birds caused by night lighting systems;
- In case of contamination of Tskaltubostskali River water, impact is expected on water related birds and animals.

It should be noted that the levels of noise propagation will not be high during the operational phase and that in case of implementing optimization measures for the night lightening system, impact would not

be significant. The proposed effective and reliable system for wastewater treatment will minimize the risk of discharging incompletely treated water.

In the operation phase, impact on fish fauna is expected in case of violation of technological process of WWTP and accidental discharge of untreated wastewater into one point of Tskaltubostskali river. Following species can get within the impact zone: Barbel – (*Barbus barbus*), Colchis nase (*Chondrostoma colchicum)*, etc. In order to reduce such risks, special attention should be paid to following of WWTP operation technological scheme. Red List species of Georgia do not inhabit within the potential impact zone and impact on this species is not anticipated.

Based on the above mentioned, impact on the wildlife during the operational phase can be assessed as a **low** impact.

It should be noted that the project will have an important positive impact on the improvement of wildlife habitat environment. At present, due to the poor management of wastewater risks of polluting individual components of the environment are quite high. Such risks will be significantly reduced in case of project implementation. A significant positive effect is expected on fish fauna of Tskaltubostskali River.

7.8.2.1 Mitigation Measures

Mitigation measures of the impact on terrestrial animals during the construction phase are:

- Strict observance of the boundaries of traffic routes and construction sites;
- Selection of the optimum speed for traffic in order to reduce the probability of direct impact on animals (collision);
- Pits and trenches should be fenced in order to avoid animals falling into them – a sharp-colored ribbon should be used for large-sized species, while for small animals all flat materials can be used - iron, polyethylene and others. Long boards or logs should be put into the trenches and pits at night time, so that small animals could come out of there. Inspection of pits and trenches before filling with soil;
- To use the minimum amount of light in order to reduce the spread of light;
- Activities causing too much disturbance of animals should be implemented in a short period of time;
- Recultivation of the construction camp and the treatment plant area after the completion of construction works;

In addition:

- Proper management of waste;
- Implementation of mitigation measures of the impacts on water, soil and ambient air, noise and so on (see the relevant chapters).

The most significant mitigation measures during the operational phase are: Systematic maintenance of the treatment plant and associated devices and optimization of night lightening systems. Systematic control of the efficiency of the treatment plant in order to minimize the impact on water related animal species.

7.8.3 Impact on Protected Areas

There are no protected areas in the vicinity of the project corridor. Therefore, the impact on protected areas is not expected.

7.8.4 Assessment of the Impact on Biological Environment

Table 7.8.4.1 Summary of the impact on biological environment

Description of impact and its sources	Impact receptors	Residual Impact Assessment					
		Nature	Probability of influence	Influence area	Duration	Reversibility	Residual impact
Construction Phase:							
Vegetation destruction / damage. Habitat loss / fragmentation. – Direct impact: o Vegetation removal from the area; o Damage of vegetation caused by violating traffic routes. – Indirect impact: o Water pollution; o Soil contamination and erosion.	Area selected for the construction of the treatment plant, wildlife, population	Direct and indirect, negative	Medium risk	– Direct impact area – construction camp and construction site – Indirect impact area – areas adjacent to the construction camp and construction site.	Medium term. Permanent on the construction site	Reversible. On construction site - irreversible	**Medium.** Considering mitigation measures – **low.**
Impact on terrestrial fauna, including: – Direct impact: o Traffic collision, falling down in trenches and others. – Indirect impact: o Damage of vegetation. o Ambient air pollution o Change in acoustic background o Change in background illumination at night; o Possible pollution of ground and surface waters; o Soil contamination and erosion o Visual impact	Animal species inhabiting in the project area	Direct and indirect, negative	Medium risk	Areas adjacent to the construction camp and construction site.	Duration is limited by the construction phase	Mostly reversible	**Medium.** Considering mitigation measures – **low.**
Operation Phase:							
Impact on fauna, including: – Noise and odor propagation; – Contamination of Tskaltubostskali River water; – Lightening; – Visual impact, etc.	Area selected for the construction of the treatment plant, wildlife	Direct and indirect, negative	Medium risk	Areas adjacent to the project area	Long term	Mostly irreversible	**Very low**

7.9 Impacts Caused by Waste Generation and Propagation

Under the paragraph 1, article 14 of the Waste Management Code of Georgia, "the natural or legal entity, whose activity causes the generation of more than 200 t non-hazardous waste or more than 1000 t of inert waste or hazardous waste with the amount of more than 120 kg is obliged to develop "Waste Management Plan of the company". The Waste Management Plan is updated in every 3 years or when substantial amendments will be made to the existing waste types or amounts or to their treatment procedures.

Since generation of significant amount of waste (including hazardous waste) is expected during implementation of planned activities, the Waste Management Plan (preliminary version) generated during the construction and operation of Tskaltubo WWTP was developed and is given in the Annex 5 of the EIA report. The plan includes the types of expected wastes and amount, conditions of their management and other issues considered by the Georgian legislation.

Significant amount of construction waste (concrete remains, ground, etc) will be generated during demolition works. Contractor will remove them by trucks. Under agreement with local government, inert construction waste will be used for backfilling of areas, which require vertical planning in order to avoid consequent negative processes (erosion, etc.).

Various types of hazardous waste will be generated on construction and operation phases: solid and liquid oil-contaminated waste, oil-contaminated ground, paint packing material, lead containing accumulators, waste containing small amount of mercury. Nowadays there is no landfill for disposal of hazardous waste. Thus generated hazardous waste will be transferred to permit holding contractors under corresponding agreement. Transportation will be provided by properly labeled vehicles with closed body. Each transportation operation of hazardous waste must be accompanied by information sheet of hazardous waste, where the information on waste generation, classification and hazardous features should be provided, as well as information on safety measures and first-aid in case of accident.

Waste, generated during implementation of works will be disposed to the nearest household waste landfill. Waste delivery and disposal to the landfill will be carried out in accordance with technical conditions issued by the Solid Waste Management Company of Georgia LLC.

Issues concerning excess sludge handling, which is generated in various structural units of WWTP should be singled out among waste, expected in the operation phase.

Sludge Handling

Sludge treatment/drying process is described in par. 4.3.

Two scenarios can be discussed for sludge handling in Tskaltubo WWTP operation phase, including:

- I – Drying, processing (composting) of sludge and using it as fertilizer;
- II Final disposal of dried sludge on environmental impact permit holder sanitary landfill.

First scenario of sludge handling is widely introduced in developed countries and the product, received by sludge processing is used for improving productivity of agricultural lands (with some restrictions), as well as non-agricultural lands (landscaping lines, areas for flower growing, etc).

In case of the first scenario it is recommended to arrange semi-closed (shed-like) buildings for sludge drying beds, allowing the sludge to dry throughout the year. In order to speed up the drying process, it is possible to use aeration process (turning over sludge layer by hand). Dried sludge is subject to laboratory examination (determination of pH, heavy metal content, pathogenic microorganism content) and then it will be prepared for realization. Preparation for realization envisages sifting the dried sludge and placing it in polyethylene packing with various capacities (based on market demand).

Georgian legislation does not regulate the sludge usage issue for agricultural purposes. In European countries it is forbidden to use the sludge:

- On lands, which are used for grazing or if 3 weeks are left before forage crop harvest;
- Vegetable cultivation plots during crop vegetation period;
- On plots, where cultivation of vegetables or fruits is planned, that are in constant contact with the soil or that are used for food in raw form, 10 months before harvest time and during the harvest period.

Waste unusable for sale will be disposed under agreement, signed with environmental impact permit holder landfill.

According to the second scenario, sludge dried on sludge drying beds, will be disposed on household landfill, having environmental impact permit. Sludge should be removed from sludge drying beds in dry period of summer, so that proper drying of sludge is achieved (sludge removal from sludge drying beds is planned once a year). Delivery of the new quantity of sludge to the corresponding section of sludge drying beds is restricted during sludge removal from the sludge drying beds. Dump trucks with covered top will be used for transportation operations to avoid sludge scattering or dusting risks during transportation process. Sludge must be loaded on trucks using auto-loader. Sludge transportation will be provided by United Water Supply Company of Georgia LLC.

According to Law of Georgia - Waste Management Code and technical regulation on "Determination and classification of the list of waste according to their types and characteristics", approved by decree №426 of the Government of Georgia, dated as August 17, 2015, sediments (code-19 08 05), generated in the settlements, in the result of wastewater processing, do not belong to the category of hazardous waste. To prove this it can be stated that there are no significant industrial facilities on Tskaltubo territory, and wastewater from existing facilities should be discharged in the sewer after preliminary treatment and in compliance with technical conditions, issued by local service of United Water Supply Company. Considering aforementioned, on WWTP operation phase risk of getting toxic substances in the generated sludge is at minimum.

Considering that currently waste can only be disposed on solid household waste landfill (the country does not have corresponding infrastructure for hazardous waste disposal), the only alternative for waste disposal, generated during WWTP operation is using the household waste landfill.

Three options are discussed for permanent disposal of excees sludge generated in the result of Tskaltubo WWTP operaton:

1. New regional landfill in the east of Kutaisi city, near villages Godogani and Chognari;
2. Existing landfill in the south of Kutaisi city, so-called Nikea Landfill; and
3. Existing landfill near the village Dapnari of Samtredia municipality.

All three landfills are operated by Solid Waste Management Company of Georgia LLC.

In case of first option, sludge transportation route must pass through settlements of Kutaisi city and adjacent villages. In case of using bypass roads, transportation distance is increased with 70-80 km.

In case of so-called Nikea Landfill alternative, the transportation distance will be the least – about 30-35 km. However, in this case it should be considered that transportation route will pass near densely populated residential zones. Besides, it should be noted that this landfill does not meet active environmental standards and the issue of its closure is under discussion.

Considering existing situation, the most acceptable alternative is disposal of excess sludge on landfill near Dapnari village in Samtredia municipality. Approximate transportation distance is 40 km. It is noteworthy that in the prospect, within the East-West Highway (E-60) modernization conditions,

transport route between the project WWTP and landfill, will be unloaded from traffic flows. Accordingly, transportation operations are not related to significant risks.

Dapnari landfill was launched in 1985. It did not meet any sanitary and ecological standards for the time when it was transferred for operation to the Solid Waste Management Company of Georgia LLC. The landfill posed a threat to the environment as well as to human health. After transferring it to Solid Waste Management Company of Georgia LLC, in 2014, the landfill was reconstructed: hydroinsulation layer was arranged, the practice of waste disposal in cells was introduced, improving conditions for local population and environmental safety. The total area, owned by Solid Waste Management Company of Georgia LLC is 6 ha, but in future it can be expanded.

Prior to commissioning of WWTP, issues of dewatered sludge removal and disposal on Dapnari landfill by UWSCG will be agreed with Solid Waste Management Company of Georgia LLC (at present preliminary agreement is reached in relation to sludge disposal on the above-mentioned landfill).

Considering the capacity of sludge drying beds (up to 1700 m^3) and annual amount of generated sludge (1406 m^3), maximum time for temporary storage of sludge is 421 days. Accordingly, the off-site sludge disposal will be organized once (maximum twice) a year. The sludge will be transported to the offsite disposal site by the transportation means owned or hired by UWSC of Georgia and its existing personnel.

It is supposed to use 10 m^3 capacity dump trucks (with covered top) for sludge transportation, to avoid sludge scattering or dusting risks during transportation process. Sludge must be loaded on trucks using auto-loader.

According to annual sludge amount, maximum number of transport trips per year will be 140 trips. As it was mentioned above, transportation distance is 40 km. Considering the practice introduced in Georgia, the expenses, required for 1 m^3 transportation on 40 km distance is 40 GEL (16,7 USD). This includes all expenses (fuel, vehicle maintenance, driver wage, etc.). Accordingly, annual transportation cost for sludge transportation, generated during Tskaltubo WWTP operation will be: 1406 x 40 = 56240 GEL (23435 USD).

As for 2017, landfill tipping fee for disposal of 1 m^3 sludge is 20 GEL (8,3 USD). Accordingly, overall annual tariff for disposal of sludge, generated during operation of Tskaltubo WWTP will be about: 1406 x 20 = 28120 GEL (11 700 USD).

Overall cost for sludge transportation-disposal will be about 84 360 GEL/a (35 150 USD /a).

The UWSCG will be responsible for payment of these costs, which will be recouped from its customers through the water-wastewater tariffs. In this manner the “user & polluter pays” principles will be integral to the Tskaltubo plant operations, which is a basis for sustainable resources management.

The sludge removal and transport activities will be conducted during normal business hours, and adjusted to the sludge generation & drying rates, UWSCG vehicle logistics and local traffic patterns (for example, to not overlap with harvest and other peak-periods for agricultural transport).

As it is clear from above-mentioned, the first scenario of sludge handling from environmental and economic point of view has number of advantages, but due to unfavorable circumstances in the country, the preference is given to the second scenario (disposal of dried sludge on household waste landfill). Following should be highlighted among unfavorable circumstances:

- Georgia does not have legislative basis for utilization of sludge, generated during WWTP operation for agricultural purposes;
- There is no such practice in the country of sludge utilization as fertilizer and accordingly, it is unlikely that there will be market demand on it.

Violation of the waste management conditions may cause some certain negative impacts on different environmental receptors, for example:

- Improper waste management (scattering in water or on the territory) may cause water or soil contamination, as well as deterioration of sanitary condition of the territory, negative visual changes, negative impact on human health and safety, etc.
- Disposal of construction wastes or sludge on an inappropriate place may cause blocking of roads, erosive processes, which may be followed by various indirect impacts, etc.
- Improper waste management may lead to negative impact on tourism and complaints of tourists.

7.10 Impact on Socio - Economic Environment

Impact on Land Ownership and Use

Area selected for the construction of treatment plant is a state-owned non-agricultural land. In the past, similar plant was operating on the project area.

Therefore, the planned activities will not be related to physical or economic resettlement.

Risks Related to Health and Safety

Except the indirect impact (deterioration of air quality, spread of noise and electric fields, etc., which are described in the relevant subsections) there is a direct risks of impact on health and safety (residents and staff working within the project) during the construction phase.

Direct impacts may be: Vehicle collision, power hit, falling from height, injuries while working with construction techniques and others. Strict security measures and a permanent supervision should to be protected in order to preven direct impacts. Security measures include:

- Personnel should to be trained on safety and labor protection issues;
- Personnel working at height must be secured with ropes and special mountings;
- Warning, prohibiting and indicative signs should to be arranged throughout the construction sites and camps;
- Maximum protection of safety rules during the transportation;
- Transportation should to be limited to a minimum in populated areas;
- Risk assessment should be conducted regularely in order to determine specific risk factors for the population and for appropriate management of such risks;
- Construction personnel shall be provided with personal protective equipment (special - clothing, helmets, etc..).

Impact on Employment and Economic Environment

A certain amount of local specialists and workers will be employeed by the construction contractor, which is the positive impact on employment.

The majority (80%) of personnel, employed on the construction will be from local population. Private houses will be rented for personnel from other regions. So according to construction organization plan, arrangement of the construction camp (permanent living containers) is not considered, thus the impact due to workforce inflow will not take place.

Building materials of local production (such as inert materials) will be required for construction works, which will also have a positive impact on activation of building materials manufacturing business.

Impacts on Transport Infrastructure, limited Traffic

The road, which is connected to Kutaisi-Tskaltubo-Tsageri-Lentekhi-Lasdili will be used for transportation of building materials and labor during the construction phase.

Condition of this road is satisfactory. During the construction works road pavement will be damaged and traffic will be increased. The risk of accidents will be also increased.

The roads should be maintained throughout the construction phase. Blocking roads with construction and other materials is prohibited. After completion of construction works, local roads should be rehabilitated.

Taking into account the intensity of the background traffic flow, limited traffic on local roads (so called traffic jams) is less expected. The impact may be relatively noticeable on the road used for transportation of construction materials. During construction, period, when machinery and construction materials will be brought to the site, should be highlighted.

WWTP discharge pipeline will cross adjacent dirt road. The length of the pipeline will be about 35 m and its construction will be short-termed. Traffic movement is of low intensity on the dirt road and besides, there are alternative bypass roads as well. Accordingly, pipeline construction will not limit movement.

Construction contractor shall plan construction activities so as to minimize the impact on roads, namely:

- Selection of an optimal bypass route to the construction site;
- Possible restrictions on the movement of vehicles on public roads (especially paved roads of Tskaltubo);
- Maximum limitation of the movement of crawlers;
- Population should be provided with the information about the time and duration of works, if necessary;
- All damaged sections of the road should be recovered, in order to make them available for the population;
- Specially designated personnel (standard bearer) should control the movement of vehicles, if necessary;
- Relevant banners will be arranged along the road, through which passengers will be informed about the ongoing works within the project area;
- Complaints should be recorded and an appropriate action should be taken.

During operation transportation operations will be related to excess sludge handling and implementation of WWTP repair works. As it was mentioned, sludge drying bed capacity, considered by the project is sufficient for temporary storage of sludge – for 421 days. It is recommended to use landfill, existing near Dapnari village for permanent disposal of sludge. This landfill in comparison to other nearby landfills is the nearest to the WWTP site. In this case sludge transportation will have minimum impact on existing intensity of traffic flows. Sludge transportation should be carried out not during peak working hours.

A Positive Impact of Treatment Plant Operation on Socio - Economic Environment

The project is expected to have a significant positive impact on social environment, namely:

- Issues related to municipal wastewater drainage and treatment will be regulated and sanitary and ecological situation will be improved in Tskaltubo and adjacent settlements;
- Prevention of discharging untreated agricultural-fecal wastewater into the surface water bodies, which is important for the improvement of surface water quality in Tskaltubo Municipality. Positive impact is expected on habitats of wildlife;
- Implementation of the project ensures the sustainable development of local infrastructure, which is important for socio-economic development of communities and regions, as well as for raising tourism potential;
- 15-20 people from local population will be employeed during the the treatment plant operation, which is a small though positive impact in terms of employment of local population.

It should be noted that project implementation is planned in two stages. On the first stage economically advantageous technology of wastewater treatment will be used, which will not be associated with high financial expenses. Accordingly, WWTP operation cannot have significant impact on existing tariffs and accessibility to water supply-wastewater drainage services will be maintained for local population.

Probable Tariff Increase and Impact

According to the tariff setting methodology developed by Georgian National Energy and Water Supply Regulatory Commission (GNERC), capital expenditures incurred as a result of the grant, are not allowed to be incorporated into the tariff. This means that the impact on tariff will only be caused by the O&M expenses incurred yearly. At this point they cannot be reliable ones. For an average household, even the tariff will be affordable. For poor families (about 10% of the population on average) the government offered "subsistence allowance" in the past and will again be offered in case of need. At the same time, costs incurred due to waste treatment can be cross financed by revenues generated from water distribution.

7.10.1 Impact Assessment

Table 7.10.1 Summary of the impact on socio-economic environment

Description of impact and its sources	Impact receptors	Residual Impact Assessment					
		Nature	**Probability of influence**	**Influence area**	**Duration**	**Reversibility**	**Residual impact**
Construction Phase:							
Restriction of access to resources:: – Impact on land owners - implementation of any type of activity on their lands, or damage of their property; – Limited use of water resources, etc.	Local population	Direct, negative	Low risk	Area adjacent to the treatment plant	Duration is limited by the construction phase	Reversible	**Low**
Positive impacts related to the employment	Local population	Direct, Positive	High probability	Population of Tskaltubo	Duration is limited by the construction phase	Reversible	**Medium**
Negative impacts related to the employment: • Expectations for employment and dissatisfaction of the local population; • Violations of workers' rights; • Reduction of employment after the completion of the project s and dissatisfactions; • Disagreement between the local residents and workers.	Construction staff and the local population	Direct, negative	Medium risk	Construction sites and nearby populated areas	Duration is limited by the construction phase	Reversible	**Low**
Risks related to health and safety: – Direct (e.g. Vehicle collision, power hit, falling from height, injuries while working with construction techniques and others.) and – Indirect (Atmospheric emissions, increased acoustic background, water and soil pollution).	Construction staff and the local population	Direct or indirect, negative	Medium risk, considering mitigation measures – low risk	Construction sites and nearby populated areas	Duration is limited by the construction phase	Reversible	**Low**

Damage of road pavement – Movement of heavy equipment ***loaded traffic flow*** – Movement of all types of vehicles and equipment ***Limitation of movement*** – Closing the local roads for the security purposes	Local infrastructure, population	Direct, negative	Medium risk	Roads used for the project activities, as well as by the population	Duration is limited by the construction phase	Reversible	**Low**
Contribution to the economy and employment – Activation and development of building materials manufacturing business and its satellite business; – Creation of jobs; – Increased budget revenues.	The city's economic activity, the local population	Direct, Positive	High probability	Impact area may be a city-wide	Duration is limited by the construction phase	-	**Medium**

Operation Phase:							
Risks related to health and safety of population: – Indirect - spread of unpleasant odor; In case of maintenance works atmospheric emissions, increased acoustic background, water and soil pollution	Plant staff and local population	Direct Negative	Low risk	Adjacent residential zone	Long-term	Irreversible	**Very low**
Employment – Creation of jobs;	Employment of local population	Direct positive	High probability	Tskaltubo city	Long-term	-	**Low**
Improvement of local wastewater infrastructure (positive impact)	Local population and tourists	Direct positive	High probability	Tskaltubo city and adjacent settlements	Long-term	-	**High**

7.11 Impact on Cultural and Archaeological Monuments

According to the results of fieldwork, there are not any historical-cultural monuments in the project area. It should be mentioned that previously an old treatment plant has been operating on the project area. Thus, late detection of archaeological sites during the construction phase is less expected.

However, during the implementation of excavation works some archeological sites can be discovered. Based on the requirements of the law of Georgia on "cultural heritage", in case of detection of an archaeological monument, construction works should be immediately stopped and the construction contractor shall invite the specialists of the competent authority in order to determine the significance of the archaeological monuments and make decision about the extension of works.

7.12 Cumulative Impact

The main objective of the cumulative impact assessment is to identify those types of impact, which do not represent any serious risks to the environment, but together with the similar kind of effect that may be caused by other current or prospective projects, will cause a much higher and significant negative or positive consequences.

Due to the low intensity of construction works, and also considering that the similar kinds of projects are not planned throughout the surrounding areas, the cumulative impact is not expected.

8 Operation of Treatment Plant

Residual Impact

Tskaltubo WWTP is projected on the area, where analogous site was operated some decades ago. The remains of old treatment plant in the form of concrete reinforcement structures are presented on the area; the selected site is exposed to significant anthropogenic load and it is not the habitat of special value. Mitigation measures planned on construction phase will significantly reduce the expected impact scale and distribution scope, accordingly, after completion of construction works, low residual impact is expected on the environment.

As for operation phase of WWTP: As it was mentioned before the project will be implemented in two phases: On phase 1, or for 2028, wastewater treatment from suspended solids (SS), BOD and COD removal will be provided and the quality of wastewater in terms of the mentioned pollutants will be in compliance with the legislation of Georgia, as well as with EU directives. However, taking into account the fact that the Nitrogen and Phosphorus removal cannot be provided, the residual impact on surface water should be considered.

It should be noted that for Phase II, WWTP update and improvement should be considered, that will be targeted to receive higher treatment quality. Namely, for 2038, the arrangement of additional facilities is planned on the WWTP site and using them it will be possible to remove Nitrogen and Phosphorus from the wastewater. Treatment of wastewater from mentioned substances will also be in compliance with Georgian legislation and EU directives.

Accordingly, in normal operation mode of WWTP, low residual impact is expected on surface water.

During operation of WWTP another significant impact should be distinguished in harmful substance emissions in the ambient air. It is noteworthy, that in order to reduce the impact the project envisages

odor nuisance monitoring using stationary and field tools. According to monitoring results if required, modern equipment (arrangement of floating aerator devices on each anaerobic tank) will be used. The equipment will ensure to minimize odor nuisance to the lowest rate and the residual impact level from this point of view should also be assumed as "low".

In order to define residual impact scale on surface water and ambient air quality, monitoring activities will be carried out, that gives the possibility to define the necessity of provision of additional mitigation measures.

Institutional Mechanisms of WWTP Operation

Tskaltubo WWTP operation will be provided by local (Tskaltubo) Service Center of "United National Water Supply Company of Georgia" LLC. Operational costs of WWTP will be covered by United National Water Supply Company of Georgia" LLC. If required addisional funds will be allocated from local or central budget.

Possible Emergency Situations

On the basis of analysis of WWTP construction project technological regulation, the possible options for emergency situation development were determined, according to which future emergency situations must be avoided. Before development of preventive measures, it is necessary to assess corresponding risk-factors, which aims to facilitate decision-making in terms of the feasibility of the project on the one hand and on the other hand, to form the basis for the prevention of negative impacts or for development of significant mitigation measures.

Environmental impact on different receptors is the last link in the cause and effect chain and its main components are:

- Development of risky situations (fire and etc.) associated with some activities outlined by the technological scheme;
- Negative impact on sensitive receptors (ambient air, soil, ground surface, some species of habitat).

Therefore, the aim of mitigation measures can be minimization of impact possibility, and on the other hand – the target of them can be minimization of impact levels. The best direction of mitigation measures is reduction of impact risks to zero point, as possible.

Possible emergency situations within planned activities:

- Fire (landscape fire);
- Spill of hazardous substances;
- Damage of the treatment facility and emergency discharge of wastewater;
- Accidents related to safety;
- Traffic accidents;
- Natural type emergency situations.

Emergency Response Plan for emergencies during WWTP construction and operation phases is given in Annex 6.

9 Termination of WWTP Operation

Short-term Termination of Treatment Plant Operation or Repair Works

In case of temporary termination of treatment plant operation or in case of maintenance (current and capital) of existing facilities, operational service is obliged to develop executive plan related to a temporary suspension of activities or repair works, which firstly should include security requirements and should be coordinated with the local self-government and all interested legal persons. The plan should include alternative ways for municipal wastewater discharge.

Long-term Termination of WWTP Operation or Conservation

In case of long-term termination of treatment plant operation or conservation, administration shall establish a liquidation body, which will develop the plan for long-term termination of WWTP operation or conservation. Long-term termination or conservation plan should be coordinated with the authorized agencies. The major content of the plan is safety requirements.

The following measures are to be carried out before the termination of the activities:

- Internal audit of the area – to record the technical condition of infrastructure, to identify the risks of emergency situations, as well as environmentally problematic areas and to solve the problem;
- Temporary demobilization of auxiliary infrastructure – to release the warehousing from stockpiled material, waste, as far as possible, and to allocate a special area for equipment and vehicles;
- To provide warning and prohibition signs throughout the outer perimeter of the area.

Liquidation of the Treatment Plant

In case of treatment plant liquidation, a special project should be developed in order to identify the ways and means of restoring previous condition of the environment.

The operator company is responsible for the project development. Under current rules, a special project of liquidation should be agreed with the competent authorities and the information should be provided to all interested individual and legal persons.

The rules and the sequence of termination of technological processes, dismantle of facilities and equipment, terms and conditions of demolition works, safety and environmental protection, terms and conditions of neutralization and disposal of hazardous waste, recultivation works and other issues should be considered in the project.

10 Environmental Management and Monitoring

The information provided in the Environmental Management Plan (EMP) is based on the information presented in some paragraphs of EIA report. Mitigation measures to be carried out are developed according to planned works and impacts expected during these activities. The place and time for implementation of mitigation measures are indicated, the authorities responsible for implementation of mitigation measures and cost are defined.

The main objective of EMP is project implementation in compliance with national legislation on environmental and social requirements, as well as World Bank Environmental and Social Policies.

EMP will be included in tender documentation for construction works and tender participants will be able to enclose their environmental obligations in the presented proposal. After starting construction works EMP will be the part of the agreement signed by the client and civil contractor and it should be necessarily implemented during construction process.

After signing an agreement, the civil contractor will develop and represent to MDF plans about thematic management:

- Detailed Waste Management Plan;
- Health and Safety Management Plan;
- Emergency Response Plan.

The project on recultivation works can be presented for the final stage of construction works.

Institutional Mechanisms for WWTP Construction and Operation Phases

Municipal Development Fund of Georgia:

The MDF is the Implementing Agency for the Project and will be responsible for all aspects of its day-to-day management, including its adherence to the present EIA.

Environmental and social governance of the project will be exercised by the MDF through its Environment and Resettlement Safeguards Unit. One environmental specialist is fully involved in the process of preparation, implementation and monitoring of EIA.

The MDF, as a client of construction works, will be responsible for enforcing compliance of contractor with the terms of the contract, including adherence to the EMP. For minor infringements, an incident which causes temporary but reversible damage, the contractor will be given 48 hours to remedy the problem and to restore the environment. If restoration is done satisfactorily during this period, no further actions will be taken. If it is not done during this period, MDF may arrange for another contractor to do the restoration, and deduct the cost from the offending contractor's next payment. For major infringements, causing a long-term or irreversible damage, there will be a financial penalty up to 1% of the contract value in addition to the cost for restoration activities.

Supervision Consultants:

The MDF hired construction supervision consultant SAFEGE SAS, which is responsible to ensure adherence to the World Bank safeguards policies and to provide safeguards monitoring during the construction phase.

In this regard the tasks of the consultant include but not be limited to the following:

- Undertake environmental and social monitoring of works and ensure that performance of contractors is compliant with EMP;
- Monitor implementation of EMP in the course of works at construction site; promptly notify Client on any deviations/violations of EMP requirements, on any complaints from local communities related to ongoing works, and on any unforeseen issues affecting environment

and/or cultural heritage which may emerge in the course of works; recommend remedial and/or corrective measures to Client and following up on their application upon Clinet's approval;
- To provide Monthly Construction Progress Report which includes status of environmental compliance;
- To provide monthly field environmental monitoring reports submitted in the format of filled-out checklists.

MDF will ensure World Bank accessibility to reports provided by the supervisor. The information submitted to the WB will be based on reports provided by the supervisor. However MDF will provide a monitoring and check the information delivered by the supervisor.

Construction Contractor:

Construction Contractor Consortium SADE and VWS Romania is responsible for full adherence to EMP which will be binding for them. Contractor's responsibilities include implementation of the mitigation measures defined by EMP, as well as, adherence to the terms of environmental impact permit.

Operator Company -"United Water Supply Company of Georgia" LLC

WWTP operation will be ensured by regional service center of "United Water Supply Company of Georgia" LLC. Environmental, Resettlement and Permit Department of the central office of "United Water Supply Company of Georgia" LLC will control environmental and social issues. The central office will designate the supervisor, who will monitor:

- The efficiency of WWTP operation and wastewater quality;
- Odor nuisance condition and monitoring results provided in this direction;
- Waste (including excessive sludge) management condition;
- Health and safety measure protection by workers;
- Local grievance address mechanism, etc.

Environmental Management Plan- Construction Phase

Work Type	Place and Time	Possible Negative Impact	Mitigation Measure	Responsible Body	Estimated Cost
Preparation works (vegetation cover removal, mobilization of temporary infrastructure)	Preparation of WWTP site and construction camp area for construction	Cutting down the vegetation, habitat lose/fragmentation	õ Vegetation cover cleaning works should start after agreement with local self-government; õ Extraction of protected species should be provided only after obtaining corresponding permit. Compensation price for Red List Species will be determined on the basis of decree #242 of the Government of Georgia on "Forest Usage Rule", dated as August 20, 2010. It is recommended to replant Red List specie – sweet laurel (*Laurus nobilis)* (VU) outside the project impact zone, to the similar habitat (to the north periphery of the project area) ; õ To prevent vegetation from additional damage construction site borders should be strictly define and control on border adherence should be established; õ Prior to starting the works instruct personnel on vegetation cover protection; õ Preparation of recultivation and landscaping project;	Civil contractor	Not related to the significant expenses; Must be included into the total cost of the project.
		Surface and ground water contamination risks	õ Machinery and potentially pollutant materials will be arranged in not less than 50 m from surface water body; õ Arrange sewage pits for industrial-fecal wastewater collection; õ Arrange drainage / diversion channels along the areas, potentially polluting the storm waters; õ Roof the areas, potentially polluting the storm waters, as possible (to arrange building like a shed);		Must be included into the total cost of the project.
		Negative visual-landscape alteration	• Storage of materials and waste in places invisible for visual receptors, as possible; • Color and design of temporary facilities must be suitable to the environment;		

Earth works	Excavations on WWTP and pumping station sites	Noise propagation, dust and combustion product emissions	• Ensure proper working conditions of machinery; • To turn off the engines or work at minimum turn, when they are not in use; õ Warn population about provision of noisy works and deliver explanations; õ Reduce noise on the production point (noise suppressing hood) and limit propagation using artificial screening; õ Instruct personnel; õ Identify/register complaints and response properly.	Civil contractor	Must be included into the total cost of the project.
		Topsoil loss and WWTP site degradation	õ Remove topsoil and separate the subsoil layer from other materials and stockpile: õ In order to prevent topsoil damage, the height of the dumps should not exceed 2 m, and tilt - 45^{o}; õ Water discharge canals should be arranged within the dump area and it should be protected from wind dispersal.		
		Erosion and deterioration of esthetic view of the site	õ For earth works the area as small as possible should be fenced; õ Place topsoil and subsoil separately. The height of subsoil should not be more than 6 m and the tilt – 45^{0}; õ Store topsoil and subsoil far from surface water bodies; õ Provide immediate backfilling, reinforcing, sealing and leveling all surfaces and slopes; if necessary to use equipment for slope stabilization; õ Recover the site by scattering the topsoil and provide suitable condition for vegetation cover recovery;		
		Surface water, ground water contamination risks.	õ Ensure proper working of machinery; õ In case of fuel/lubricant spillage, localize/clean spilled products in the shortest period of time; õ Those devices, which bear risk of ground water contamination while working, should be equipped with drip collector means.		

		Animal damage/injury	õ Construction site should be strictly protected; õ Fence holes, trenches, etc. at night with some barrier to prevent fall of animals into them; õ Earth works should be provided in the shortest time.		
		Finding archeological sites	õ Stop immediately all works and inform technical supervisor or client; õ Resume works only after receiving official instruction from technical supervisor or the client.	Civil contractor	Preliminary estimation is not possible. It will be covered from state budget.
Transport operations	Road corridors used during transportation of necessary material, temporary structures, workforce and waste	Noise propagation, dust and combustion product emissions	õ Ensure maintenance of transport means; õ Ensure optimal speed of the vehicle (esp. during movement on the ground road); õ Limit usage of the roads passing through settlements, define/use alternative routes. õ Water working roads during dry weather conditions; õ To cover vehicle engine properly during transportation of easily dust-forming materials; õ Inform local population on intensive transport movement.	Civil contractor	Must be included into the total cost of the project.
		Damage to local road surface	õ Restore all damaged sections of the road to become accessible for population;		
		Heavy traffic flow and limit of local population movement	õ Choose optimal - bypass route for the access road to construction site; õ Maximum restriction of movement of caterpillar machine on the public roads, as possible; õ Notify population about intensive transport operation time-frame;		
		Local population and workers safety risks	õ Ensure maintenance of machinery; õ Keep optimal speed of the traffic; õ Limit usage of the roads passing through settlements; õ The movement of heavy equipment should be controlled by standard bearer; õ Provide corresponding training of personnel.		
Construction of WWTP	WWTP and pumping station site	Noise propagation, dust and combustion product	õ Ensure maintenance of machinery; • To turn off the engines or work at minimum turn,	Civil contractor	Must be included into the total cost

infrastructural facilities		emissions	when they are not in use; õ Provide information and explanations for local population; õ Reduce noise on the production point (noise suppressing hood) and limit propagation using artificial screening; õ Instruct personnel; õ Identify/record claims and response properly.		of the project.
		Surface water, ground water contamination risks.	õ Proper waste management; õ Cleaning of industrial-fecal wastewater collector pits; õ Washing machinery in the riverbeds is not allowed (use private auto-washing services);		
		Disturbance and migration of local fauna	õ Minimize direct light usage to reduce light spreading; õ Provide implementation of works that cause animal disturbance, in the shortest period of time. õ Proper waste management, provide noise and harmful substance emission mitigation measures .		
		Local population and workers safety risks	õ Ensure proper maintenance of machinery; õ Fence work area and arrange warning, indicating signs along its perimeter; õ Ensure protection of work area perimeter; õ Personnel insurance with ropes and special fasteners during the work on height; õ Use private protection equipment by personnel; õ Electrical protection; õ Keep accident record register; õ Prepare detail emergency response plan.		
Waste management	Waste temporary storage areas, transport corridors and final disposal areas	Unorganized scattering of waste, pollution of receptors (soil, aquatic environment)	õ Prepare detailed waste management plan; õ Cleaning the area and proper management of waste , produced after demolition; õ Deliver construction material in necessary amount for the project; õ Recycling of wastes if possible; õ Arrange special storage area on the construction camp territory for temporary storage of hazardous waste, and arrange labeled, sealed containers on construction	Civil contractor	Must be included into the total cost of the project.

			camps; õ Removal of the hazardous waste from the construction camps for the further management to be done by the contractor having an appropriate permission on these activities. õ Establish corresponding record mechanism and keep corresponding register for waste generation, temporary storage and further management processes; õ Appropriately trained staff to be provided for the waste management; õ Instruct personnel.		

Environmental Management Plan – Operation Phase

Work Type	Place and Time	Possible Negative Impact	Mitigation Measure	Responsible Body	Estimated Cost
WWTP operation	WWTP area, adjacent sites	Odor nuisance in ambient air	• Plant/grow of coniferous plants on the perimeter of treatment plant site (esp. on the North perimeter); õ Arrange floating aerators on the surface of anaerobic tanks (on the basis of monitoring results); õ Strict adherence of technological scheme for excess sludge extraction, temporary disposal and removal to the permanent disposal site; õ Using vehicles with covered top for excess sludge transportation.	UWSCG LLC	Must be included into the operational costs of WWTP.
		Surface water pollution risks	õ Consider maximum permissible concentrations (MPC) of pollutants, discharged with wastewater; õ Regular supervision on observation of rules related to the fuel/oil storage and usage; õ In case of fuel/oil spill, localization of the spilled product and take preventive measures to avoid surface water pollution; õ Inform The Ministry of Environmental Protection and Natural Resources of Georgia about the amount and consistence of wastewater;	UNWSCG	Must be included in WWTP OPEX

			õ Instruct personnel on environmental issues.		
		Ground and ground water pollution risks	õ Provide corresponding technical means and inventory (containers, spill collector chambers and so on) for the facility. õ In case of pollution with fuel and oil spill , removal of polluted layer of the soil and carry out remedial measures;		
Waste (including excessive sludge) treatment during WWTP operation process	Waste temporary storage sites, transport corridors and final disposal areas.	Unorganized scattering of wastes, pollution of environmental receptors (soil, aquatic environment)	õ Arrange appropriate site for temporary storage of the sludge, extracted from WWTP facilities; õ Dewatered excessive sludge should be transported by special vehicles with covered top; õ Dewatere sludge should be disposed on landfill near Dapnari village with consideration corresponding rules; õ Disposal of dewatered sludge extracted from WWTP on Tskaltubo landfill; õ Arrangement of appropriate storage infrastructure for temporary storage of hazardous waste on plant site; õ Place appropriate container for household waste; õ Appropriately trained staff to be provided for the waste management, which will be periodically trained and tested; • Instruct personnel; • Removal of the hazardous waste for the further management to be done by the contractor having an appropriate permission on these activities. õ Keep appropriate register for waste management.	UNWSCG	Must be included in WWTP OPEX
		Impact on traffic flows	õ It is recommended to use landfill near Dapnari village for permanent disposal of dewatered sludge; õ Excess sludge transportation should be carried out not during peak working hours in order to avoid overloading of traffic flows.	UNWSCG	Must be included in WWTP OPEX
Labor protection and ensure human safety	WWTP area	Human (working personnel, local residents) health and safety risks	õ Train personnel on health and labor protection issues; õ Provide staff with personal protective equipment; õ Fencing work areas dangerous for health; õ Provide medical kits on the plant;	UNWSCG	Must be included in WWTP OPEX

			õ Ensure proper working of machinery; õ Control getting and moving of strangers at the workplace without special permit or without special protective equipment; õ Keep register for accidents and incidents.		

Environmental Management Plan – Termination Phase

Work Type	Place and Time	Possible Negative Impact	Mitigation Measure	Responsible Body	Estimated Cost
Short-term termination or repairing of WWTP	WWTP area	Surface water pollution with untreated wastewater	õ Prepare executive plan related to the temporary termination or repairing of WWTP; õ Reach an agreement with local self-government and with any interested legal person; õ Find alternative ways for wastewater discharge;	UNWSCG	Must be included in WWTP OPEX
Long-term termination of WWTP operation or conservation	WWTP area	Surface water pollution with untreated wastewater	õ Develop a plan for long-term termination or conservation of the treatment plant operation; õ Reach an agreement with local self-government and with any interested legal person; õ Find alternative ways for wastewater discharge;	UNWSCG	Mobilization of additional financial resources from central or local budget

		Pollution of Environment with wastes	õ Conduct internal audit of the area; õ Define qualitative and quantitative condition of existing waste; õ Waste removal and final disposal according corresponding rules;		
		Risks related to the safety issues	õ Reveal emergency risks and solve the problem; õ Provide outer perimeter with warning and prohibiting marks.		
WWTP liquidation	In case of making decision on WWTP liquidation, special project should be developed. The project will consider rules and sequence of technological process liquidation, demolition of buildings and structures, rules and conditions of demolition works, security and environmental protection measures, hazardous waste neutralization and disposal norms and conditions, etc. The project should be agreed with all stakeholders.				

11 Environmental Monitoring Plan

Organization of environmental monitoring within the implementation of WWTP construction and operation project considers resolution of following objectives:

- Confirmation of active environmental requirement performance during construction and operation processes;
- Ensuring controllability of risks and environmental impacts;
- Provision stakeholders with relevant environmental information;
- Confirmation of mitigation measure performance, determination of their efficiency and their adjustment whenever necessary;
- Permanent environmental control throughout the project implementation period (construction works and operation).

Environmental monitoring will be an integral part of MDF's supervisory work in the course of the project implementation. The MDF will be responsible to ensure that on-site managers of works contractors are familiar with EMPs and instruct workers/personnel on the compliance with these EMPs. The MDF will demand from works contractors timely submission of environmental permits for the operation of asphalt/concrete plants (if any); licenses for the extraction of rock, gravel, and send (if operating quarries); and written agreements with local authorities on the disposal of waste. The MDF will conduct regular on-site monitoring of civil works to verify contractors' adherence to the requirements set out in EMPs, to identify any outstanding environmental issues or risks, and to ensure proper application of the prescribed remedial actions. In case of recorded incompliance with EMPs, MDF will instruct contractors on the corrective measures and closely monitor their further progress.

In the operation phase, environmental monitoring will be implemented by United Water Supply Company of Georgia LLC.

Environmental Monitoring Plan

What? (is the parameter to be monitored?)	**Where?** (is the parameter to be monitored?)	**How?** (will the parameter be monitored?)	**When?** (Define frequency and duration)	**Who?** (is responsible for monitoring?)
Construction Phase				
Air (dust and emissions)	õ Construction sites; õ Access road to the construction site; õ The nearest receptor (residential zones)	Visual observation; õ Significant dust distribution is not identified; õ Machinery/equipment are properly maintained and there is no significant exhaustion; õ Instrumental measurement.	õ Check dust spreading during intensive work and traffic movement, especially in dry weathers; õ Check technical functionality at the beginning of the working day; õ Instrumental measurements in case of grievances;	Through MDF technical supervisor
Noise propagation	õ Construction sites; õ Access road to the construction site; õ The nearest receptor (residential zones)	õ Control over technical functionality of the machinery/equipment õ Instrumental measurement	õ Check technical functionality at the beginning of the working day; õ Instrumental measurements in case of grievances;	Through MDF technical supervisor
Soil-ground quality	õ Construction area; õ Material and waste storage area; õ Access road corridor.	Visual observation: õ Significant facts of oil spillage are not identified; Laboratory control	õ Visual observation – at the end of the working day; õ Laboratory investigation – in case of salvo spillage of oil.	õ Visual observation - Through MDF technical supervisor õ Laboratory control – with the help of contractor
Temporary storage of removed ground and topsoil	õ Construction area;	Visual observation: õ Subsoil and topsoil piling in separate places; õ Topsoil dump height does not exceed 2 m; õ The tilt of the dumps is up to 45°; õ Soil piles are far from surface water bodies; õ Temporary storage of soils is provided in places preliminary agreed with local government and technical supervisor;	Shortly after completion of earth works.	Through MDF technical supervisor

	õ Civil contractor office	Check documented agreement on temporary disposal of soil.		
Industrial-fecal wastewater management	õ Construction camp; õ Construction area; õ Civil contractor office	Visual observation: õ Collection of industrial-fecal wastewater in sewage pits; õ Untreated wastewater is not discharged into the river; Check documented information about treatment of sewage pits.	õ Visual observation – during each working day; õ Check documentation- once a month.	Through MDF technical supervisor
Solid waste management	õ Construction area; õ Waste temporary storage area; õ Civil contractor office	Visual observation: õ Labeled areas for temporary waste disposal are allocated on construction site; õ The place for hazardous waste storage is protected from foreigners and weather influence; õ Labeled containers for household waste collection are arranged in designated places of the area; õ The sanitary condition of the territory is satisfactory- waste scattering is not identified; õ Waste is not kept for long on the site; Check waste record register; Check documented agreement on waste removal;	õ Visual observation – during each working day; õ Check documentation- once a month.	Through MDF technical supervisor
Lubricants and oil product handling	õ Construction area; õ Storage sites.	Visual observation: õ Labeled places are designated for storage of lubricants, oil products and other liquid substances ;	õ Visual observation – at the end of each working day;	Through MDF technical supervisor
Condition of vegetation cover	õ Construction area perimeter; õ Civil contractor office	Visual observation: õ Borders of work area are protected; õ Vegetation cover is not additionally damaged or there is not illegal wood-cutting identified;	õ Visual observation – during cleaning process of vegetation cover; õ Check documentation – prior to cleaning works of vegetation cover;	Through MDF technical supervisor

		õ Check documented agreement on cleaning of vegetation cover;		
Technical condition of access road, possibility for free movement.	õ Access road corridors;	Visual observation : õ Providing transportation movement with preliminary determined routes, bypassing the settlements, as possible. õ Traffic roads are in satisfactory condition õ Free movement is not limited; õ Traffic speed is under control;	õ While providing intensive transport operations.	Through MDF technical supervisor
Labor safety	õ Work implementation area	Visual observation õ The area is fenced and protected from getting outsiders to the territory without permit; õ Personnel is provided with personal protective equipment; õ Maintenance of used machinery is in satisfactory condition; õ Electric and firefighting safety is protected; õ Warning, prohibiting and indicating signs are provided on corresponding places of the site; õ The banner indicating primary safety rules is arranged on the site; õ Special place for smoking is provided; Unplanned control (inspection): õ Working personnel follow safety rules, use personal protective equipment.	õ Visual observation – before starting each working day; õ Inspection- periodically.	Through MDF technical supervisor
Operation phase				
Odor nuisance	õ Plant site; õ The nearest receptor (residential zones)	õ Control of technical functionality of WWTP machinery; õ Personnel/population survey; õ Instrumental measurement (use stationary tools for odor measuring and field lactometer).	Control of technical functionality - periodically; Personnel/population survey - periodically; Instrumental measurement - periodically, especially in dry and windy weather, as well as in case of grievances.	By UNWSCG through designated technical supervisor

Tskaltubostskali River water quality	In 200 m downstream from wastewater discharge	õ Laboratory test of river water on the following perimeters:	Quarterly	UNWSCG, with the help of accredited laboratory if necessary
		õ PH		
		o Suspended solids;		
		o BOD;		
		o COD;		
		o Total nitrogen;		
		o Total Phosphorus;		
		o Lactose positive intestinal rods		
Quality of wastewater	õ Prior to wastewater discharge into Tskaltubostskali river	õ Effluent laboratory test:		UNWSCG, with the help of accredited laboratory if necessary
		o Suspended solids;	daily	
		o BOD;	daily	
		o PH	daily	
		o COD;	daily	
		o Total nitrogen;	Once a month	
		o Total Phosphorus;	Once a month	
		o Lactose positive intestinal rods	Quarterly	
Excess sludge handling	WWTP area, dewatered sludge temporary storage area.	Visual observation: õ Dewatering of excess sludge; õ Places with corresponding areas are used for temporary disposal of excess sludge; õ Excess sludge is not kept for a long; õ Water generated on the sludge beds are connected to the wastewater treatment system; õ Sludge bed perimeter is provided with properly maintained storm water drainage system õ Removal of dewatered excess sludge and checking of documented agreement on final disposal.	Periodically	By UNWSCG through designated technical supervisor
Other waste handling	õ WWTP area; õ Waste disposal areas.	Visual observation: õ Area for temporary storage of waste are allocated on the site, which is labeled appropriately; õ Hazardous waste storage areas are protected from outsiders infringement and weather	Periodically	By UNWSCG through designated technical supervisor

		influence; õ Labeled containers for collection of household waste are placed in corresponding places of the site; õ The sanitary condition of the site is satisfactory and waste scattering is not identified; õ Waste is not kept for long on the site;		
Labor safety	õ WWTP area	Visual observation: õ The area is fenced and protected from getting outsiders to the territory without permit; õ Personnel is provided with personal protective equipment; õ Maintenance of used machinery is in satisfactory condition; õ Electric and firefighting safety is protected; õ Warning, prohibiting and indicating signs are provided on corresponding places of the site; õ Special place for smoking is provided; Unplanned control (inspection): Working personnel follow safety rules, use personal protective equipment.	Periodically	By UNWSCG through designated technical supervisor
Phasing-out				
Executive plan on temporary or long-term termination of WWTP operation	Office of operator company or/and building of local self-government	The content of the plan is in compliance with national legislation and international requirements. The plan includes: õ The sequence of termination of WWTP operation; õ Alternatives for wastewater sewerage and treatment; õ Management conditions for generated waste; õ Safety issues.	After making decision on termination of WWTP operation .	Local government; Ministry of Environment Protection and Natural Resources of Georgia and other stakeholders.
Planned works during termination of WWTP operation is the same as on construction phase. Accordingly, in case of making decision on termination of operation, mitigation measures developed for construction phase should be considered. Regulatory body for mitigation measure performance can be local self-government and the Ministry of				

Environmental Protection and Natural Resources of Georgia.

12 Stakeholder Engagement and Grievance Redress Mechanisms

Consultation with stakeholders and grievance redress mechanism will be carried out considering World Bank policy, requirements of national legislation and international practice.

Consultation with Stakeholders

In the preparation process of conceptual design of Tskaltubo WWTP local self-government (Tskaltubo municipality) was engaged. Consultations were held between MDF, UWSCG and local government on selection of alternative territory for WWTP. Based on consultations it was decided to choose ld treatment plant location as the most acceptable alternative, as the mentioned land is adapted and similar facility had been operated there for years.

The information about public hearing of EIA will published in central press (Newspaper ``Sakartvelos Respublica``, July 22, 2017) as well as in local press (Newspaper ``Akhali Tskaltubo``, August 3, 2017), where the time and place of holding public hearing is indicated: At 12:00 p.m. of September 12th of 2017 at the Meeting Hall of Tskaltubo Municipality Administration Building (Address: #25, Rustaveli street, Tskaltubo) AND At 16:00 p.m. of September 12st of 2017 at Adminsitration Building of Gvishtibi Village in Tskaltubo Municipality. The statement containing similar information have been posted in the building of Tskaltubo municipality.

In published statement contained information about ways how stakeholder can have an access to EIA report, namely:

- Printed and electronic version of non-technical summary of EIA report will be accessible on the following address:
  - Tskaltubo Municipality building- address: Rustaveli str. №25, Tskaltubo;
  - Gamma Consulting LTD office, Guramishvili ave №17a, Tbilisi. Tel: 2 60 15 27;
  - The office of Municipal Development Fund of Georgia- address: III floor, D. Aghmashenebeli ave. №150, Tel: 2 43 70 01; 2 43 70 02; 2 43 70 03; 2 43 70 04;
- During public hearing, it is possible to download electronic version of EIA from following web-site:
  - Web-site of Municipal Development Fund of Georgia: www.mdf.org.ge;
  - Web-site of the Ministry of Environment Protection and Natural Resources of Georgia: www.moe.gov.ge ;
  - Web-site of Gamma Consulting LTD: www.gamma.ge .

During public hearing stakeholders should send written notes and comments to the following e-mail:

- Ana Rukhadze (Municipal Development Fund of Georgia). Tel: 593 90 51 58; E-mail: arukhadze@mdf.org.ge
- Giorgi Bzhalava (Gamma Consulting LTD). T: 5 77 64 18 80; 2 60 15 27; E-mail: goga@gamma.ge ;

Any stakeholder is free to attend the session of public hearing. Notes and comments expressed by stakeholders will be formulated on the session of public hearing, that will be reflected in the final report of EIA.

After considering the notes and recommendations expressed by public in the process of public hearing, the final version of EIA will be prepared. The final version of EIA report, with all attached documentations will be submitted to the local government (Tskaltubo municipality) and consultations will be held between the implementing agency and appropriate authorities.

EIA report version for ecological examination will be prepared based on comments and recommendations, entered during public hearing process and will be submitted to permit issuing

administrative body. Permit issuing body will submit EIA report to the Ministry of Environment and Natural Resource Protection of Georgia, which in its turn will issue ecological examination conclusion within 15 working days. Ecological examination conclusion will be the basis for issuing permit for the construction. After obtaining construction permit it will be possible to start WWTP construction.

Terms for construction permit obtainment and EIA process duration are detailed in table 12.1.

Table 12.1. Procedure for Construction Permit Obtainment and EIA Process Terms

№	Procedure/Step	Terms/Duration
1.	After preparation of EIA version for public hearing, MDF will publish announcement in central and local press, where information on date and place for holding public hearing will be provided.	-
2.	EIA documentation, required for public hearing will be submitted to the Ministry of Environment and Natural Resource Protection Of Georgia and Tskaltubo Municipality Administration. Announcement will be placed in the building of Tskaltubo municipality Administration, where date and place for holding public hearing will be provided.	*Within 3 days* after publication of the information on public hearing in central press.
3.	Written comments and recommendations from public representatives will be received and discussed.	*Within 45 days* after publication the of information on public hearing in central press.
4.	Public hearing will be held in administrative building of Tskaltubo Municipality.	*Not earlier than 50 days and not later than 60 days* after publication of the information on public hearing in central press
5.	Minutes will be signed on public hearing results, where comments and recommendations, entered during public hearing will be detailed.	*Within 5 days* from public hearing.
6.	EIA documentation and Minutes of Public Hearing will be submitted to Tskaltubo Municipality Administration.	Based on agreement signed between MDF and Gamma Consulting LTD, final version of EIA report will be prepared within 15 days after public hearing. It will be submitted to municipality *within about 20 days* since public hearing.
7.	Tskaltubo Municipality Administration will submit EIA documentation and Minutes of public hearing to the Ministry of Environment and Natural Resource Protection of Georgia.	According to national legislation requirements – within 1 year from holding public hearing. Based on practical reality documentation will be submitted *within 7 days* since registration of the application.
8.	The Ministry will provide ecological examination for EIA documentation, based on which ecological examination conclusion is prepared.	In case of positive conclusion of ecological examination environmental permit is issued *within 15 working days* since registration of application.
9.	Construction permit is issued by Tskaltubo Municipality Administration on the basis of ecological examination conclusion.	Based on practical reality *within 10 working days* from submission of documentation.

According to Table 12.1., approximate cumulative duration for the issuance of the construction permit for Tskaltubo WWTP project will be 110-120 days from publication of information on public hearing in central press (maximum terms are provided in the table. With effective management cumulative time for obtainment of the construction permit can be reduced with 10-15 days).

Communication Policy with Persons within Impact Zone

Prior to the construction, the banner, presenting information about the current project, as well as the identity contact details of the executor of works and contractor company, will be placed on the perimeter of construction site.

On construction phase, the local population will be informed in advance about any activity, which may restrict the free movement, usage of natural resources and so on. , they will be notified in advance. If necessary, MDF will provide alternative means.

Grievance Redress Mechanism during Construction Works

The MDF has developed a number of methods for filling up complaints/notices:

- The project web-site consists the system of receiving and further processing of grievances;
- The complaint form can be also filled according to the form attached (see the annex 7).

The forms will be uploaded on the website of th project: www.mdf.org.ge and will be available at local administrative offices, as well as at the places where the meeting with stakeholders is planned.

In case of receiving any complaint from public, the later will be processed in several stages. Statements on information/complaints will be considered and, where it is possible, the response will be issued in 5 or 10 working days- depending on the nature of required information/on complexity of the complaint.

All complaints will be recorder in the grievance book, in order to give individual number to each complaint, control and response to each received complaint/ claiming process. The grievance book will be used for analyzing the frequency of complaints, the most frequent problems and trends periodicity. The book contains:

- The date of grievance entry;
- Individual Number;
- Content of grievance;
- Define responsible sides on problem resolution;
- Start and end date of investigation;
- Information about proposed action for problem resolution, that was sent to the applicant (if the applicant is not anonymous) and the date of sending response; The closing date of the complaint;
- Statement on applicant satisfaction, reason of impossibility of problem resolution;
- Measures to be taken for unresolved complaints.

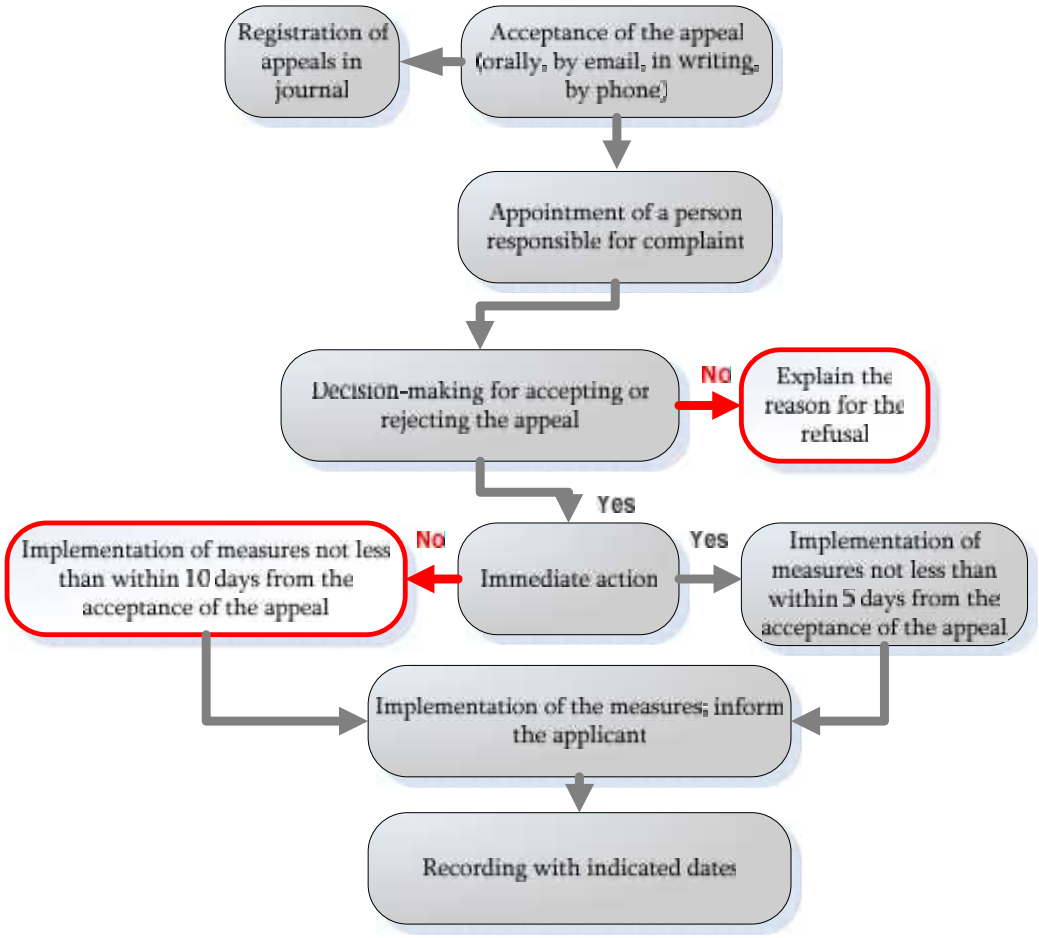
Full documentation of appeals is kept in a folder for 2 years and then it is archived. MDF will monitor the types and level of an appeal. If the appeal cannot be met within the above-mentioned period of time, MDF should inform the applicant about this and the after conducting the investigation, they will discuss and agree on the resolution. MDF is able to conduct follow-up monitoring to check that the problem does not recur.

Management and resolution of any complaint by the MDF will be monitored by the World Bank.

Applicants will be able to keep their privacy. MDF will ensure that their names and contact information will not be published without their consent and this data will be available only for those groups working on the investigation of the complaint.

Figure 11.3.1 Grievance procedure chart is given below

Figure 11.3.1 Appeal procedures



(A complainer will be informed in advance on extension of the complaint review period in case of making decision).

13 Conclusions

The following key conclusions were developed during preparation of the present report on assessment of possible environmental impacts caused by WWTP construction and operation process:

Conclusions:

- According to the proposed effective system of wastewater treatment and in case of its implementation, normalized treatment of sewage wastewater of Tskaltubo town will be provided;
- The project will be implemented in two phases: On phase 1 treatment of wastewater, expected for 2028 is projected, and on phase 2- wastewater, expected for 2038 will be treated, for this reason additional infrastructure will be arranged. The area and configuration of the site allows further expansion;
- In case of implementation of the planned activities, the discharge of untreated wastewaters into the water bodies adjacent to Tskaltubo town (mainly into Tskaltubostskali river) will be reduced to the minimum level, what is essential for improvement of the quality of local water bodies;
- The implementation of Wastewater Treatment Plant project ensures the sustainable development of local infrastructure, which is very important for socio-economic development of the region, for growing the touristic potential of Tskaltubo;
- The selected area for WWTP is exposed to significant anthropogenic load. The remains of old treatment plant in the form of concrete reinforcement structures are presented on the area; the major part is polluted with construction wastes. The existing anti-sanitarian situation threatens the certain environmental receptors (including impact on wild fauna, Tskaltubostskali river water pollution risks, high risks of disease prevalence and hazards to the health of the population);
- In case of project implementation, the area will be cleaned and existing sanitarian-environmental conditions will be significantly improved, what substantially will reduce above-mentioned impact risks;
- The main receptor of possible negative impact caused by the project implementation is the population of Gvishtibi village. The settlement is situated in the distance of 300 m and more from the projected area;
- The certain number of job-places will be created on WWTP construction and operation phases, that is very important in terms of local population employment;
- According to the calculation results carried out during the environmental impact assessment, the impact related to the ambient air quality deterioration during plant construction phase will not be significant. The odor distribution risks are noteworthy during operation phase. Based on calculations, the negative impact risks will not be significant on the nearest settlements, however, the project envisages providing corresponding monitoring activities and implementation of additional mitigation measures, as necessary;
- According to conducted calculations, the impact related to the noise distribution on local population is hardly expected. In case of carrying out corresponding mitigation measures the impact will not be significant;
- If corresponding mitigation measures are carried out and operation conditions are thoroughly considered, the water environment impact risk during project construction and operation phases will not be high. In terms of water environment impact, the operation of WWTP bears positive environmental effect;

- There is no topsoil presence on the large section of the projected area. The soil cover presented here and there is sparse and has no significant value. In case of project implementation the soil and ground impact will not be substantial;
- The engineering-geological survey conducted within the area, shows that hazardous process development risks is minimal within its borders. There is no need in providing significant mitigation measures from this point of view;
- The corresponding hydrological calculations revealed that during the affluence the inundation risks are minimal and the mitigation measures should not be carried out;
- It will be necessary to clean vegetation cover on projected area during construction phase. The specie under special protection (walnut) may be damaged. It is possible to reduce the impact by carrying out relevant mitigation measures and monitoring;
- The selected area is of high anthropogenic load and animal species used to intensive activities of a man are distributed within its borders. In case of project implementation the impact on wildlife will not be high. Risks of direct and indirect impact on Red List species of Georgia are minimal;
- As the protected areas are far from the site, the expected negative impact on them during project implementation is very low;
- The plant construction process will be connected to visual-landscape changes that can be reduced by considering planned mitigation measures. In total the project implementation will bring the positive results in this direction;
- There is no historical-cultural monuments identified within the project area and its environs and accordingly, the negative impact on them is not expected;
- The allocated area for the construction of the plant is non-agricultural land in the state property. Therefore, the project implementation is not connected with individual and economic resettlement;
    - The local natural resources (sand-gravel storage, water resources for potable-industrial and technical purposes, etc.) can be used for plant construction, which is noteworthy in terms of local environmental impact;

Main environmental protection measures to be undertaken during work implementation:

1. The company carrying out the works and the construction contractor will strictly control the thorough implementation of measures defined by mitigation measures and ecological expertise conclusion, given in the environmental impact assessment;
2. The staff employed on construction and further on operation of the plant will be periodically (once in 6 months) trained and tested on environment protection and professional security issues;
3. The staff employed on construction and operation will be provided with individual protective equipment;
4. The recultivation and landscaping works of the construction camp site will be considered in the project documentation;
5. In case of fuel storage reservoir arrangement on the construction camp site, the reservoir should have concrete or clay fencing, the internal capacity of which will be less than 110% of the total reservoir volume. By fencing the reservoir it is possible to prevent oil products prevalence in case of accidental oil spillage;
6. For hazardous waste temporary disposal the corresponding storage facility will be arranged during construction – on the construction camp site, and on operation phase- on the treatment plant site; the hazardous waste storage facility will be arranged considering the following options:
    - Storage will have waterproof floor;
    - Storage ceiling will be painted by the moisture resistant paint;

- Shelves and racks will be arranged inside the storage for waste accommodation;
- The storage will be equipped with the following facilities: indoor and outdoor lighting systems, exhaust ventilation system, wash stand and tap to water and wash the area, water intake trap, fire stand, warning and prohibiting signs.

7. The disposal and management of hazardous waste accumulated during construction and operation process will be provided by the contractors authorized to conduct such activity;
8. The dewatered sludge extracted from the treatment plant will be disposed to the local landfill under relevant agreement;
9. The population and personnel will be time to time interviewed during construction phase on noise distribution issues. When necessary, the noise levels will be measured at sensitive receptors. In case of revealing violations by monitoring, the relevant mitigation measures will be carried out (arrangement of noise protective screens).
10. In order to control treatment system proper maintenance and wastewater treatment efficiency the continuous monitoring will be set. The population and personnel will be periodically interviewed to assess the efficiency of odor distribution preventive measures.
11. To prevent odor distribution, the trees and plants will be planted/grow on the perimeter of the area. Other additional effective mitigation measures are considered;
12. According to monitoring plan, the laboratory examination of the treated water will be carried out periodically.

14 References

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15 Annexes

15.1 Annex 1. Tskaltubo WWTP Project Description

In consideration of the current environmental situation with no wastewater treatment at all in Tskaltubo and stringent financial situation, a two-phase strategy for WWTP is well justified:

- On the first phase, the infrastructure facilities, that provide wastewater treatment in the amount expected for 2028 (PE 18500), will be arranged. The carbon removal will be achieved;
- On the second phase, the infrastructure facilities, that provide wastewater treatment in the amount expected for 2038 (PE 25 500), will be arranged. It is planned to update the treatment plant for total nitrogen removal.

Design Loads and Flows

Initial data (project flows and loads of pollutants), to be considered during designing of the phase-1 (2028) and phase-2 (2038) of the project, are given in the table below.

WWTP design flows and loads for both phases

Parameter	Dimensioning Unit	2028 (I Phase) (Low Season)	2028 (I Phase) (High Season)	2038 (II Phase) (High Season)
Population Equivalent	PE_{60}	12,500	18,500	25.500
Average daily project flow	m^3/d	4,431	6,171	6,477
Biochemical Oxigen Demand (BOD_5) load)	Kg/d	759	1,109	1,542
Suspended Solids	Kg/d	1,034	1,440	1,729
Nitrogen Load	Kg/d	177	247	278
Phosphorus Load	Kg/d	31	45	52

Design Quality of Treated Wastewater

While defining effluent quality parameters at WWTP design stage, the requirements of Georgian environmental standards were considered. However, for practical reasons, the MDF decided to follow the effluent quality recommendations made by the European Union in its Council Directive 91/271/EEC5 on urban wastewater treatment. Based on the requirements of this EU directive, effluent quality must meet the more stringent requirements.

In order to match developments over time in customer affordability of WWTP Operator Company, service center sustainability/ cost recovery as well as WWTP staff technical operational capabilities, a staged WWTP development is foreseen.

In the first Phase (design year 2028) the WWTP will provide carbon removal. In the second Phase (design year 2038), the WWTP will be upgraded to perform nitrogen removal.

The effluent quality requirements for phase 1 and phase 2 are given in the table.

Design Quality requirements for the treated wastewater

Parameter	Concentration
Wastewater Quality - Phase 1- Design year 2028	
Biochemical oxygen demand (BOD_5 at 20 °C) without nitrification	25 mg/l
Chemical oxygen demand (COD)	125 mg/l

SS	35 mg/l
Additional nitrogen removal. Phase 2- Design Year 2038	
Total Nitrogen (TN)	15 mg/l
Total Phosphorus (TP)	2 mg/l

Brief Description of WWTP Operation Process

WWTP process implemented in phase 1 shall be designed to achieve carbon decrease. The WWTP treatment process composed of inlet pumping station, inlet flow measurement, connection pipe to the WWTP, fine screens, sand trap and distribution chamber, anaerobic tanks, trickling filter lift and recirculation pumping station, trickling filters, secondary sedimentation tanks with circular clarifiers, flow measurement of treated water and connection to the general by-pass pipe to discharge into the river.

The technical scheme for WWTP process for Phase 2 considers nitrogen removal from wastewater. Nitrogenous compounds will be removed biologically from wastewater in a two-stage process: nitrification and denitrification.

The future biological process will involve supplementary biological tanks. In order to adapt the actual configuration, the main change will be:

- A supplementary anaerobic pond;
- An activated sludge tank (Sequenced aerated ditches) downstream trickling filters, to treat nitrogen components;
- A blower station to provide process air;
- A supplementary clarifier due to higher sludge concentrations in the biological tanks.

Configuration, Operation and Maintenance of the WWTP

In order to ensure optimal operation of WWTP and its proper maintenance, following issues are considered by the project:

- Division of wastewater treatment lifecycle at least into two independent lines;
- Control, automation and alarm system immediately indicating any default;
- Careful choice of reliable and high-quality equipment and technology;
- Stand-by equipment for entire main equipment

The mechanical and biological treatment, as well as the sludge treatment are designed in a way which ensures partial treatment capacity, at least for a limited period of time in case of failure or maintenance of individual treatment units.

The Phase 1 of the project envisages the installation of the following main infrastructural units and equipment:

- Inlet pumping station (3+1pumps);
- Inlet Flow measurement;
- Connection of main pipeline to the WWTP;
- Mechanical treatment unit (so-called screening system)- 1 Automatic fine screen and one emergency coarse screen channel; Screening conveyor-compactor;
- Grit chamber and distribution chamber;
- Anaerobic tanks – 2 units;
- Trickling filter pumping station – 3 pumps;
- Trickling filter – 2 units;
- Secondary sedimentation tank – 2 units of circular clarifiers;

- Flow measurement of treated water and connection to the general by-pass pipe to discharge into the river;

Sludge handling:

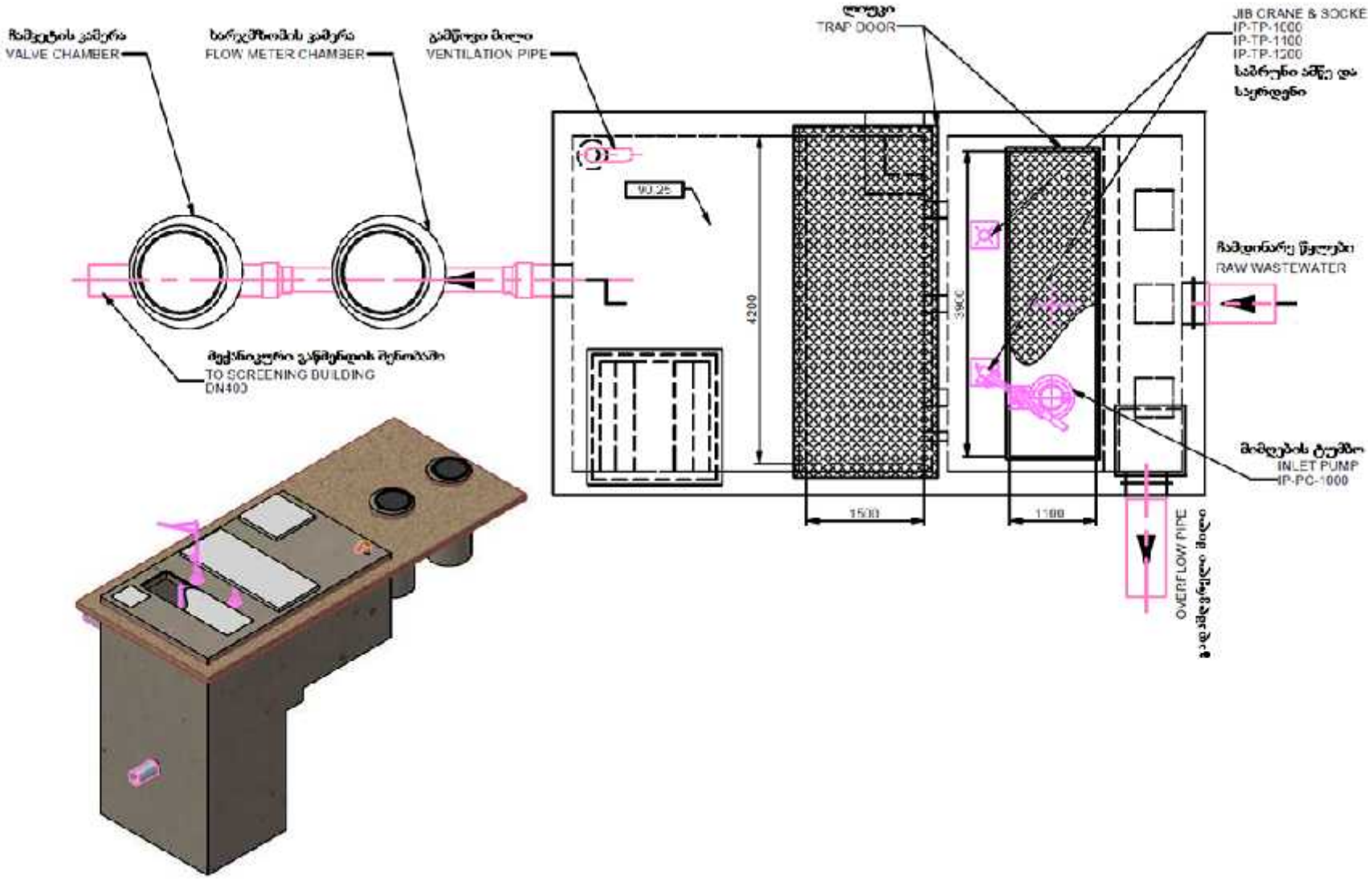
- Sludge drying beds – 5 units.

Auxiliary infrastructure: Technical Water Supply Network; Control Room and Maintenance Station.

Inlet Pumping Station

It is planned to dismantle old pumping station and to arrange the new one instead. Raw wastewater will move to inlet pumping station. It is considered to arrange 4 submerged, centrifugal pumps, calculated for 135 l/s peak flow. Flow meter device will be installed on the pipeline.
Design figure of the pumping station is given below.

Inlet Pumping Station, m 1:50



Wastewater Pre-Treatment (Mechanical Treatment)

For pre-treatment it is planned to arrange fine screens (automatic) and sand trap.

Fine Screens

Raw water will pass through 2 automatically tilted fine screens, with 6 mm hole size. Screens will be placed in separately. Screens will be arranged to avoid congestion in treatment units. Fine screens are designed so that in case of failure of one of them, full stream can be passed through another screen. Screens are fully automated. They will be equipped with lock shields, installed on upper and lower section of the screen. In addition, lock shield is also considered for isolation of one of the channels, in case of maintenance.

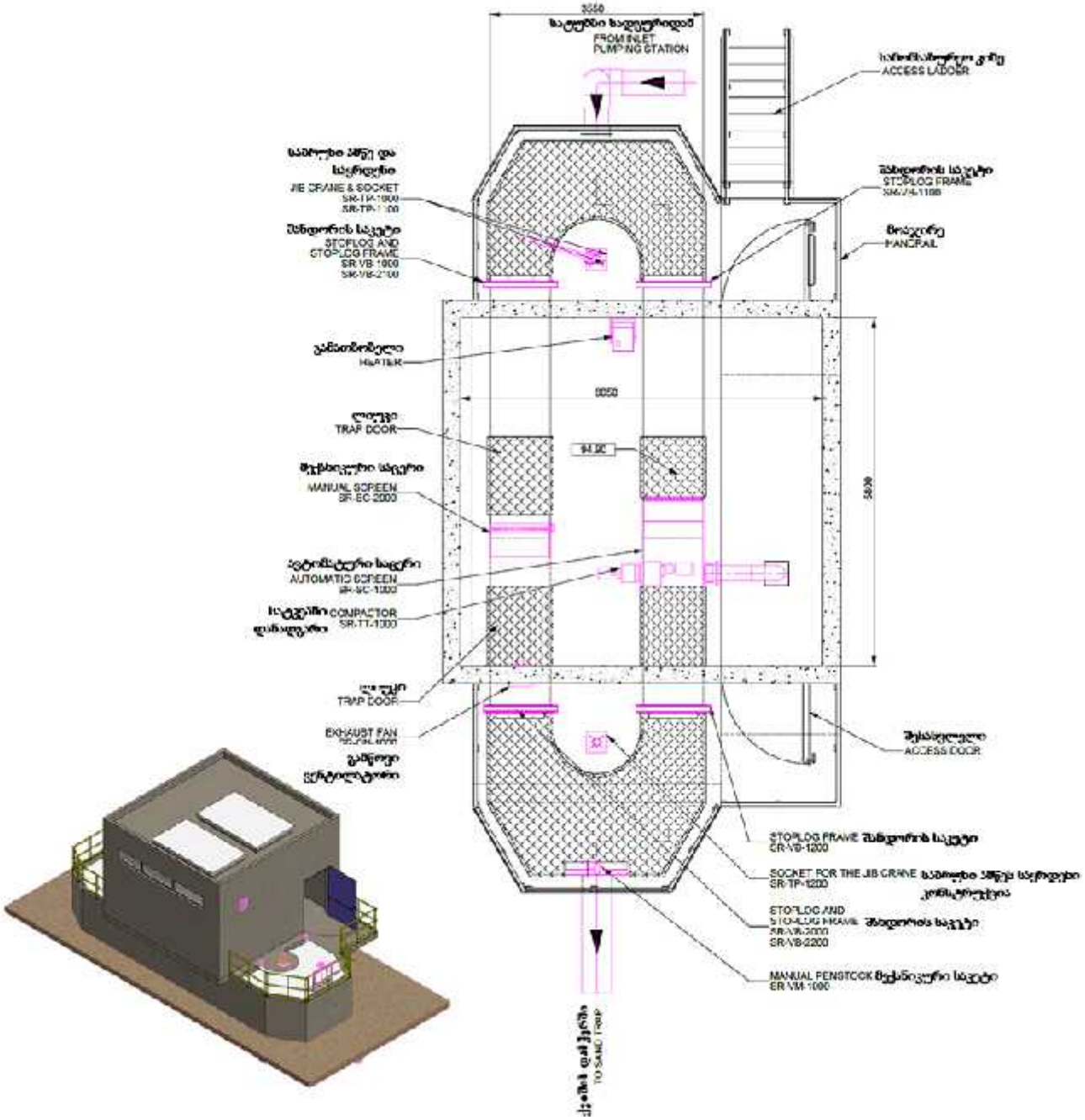
Removed fine particles will be transferred to the compactor, which will be emptied in container.

Grit Chamber

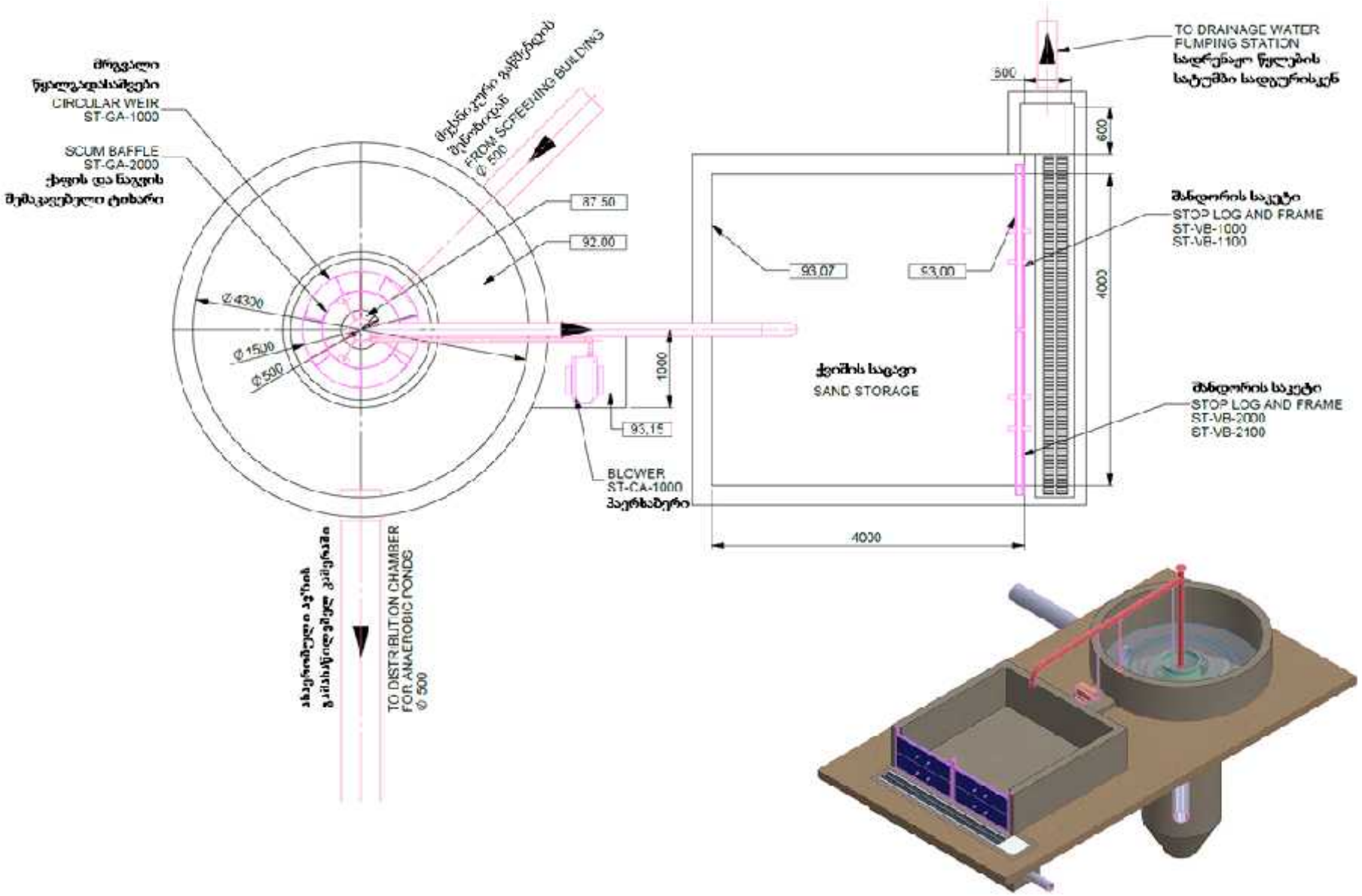
Access accumulation of grit in the water can cause wearing of mechanisms. On following stages of the technological scheme, in order to protect installed machinery, the project considers arrangement of the grit chamber. Wastewater will be discharged into channel through this grit chamber with relatively low speed so that heavy inorganic grit will be silted on the bottom, from where it can be removed. Grit chamber is equipped with circular sand trap and cesspool. Grit, silted on the bottom of the cesspool, is transferred to the grit disposal site through air pump.

See the plan of mechanical treatment building below.

Mechanical Treatment Building, m 1:50



Sand Trap, m 1:50



Biological Treatment

Anaerobic Tanks

The anaerobic tanks provide primary wastewater treatment by anaerobic degradation of dissolved organic compounds, sedimentation of settable solids and subsequent anaerobic digestion. The pond serves both as sludge storage tank and also as balancing tank for the hydraulic peaks. As there is recirculation from secondary settlers, both primary sludge and secondary sludge are mixed in the ponds. It allows a good stabilization of organic matters. A soft mixing in small surface layer is required to avoid odour productionIt

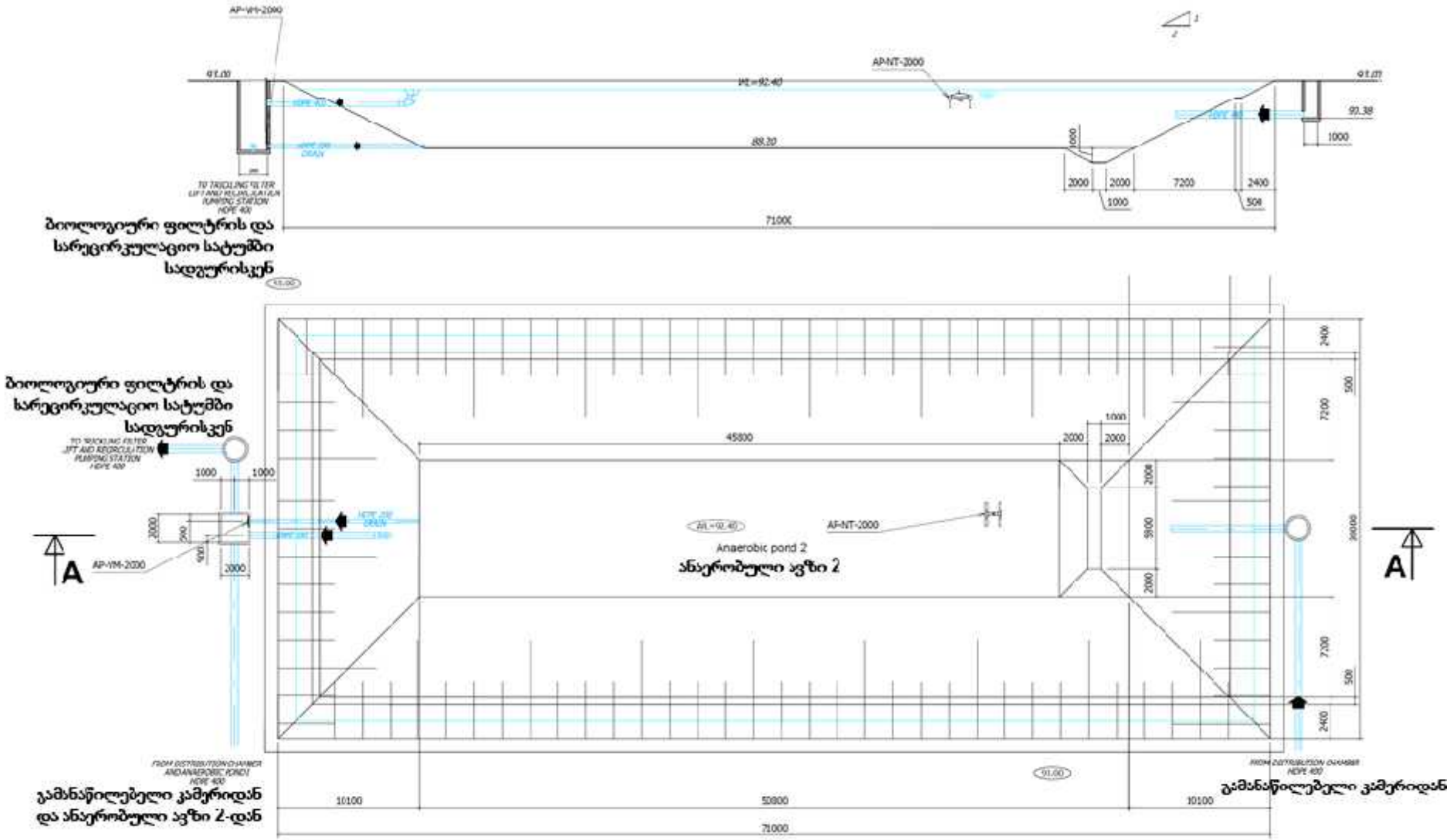
The sludge will be withdrawn from tanks by means of a floating suction device, pumping the sludge directly to the sludge drying beds. The anaerobic ponds will be equipped with a ramp which enables more suitable operation of the floatable sludge removal device.

Sludge withdrawal device has following main equipment:

- 2 small deep mixer;
- 2 isolation penstocks in the outlet chamber of each pond;
- 1 sludge removal device, including dredging pump.

Plan and section of anaerobic pond is given in figure below:

Plan and Section of Anaerobic Pond. m 1:200



Trickling Filter

The biological treatment is defined as a low-load trickling filter. The purpose of this treatment is to allow sewage water to be in contact with biological population. Organic matters degradation occurs when biological population is growing.

Pre-settled wastewater is continuously 'trickled' or sprayed over the filter. As the water migrates through the filter surface, soluble organics are aerobically degraded by the microorganisms, growing on the filter material. Once the soluble organic material concentration falls below a threshold value, also nitrification takes place. The microorganisms are steadily replicating.

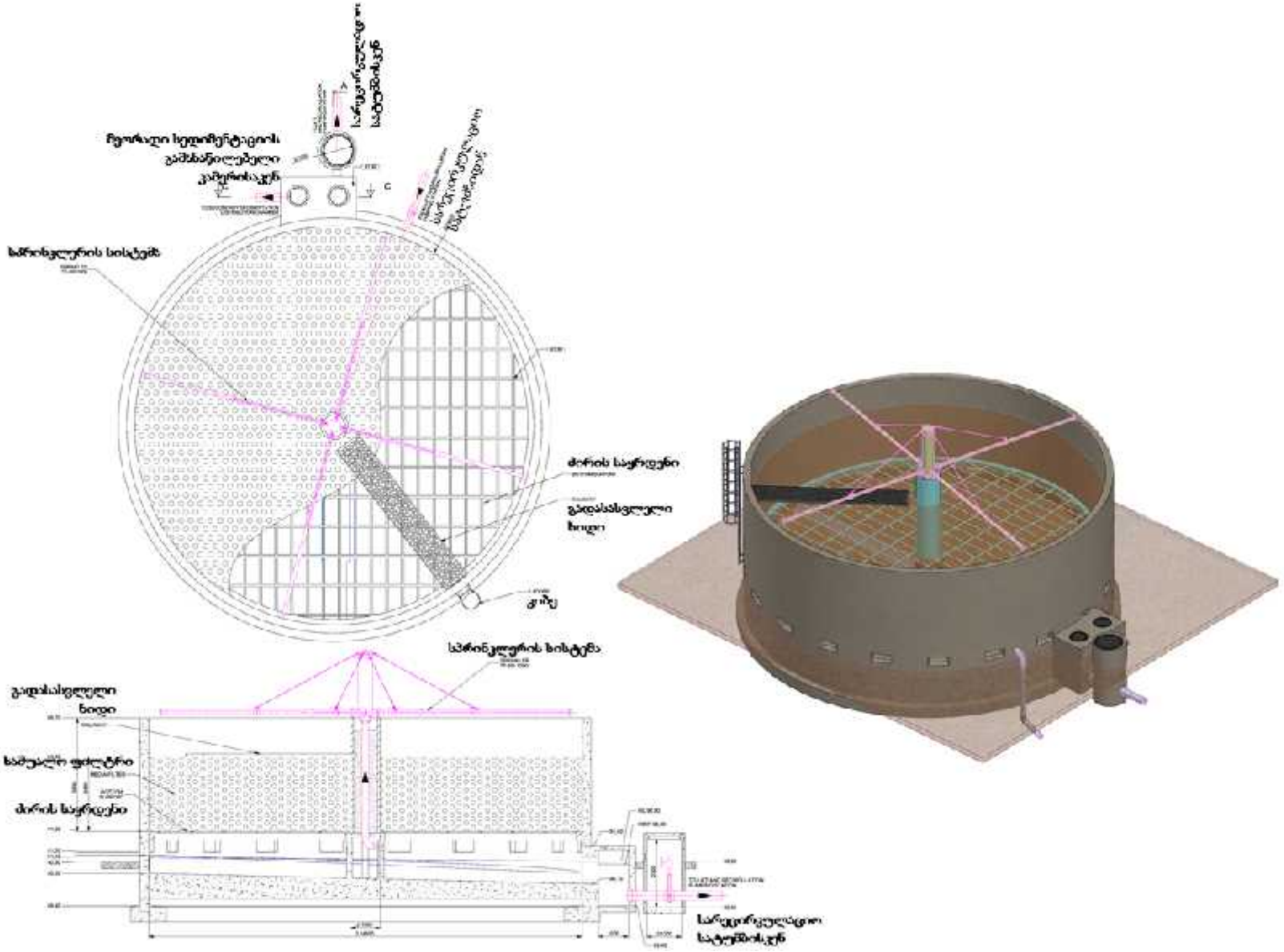
Trickling filter generally operates in aerobic conditions. Raw water goes down through perforated floor and then is led on the bottom slope to drainage ring-channel, then goes out to secondary settler. To allow recirculation of organic matters and treated water, a valve is installed on this pipe and when it is shut water overflows to recirculation pit.

Trickling filter system is designed for the average daily flow, as anaerobic ponds balance the variation of the daily flow Trickling filter system capacity is composed of 2 filters (for a total population of 18 500 PE). Total flow of the installation is divided by 2 and by the way 40 l/s feed each filter.

The trickling filter pumping station is equipped with pumps to feed distribution arms. As to avoid flooding the plant if pumps stop, this station is in hydraulic balance with ponds outlets and has an overflow connection to discharge pretreated water to the river.

Plan and section of the trickling filter is given in figure:

Trickling Filter, m 1:50



Distribution Chamber to Secondary Settlers

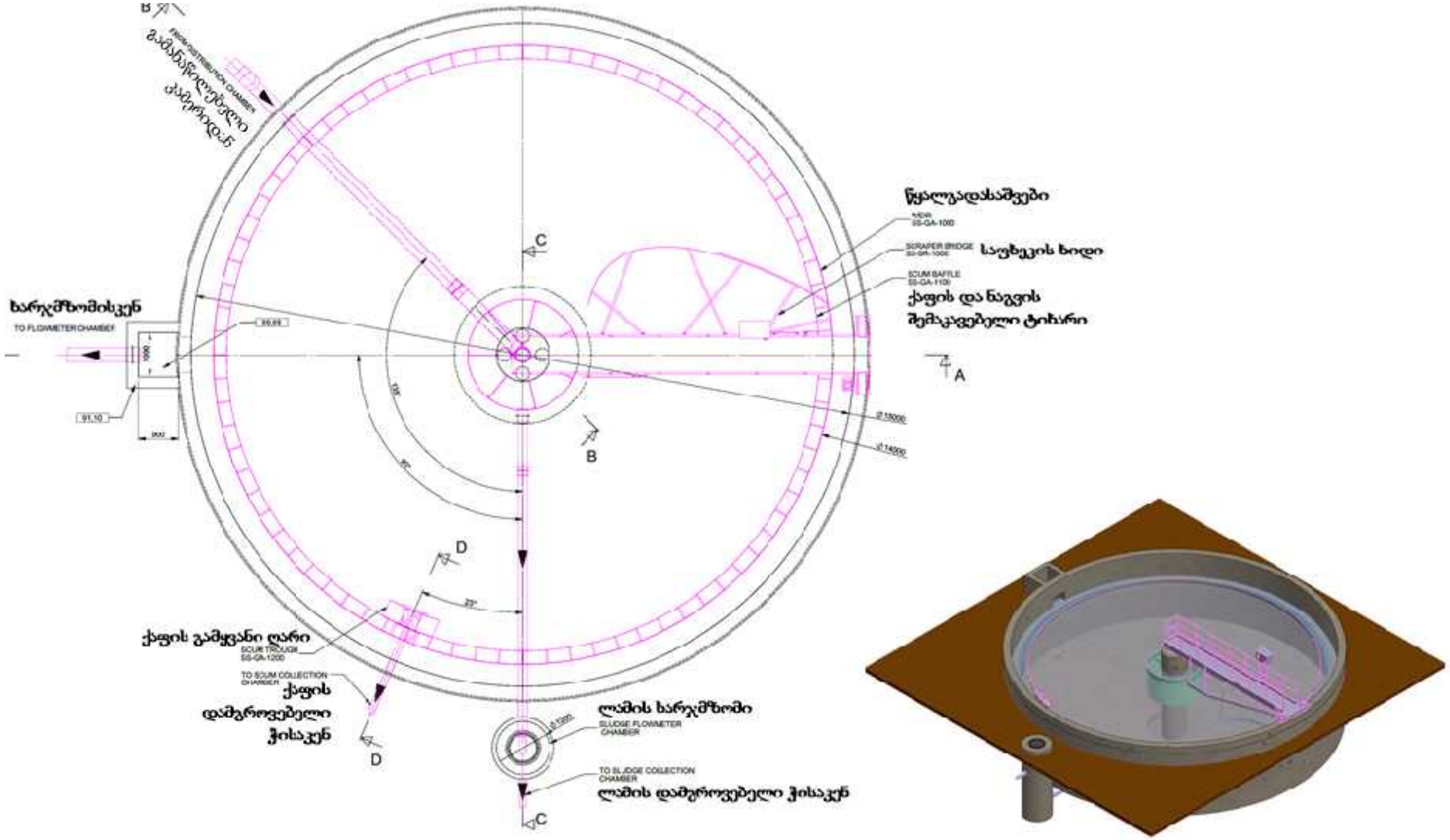
After passing through the trickling filter the water enters the secondary settling step. A distribution chamber will be provided to split the flow into two equal parts. Each treatment line will be equipped with manual stop logs.

Secondary Sedimentation Tanks

The outflow of the trickling filters contains biofilm fragments that have been sloughed off from the trickling filter media. The secondary sedimentation tank separates the sludge particles from the clear effluent. Flow enters through the central diffuser drum and is forced downward, ensuring a proper settling time in the clarifier to allow for the settling of the solids. The water then rises and exits through a wall mounted weir placed on the inner circumference of the clarifier. A surface skimmer sweeps over the surface of the clarifier to collect the floatable solids and removes them via the scum trough. The collected scum will be intermittently pumped to the sludge drying beds. Solids which settle to the bottom of the clarifier are scraped by a bottom scraper toward a central sump. The sludge will be transferred from the collection chamber of clarifier toward the distribution chamber upstream of the anaerobic ponds.

The plan and section of secondary settler is given in figure:

Secondary Settler, m 1:50



Effluent Measuring & Service Water Pumping Station

A final flowmeter will be installed on the outlet pipe. An automatic sampler for effluent quality will be provided. Near the flowmeter structure, a service water pumping station is provided in order to supply water for general washing of equipment.

Sludge Treatment/Drying

The main purpose of the sludge treatment on site is to reduce and concentrate the resulting sludge from the water treatment line and to stabilize it in anaerobic ponds. Sludge dewatering using sludge drying beds will be provided.

Sludge drying beds are equipped with two intake pipes, which are connected to the sludge piping system, which is directly fed by the float-mounted sludge suction device.

For optimal drying a maximum height of 200mm of sludge will be stored at a time and one month minimum delay is required before a new feeding. After a maximum storage of 600mm of sludge, dewatered sludge will be removed. Drained water and liquors from the Sludge Drying Beds will be collected and directed to the distribution chamber.

Sludge Treatment after Dewatering

Considering the fact that there are not any important industrial enterprises in Tskaltubo, the wastewater and sludge contamination risk with toxic metals will be insignificant and accordingly, it will be possible to dispose the sludge to the landfill for domestic waste. For this purpose, it is assumed to use the nearest landfill at Dapnari village. The sludge transportation to the landfill will be provided by means of special transport.

Besides, the alternative method for sludge extraction from WWTP is discussed for future perspective, namely: As it is known, after corresponding processing (composting) the sludge can be reused as the fertilizer on agricultural lands. In case of interest, the sludge stored on the temporary storage areas can be handed to the interested people after corresponding processing, free of charge. In such case, the pH characteristics and heavy metal concentration of the ground should be defined in order to reach the optimum level of dosing.

The important fact is that the Georgian legislation does not regulate the sludge usage issue for agricultural purposes. In order to regulate this field, the European legislation can be used, according to which it is forbidden to use the sludge:

- On lands, which are used for grazing or if 3 weeks are left before forage crop harvest;
- Vegetable cultivation plots during crop vegetation period;
- On plots, where cultivation of vegetables or fruits is planned, that are in constant contact with the soil or that are used for food in raw form, 10 months before harvest time and during the harvest period.

In case of using the sludge as a fertilizer, it is necessary to provide sludge sampling as well as the plot soil sampling and periodic laboratory tests should be implemented, where the sludge will be examined.

Considering the fact, that the demand on using the sludge as a fertilizer will be seasonal (in spring and autumn), the sludge management method, which accumulated during plant operation, will be its disposal to the landfill.

Biological Treatment Considered for the Phase 2 (2038)

The Phase 2 involves nitrogen removal using biological method: nitrification and denitrification. Phosphorus removal will be provided by chemical precipitation.

Phase 2 biological process will involve supplementary biological tanks.

There are following main changes to be adopted on Phase 2:

- Supplementary anaerobic ponds;
- An activated sludge tank downstream trickling filters, to treat nitrogen components;
- A blower station to provide process air;
- A supplementary clarifier due to higher sludge concentrations in the biological tanks.

Nitrogen Removal

Nitrogenous compounds will be removed biologically from wastewater in a two-stage process: nitrification and denitrification.

Nitrification, which is often the more delicate process in biological nitrogen removal, requires suitable environmental conditions, e.g. suitable dissolved oxygen and ammonia (NH_4^+) concentration and minimum water temperatures. Denitrification, which is often the limiting step in the total biological nitrogen removal, requires sufficient concentration of a readily available carbon source, and the absence of dissolved oxygen.

The ammonia concentration increases in the biological reactors due to ammonia and organic nitrogen in the influent. The concentration of nitrate, which was produced during an oxic phase in the previous cycle, will decrease as a result of denitrification.

Nitrification and denitrification volumes are determined based on the influent wastewater characteristics. A sufficient aerobic sludge age is incorporated to ensure BOD removal and complete nitrification at the lowest anticipated wastewater temperature. Typically, a safety factor is also applied which results in a relatively conservative design to accommodate diurnal and seasonal variations in the rate and volume of flow.

By varying the duration of the different aeration phases, it is possible to actually adjust the oxic and anoxic volumes supplied for nitrification and denitrification of the wastewater.

The oxic/anoxic phase lengths are controlled by monitoring the dissolved oxygen concentration and the REDOX-potential in the aeration tanks.

The nitrification and denitrification are realized in one oxidation ditch.

To obtain the two stages of Nitrogen removal processes in the same tank, the oxygen supply is sequenced to allow successive aerobic (= aeration ON) and anoxic (= aeration OFF) conditions in this tank for the biomass.

During the denitrification cycle where aeration is stopped, in order to maintain the biomass in suspension to be constantly in contact with pollution, submersible mixers are put in operation.

Phosphorus Removal

Phosphorus removal will be achieved by Phosphorus precipitation by adding Ferric Chloride in the aerobic tank.

The process type selected will be a configuration with aerated-anoxic phases for nitrification-denitrification. That will be a low load aerated tank with a F/M load < 0,08 kgBOD/kgSS/d. Design temperature is 12°C.

Supportive Infrastructure

Operation Building and Maintenance Garage

The Operations Building is a rectangular one-story building. The building is constructed as a reinforced concrete framework with a flat roof.

The operation building shall include following rooms, separated according to function:

- Control & office room (office)
- Laboratory;
- Kitchen and recreation room (recovery);
- Toilets;
- Locker room with showers;
- First aid room;
- Warehouse;
- Work shop;
- Storage room;

Control, Automation and Alarm system

The whole process of WWTP is controlled by a simple SCADA system, which immediately informs the Operator(s) of any default occurring in the plant.
In a first step, the SCADA system will automatically activate the stand-by equipment and simultaneously send an alarm to the Operator(s). In a second step, the Operator(s) will check whether the automatic system responded correctly or whether corrections such as bypassing faulty lines or repairing faulty equipment, by the use of stand-by units, will be necessary to mitigate any default.

Drinking and Industrial Water Supply

According to the project wells will be arranged at the operational stage (wells will be arranged in accordance with the requirements of Georgian environmental legislation). Considering the location of the project area, high-quality water with sufficient debit could be obtained at a relatively small depth (>10-15 m).

Drinking water supply system will be equipped with appropriate filter and disinfection system.

Sewerage and Drainage System

Proposed sewerage and drainage system will collect water drained from the Screening Building, the Operation Building, the Grit Storage Area, the Sludge Loading/Storage Area, as well as liquors from the Sludge Drying Beds. All of the a.m. flows (contaminated water) will be directed to the distribution chamber.

All other paved areas and maintenance roads, where no surface pollution occurs, will be drained to the adjacent green areas. The respective roads and areas will be designed with a sufficient surface inclination.

Fire-Fighting System

Appropriate fire detection and alarm facilities will be provided on the WWTP site. Manual alarm buttons, smoke and heat sensing detectors will be installed in all buildings, plant operation areas, storage areas, etc. A master alarm annunciator will be located in the control room.

The system will be manufactured in accordance with current IEC standards and installed in accordance with local regulations.

A pressurized fire-fighting water supply network, hydrants as well as portable fire-fighting appliances will be supplied and installed according to the local requirements.

All buildings and structures, where required, will be provided with lightning protection equipment.

Lighting System

External lighting will be provided in the following areas:

- Building access points;
- Major walkways;
- Process plant access points;
- Local operator control areas;

Internal lighting will be provided in the following buildings:

- Initial treatment station;
- Operation Building;
- Maintenance station.

Fixed emergency lighting will be installed at strategic points in the installations, including control rooms, switch rooms, the main entrance and in all other buildings and areas where required for safety reasons.

15.2 Annex 2. Report on Pollutant Emissions into Ambient Air

Report on Pollutant Emissions into Ambient Air on Operation Phase

Emission during the Operation of Road Construction Vehicle (Excavator)

Source of emission of the pollutant substances is road-construction vehicle engines, loading during the work and during idle mode.

The calculation is performed according to the following methodological guidelines [4, 5]

Quantitative and qualitative characteristics of emission of the pollutant substances from the road-construction vehicles, is given in the table.

Quantitative and qualitative characteristics of emission of the pollutant substances from the road-construction vehicles

Pollutants		Maximum Emission, g/s	Annual Emission, t/a
Code	Name		
301	Nitrogen dioxide (nitrogen (IV) oxide)	0,0327924	0,281436
304	Nitrogen (II) oxide	0,0053272	0,04572
328	Particulate	0,0045017	0,038632
330	Sulfur dioxide	0,00332	0,028467
337	Carbone oxide	0,0273783	0,234025
2732	Fraction of hydrocarbons kerosene	0,0077372	0,066308

Calculation is made in conditions of external temperature of construction sites of the road-construction vehicles (RCV). Number of work days – 300.

Initial data for calculation of emission of the pollutant substances is given in the table.

Initial Calculation Data

Name of the road-construction vehicles (RCV)	Idle mode, minute	Number	Working Time per Vehicle							Number of working days
			Per day, h				In 30 min, min			
			Total	Without load	With load	Idle mode	Without load	With load	Idle mode	
	Caterpillar RCV, capacity 61-100 kW (83-136 horse-power)	1 (1)	8	3,5	3,2	1,3	13	12	5	300

Provisional marking, calculation formulas, calculating parameters and their explanation are given below:
The maximum of ***i***-type substance – one-time emission is performed by the following formula:

$$G_i = \sum_{k=1}^{k} (m_{ДВ\,ik} \cdot t_{ДВ} + 1{,}3 \cdot m_{ДВ\,ik} \cdot t_{НАГР.} + m_{XX\,ik} \cdot t_{XX}) \cdot N_k / 1800, \text{ g/s};$$

Where,

$m_{ДВ\,ik}$ – for ***k***-type group, ***i***- type substance specific emission during vehicle drive without loading, g/min;

$1{,}3 \cdot m_{ДВ\,ik}$ – for ***k***-type group, ***i***-type substance specific emission during vehicle drive with load, g/min;
$m_{ДВ\,ik}$ – for ***k***-type group, ***i***-type substance specific emission during vehicle idle mode, g/min;
$t_{ДВ}$ - vehicle working time with 30 minutes interval, without load, min;
$t_{НАГР.}$ - Vehicle working time with 30 minutes interval, with load, min;

t_{XX} - vehicle working time with 30 minutes interval with idle mode, min;
N_k – k-type group vehicle amount working simultaneously with 30 minutes interval

i - type substance total emission from road-vehicles is calculated with the following formula:

$$M_i = \sum_{k=1}^{k}(m_{ДВ\,ik} \cdot t'_{ДВ} + 1{,}3 \cdot m_{ДВ\,ik} \cdot t'_{НАГР.} + m_{XX\,ik} \cdot t'_{XX}) \cdot 10^{-6}, \text{ t/a;}$$

Where

$t'_{ДВ}$ – k- type group vehicle total working time without load, min;

$t'_{НАГР.}$ – k- type group vehicle total working time with load, min;

t'_{XX} – k- type group total working time with idling drive mode, min.

Specific emissions of pollutants during the operation of road-construction vehicles are given in table.

Specific emissions of pollutants during the operation of road-construction vehicles, g/min

Type of road-construction vehicles (RCV)	Pollutant	Driving mode	Idle mode
Caterpillar RCV, capacity 61-100 kW (83-136 horse-power)	Nitrogen dioxide (nitrogen (IV) oxide)	1,976	0,384
	Nitrogen (II) oxide	0,321	0,0624
	Soot	0,27	0,06
	Sulphur dioxide	0,19	0,097
	Carbone oxide	1,29	2,4
	Fraction of hydrocarbons kerosene	0,43	0,3

Calculation of annual and maximum single emission of pollutants is given below:

G_{301} = (1,976·12+1,3·1,976·13+0,384·5)·1/1800 = 0,0327924 g/s;

M_{301} = (1,976·1·300·3,5·60+1,3·1,976·1·300·3,2·60+0,384·1·300·1,3·60)·10^{-6} = 0,281436 t/a;

G_{304} = (0,321·12+1,3·0,321·13+0,0624·5)·1/1800 = 0,0053272 g/s;

M_{304} = (0,321·1·300·3,5·60+1,3·0,321·1·300·3,2·60+0,0624·1·300·1,3·60)·10^{-6} = 0,04572 t/a;

G_{328} = (0,27·12+1,3·0,27·13+0,06·5)·1/1800 = 0,0045017 g/s;

M_{328} = (0,27·1·300·3,5·60+1,3·0,27·1·300·3,2·60+0,06·1·300·1,3·60)·10^{-6} = 0,038632 t/a;

G_{330} = (0,19·12+1,3·0,19·13+0,097·5)·1/1800 = 0,00332 g/s;

M_{330} = (0,19·1·300·3,5·60+1,3·0,19·1·300·3,2·60+0,097·1·300·1,3·60)·10^{-6} = 0,028467 t/a;

G_{337} = (1,29·12+1,3·1,29·13+2,4·5)·1/1800 = 0,0273783 g/s;

M_{337} = (1,29·1·300·3,5·60+1,3·1,29·1·300·3,2·60+2,4·1·300·1,3·60)·10^{-6} = 0,234025 t/a;

G_{2732} = (0,43·12+1,3·0,43·13+0,3·5)·1/1800 = 0,0077372 g/s;

M_{2732} = (0,43·1·300·3,5·60+1,3·0,43·1·300·3,2·60+0,3·1·300·1,3·60)·10^{-6} = 0,066308 t/a;.

Total emission during the operation of single-bucket excavator is determined by the following formula:

M = Q_{exc} x E x K_{exc} x K_1 x K_2 x N/T_{sb}, g/s, where:

Q_{exc} = Specific emission of dust from 1m^3 loaded material, g/m^3 [4,8]

E - Bucket capacity, m^3 [0,7-1]

K_{exc} - Excavator coefficient [0,91]

K_1 - Wind speed ratio (K_1=1,2);

K_2 - Moisture ratio (K_2=0,2);

N – Number of simultaneously working techniques (unit);

T_{ec} - Excavator cycle time, sec.[30]

$M = Q_{exc} \times E \times K_0 \times K1 \times K2 \times N/T_{sb}$ = 4,8*1*0,91*1,2*0,2*1/30=0,035 g/s.

Total dust emission during the operation of single-bucket excavator is determined by the following formula:
$G = M \times 3600 \times T \times 10^{-6}$ = 0,035 x 3600s x 8hr x 300day x 10^{-6} = 0,303 t/a.

Emissions during Operation of Road-construction Vehicle (Bulldozer)
Gaseous emission is identical to the excavator and the maximum emissions of suspended particles shall be calculated as follows:
$G = (Q_{bull} \times Q_{density} \times V \times K_1 \times K_2 \times N)/(T_{bc} \times K_{\delta 3})$, g/s;

Where,

Q_{bull} - Specific emission of dust 1 t, from the transporting material, g/t - 0,74

$Q_{density}$ - Rock density (t/m^3-1,6).

K_1 – Wind speed ratio (K_1=1,2);

K_2 - Moisture ratio (K_2=0,2);

N- Number of simultaneously working techniques (unit);

V - Prism displacement volume (m^3) 3,5

T_{bc} - Bulldozer cycle time, sec. - 80.

K_{lr} - ratio of loosening the rock (K_{lr} -1,15)

$G = (Q_{bull} \times Q_{density} \times V \times K_1 \times K_2 \times N)/(T_{bc} \times K_{lr})$ = 0,74*1,6*3,5*1,2*0,2*1/(80*1,15)=0,011 g/s

Total dust emission during the operation of bulldozer is determined by the following formula:
$G = M \times 3600 \times T \times 10^{-6}$ = 0,011 x 3600 sec x 8 h x 300 day x 10^{-6} = 0,095 t/year.

Emission during Welding Operations

For the identification of pollutants emission during the welding works, the calculation methods are used by the support of specific emission (by recalculating the used electrode per unit mass) of the pollutant substances.

Welding aerosol, metal oxides and gaseous compounds are emitted in ambient air during the welding works, quantitative characteristics of which depend on the elements existing in composition of the electrodes.
The calculation of emission of pollutants is performed in accordance with [6]. Quantitative and qualitative characteristics of emissions of pollutants are given in table

Quantitative and Qualitative Characteristics of Pollutant Emissions

Pollutants		Maximum single emission, g/s	Annual emission, t/y
Code	Title		
123	Iron oxide	0,0010096	0,0043615
143	Manganese and its compounds	0,0000869	0,0003754
301	Nitrogen dioxide	0,0002833	0,001224

Pollutants		Maximum single emission, g/s	Annual emission, t/y
Code	Title		
304	Nitric oxide	0,000046	0,0001989
337	Carbon oxide	0,0031403	0,013566
342	Gaseous fluorides	0,0001771	0,000765
344	Hardly soluble fluorides	0,0003117	0,0013464
2908	Inorganic dust (70-20% SiO_2)	0,0001322	0,0005712

Initial data for calculation of emissions is given in table

Name	Design parameters		
	Characteristics, indication	Unit	Significance
Electric arc welding with unit electrodes УОНИ-13/45			
	Specific indicators of emission of the pollutant substances("x") on per unit mass of the consumption material;		
123	Iron oxide	g/kg	10,69
143	Manganese and its compounds	g/kg	0,92
301	Nitrogen dioxide	g/kg	1,2
304	Nitric oxide	g/kg	0,195
337	Carbon oxide	g/kg	13,3
342	Fluorides	g/kg	0,75
344	Hardly soluble fluorides	g/kg	3,3
2908	Inorganic dust (70-20% SiO_2)	g/kg	1,4
	Waste normative of a single used electrode, n_o	%	15
	Annual cost of used electrode, B''	g/kg	1200
	Cost of used electrode during intensive operation, B'	g/kg	1
	Intensive work time, τ	hr	1
	Simultaneousness of the operation	-	yes

Obtained provisional markings, calculation formulas, calculating parameters and their explanations are given below.
The volume of pollutants emitted in ambient air during the welding works is determined by following formula:

$$M_{bi} = B \cdot K^x_m \cdot (1 - n_o / 100) \cdot 10^{-3}, \text{ kg/hr}$$

Where,

B - Electrode consumption, (kg/hr);
"x" - Specific emission of pollutants at the expense of K^x_m - electrode unit mass, g/kg;
n_o - Used electrode residual normative %.

When technical equipment is equipped with local draft - emission of pollutant substance from this equipment equals to mass of emission of pollutant substance – times - local draft effectiveness (in unit portion). Calculation of annual emission of the pollutant substances during electrode usage is calculated with the formula:

$$M = B'' \cdot K^x_m \cdot (1 - n_o / 100) \cdot \eta \cdot 10^{-6}, \text{ t/year}$$

Where,

B''- Electrode annual consumption, kg/year;

η - Effectiveness of local draft (in unit portion)

Maximum emission is calculated with the formula:

$$G = 10^3 \cdot M_{bi} \cdot \eta / 3600, \text{ g/sec}$$

Calculation of maximum on-time and annual emission of the pollutant substances in air is given below:

Electric arc welding with unity electrodes УОНИ-13/45

$B = 1 / 1 = 1$ kg/hr;

123. Iron oxide
$M_{bi} = 1 \cdot 10{,}69 \cdot (1 - 15 / 100) \cdot 10^{-3} = 0{,}0090865$ kg/hr;
$M = 1200 \cdot 10{,}69 \cdot (1 - 15 / 100) \cdot 0{,}4 \cdot 10^{-6} = 0{,}0043615$ t/a;
$G = 10^3 \cdot 0{,}0090865 \cdot 0{,}4 / 3600 = 0{,}0010096$ g/s.

143. Manganese and its compounds
$M_{bi} = 1 \cdot 0{,}92 \cdot (1 - 15 / 100) \cdot 10^{-3} = 0{,}000782$ kg/hr;
$M = 1200 \cdot 0{,}92 \cdot (1 - 15 / 100) \cdot 0{,}4 \cdot 10^{-6} = 0{,}0003754$ t/a;
$G = 10^3 \cdot 0{,}000782 \cdot 0{,}4 / 3600 = 0{,}0000869$ g/s.

301. Nitrogen dioxide
$M_{bi} = 1 \cdot 1{,}2 \cdot (1 - 15 / 100) \cdot 10^{-3} = 0{,}00102$ kg/hr;
$M = 1200 \cdot 1{,}2 \cdot (1 - 15 / 100) \cdot 1 \cdot 10^{-6} = 0{,}001224$ t/a;
$G = 10^3 \cdot 0{,}00102 \cdot 1 / 3600 = 0{,}0002833$ g/s.

304. Nitric oxide
$M_{bi} = 1 \cdot 0{,}195 \cdot (1 - 15 / 100) \cdot 10^{-3} = 0{,}0001658$ kg/hr;
$M = 1200 \cdot 0{,}195 \cdot (1 - 15 / 100) \cdot 1 \cdot 10^{-6} = 0{,}0001989$ t/a;
$G = 10^3 \cdot 0{,}0001658 \cdot 1 / 3600 = 0{,}000046$ g/s.

337. Carbon oxide

$M_{bi} = 1 \cdot 13{,}3 \cdot (1 - 15 / 100) \cdot 10^{-3} = 0{,}011305$ kg/hr;

$M = 1200 \cdot 13{,}3 \cdot (1 - 15 / 100) \cdot 1 \cdot 10^{-6} = 0{,}013566$ t/a;
$G = 10^3 \cdot 0{,}011305 \cdot 1 / 3600 = 0{,}0031403$ g/s.

342. Gaseous fluorides
$M_{bi} = 1 \cdot 0{,}75 \cdot (1 - 15 / 100) \cdot 10^{-3} = 0{,}0006375$ kg/hr;
$M = 1200 \cdot 0{,}75 \cdot (1 - 15 / 100) \cdot 1 \cdot 10^{-6} = 0{,}000765$ t/a;
$G = 10^3 \cdot 0{,}0006375 \cdot 1 / 3600 = 0{,}0001771$ g/s.

344. Hardly soluble fluorides
$M_{bi} = 1 \cdot 3{,}3 \cdot (1 - 15 / 100) \cdot 10^{-3} = 0{,}002805$ kg/hr;
$M = 1200 \cdot 3{,}3 \cdot (1 - 15 / 100) \cdot 0{,}4 \cdot 10^{-6} = 0{,}0013464$ t/a;
$G = 10^3 \cdot 0{,}002805 \cdot 0{,}4 / 3600 = 0{,}0003117$ g/s.

2908. Inorganic dust (70-20% SiO_2)
$M_{bi} = 1 \cdot 1{,}4 \cdot (1 - 15 / 100) \cdot 10^{-3} = 0{,}00119$ kg/hr;
$M = 1200 \cdot 1{,}4 \cdot (1 - 15 / 100) \cdot 0{,}4 \cdot 10^{-6} = 0{,}0005712$ t/a;
$G = 10^3 \cdot 0{,}00119 \cdot 0{,}4 / 3600 = 0{,}0001322$ g/s.

Emission during Diesel-Fuel Receive-Storage

Ambient air pollution source is a breathing valve of the tank while conserving (small breathe) the oil product and when loading (big breathe). Climate zone – 3.

The calculation of emission of the pollutant substances is performed in accordance with [8]. Quantitative and qualitative characteristics of emission of the polluted substances are given in table

Pollutants		Maximum single emission, g/s	Annual emission, t/y
Code	Title		Code
333	Dihydrogen sulphide (Hydrogen Sulphide)	0,000055	0,00001
2754	Alkanes C_{12}-C_{19} (Saturated hydrocarbons C_{12}-C_{19})	0,0195	0,0038

Initial data for emission calculation is given in table

Product	Amount per year, t/y		Tank Design	Pump capacity, m^3/hr	Tank capacity, m^3	Number of tanks	Simultaneousness
	$B_{aut\text{-}win}$	$B_{sum\text{-}spr}$					
Diesel fuel. Group A. Fluid temperature is close to the ambient air temperature	150	150	Surface vertical. Operation regime – "measuring". No emission limiting system.	20	50	4	+

Obtained provisional marking, calculation formulas, calculating parameters and their explanations are given below.

Oil product vapor maximum emission is calculated with the formula:

$$M = (C_1 \cdot K^{max}_p \cdot V^{max}_q) / 3600, \text{ g/s};$$

Oil product vapor annual emission is calculated with the formula:

$$G = (Y_2 \cdot B_{оз} + Y_3 \cdot B_{вл}) \cdot K^{max}_p \cdot 10^{-6} + G_{хр} \cdot K_{нп} \cdot N, \text{ t/a}.$$

Where:

Y_2, Y_3 – Average specific emission diesel fuel tank during a year for autumn-winter and spring-summer periods g/t is obtained according to Annex 12.

$B_{оз}, B_{вл}$ – Liquid amount to be loaded in diesel fuel tanks in autumn-winter and spring-summer periods, t.

K^{max}_p - Coefficient as a result of test is obtained according to Annex 8.

$G_{хр}$ - Oil product vapor emission while keeping per tank, t/y ; obtained according to Annex 13.

$K_{нп}$ - Coefficient as a result of test, obtained according to Annex 12.

N – Number of tanks.

Calculation of maximum one-time and annual emission of the pollutant substances in air is given below:

Diesel fuel

$M = 3,92 \cdot 0,9 \cdot 20 / 3600 = 0,0196$ g/s;

$G = (2,36 \cdot 150 + 3,15 \cdot 150) \cdot 0,9 \cdot 10^{-6} + 0,27 \cdot 0,0029 \cdot 4 = 0,0038759$ t/a;

333 Dihydrogen sulphide (Hydrogen Sulphide)

$M = 0,0196 \cdot 0,0028 = 0,0000549$ g/s;

$G = 0,0038759 \cdot 0,0028 = 0,0000109$ t/a;

2754 Alkanes C_{12}-C_{19} (Saturated hydrocarbons C_{12}-C_{19})

M = 0,0196 · 0,9972 = 0,0195451 g/s;

G = 0,0038759 · 0,9972 = 0,003865 t/a;

Maximum Permissible Concentration of Harmful Substances in Ambient Air

Emission of harmful substances is expected during the operational phase of the plant. The maximum single and daily average maximum permissible concentrations are given in table.

Maximum permissible concentrations of harmful substances in ambient air

№	Harmful substances	Code	Maximum permissible concentrations (MPC) mg/m³	
			Maximum single	Daily average
1	Nitrogen dioxide	0301	0,2	0,04
2	Nitric oxide	0304	0,4	0,06
3	Soot	0328	0,15	0,05
4	Sulfur Dioxide	0330	0,5	0,05
5	Hydrogen sulphide	0333	0,008	-
6	Carbon monoxide	0337	5,0	3,0
12	Benz(a)piren	0703	-	0,000001
13	Saturated hydrocarbons (kerosene fraction)	2732	1,2	-
14	Formaldehyde	1325	0,035	0,003
15	Saturated hydrocarbons (C_{12}-C_{19})	2754	1,0	-
16	Dust: 70-20% SiO_2	2908	0,3	0,1
17	Dust: <70-20% SiO_2	2909	0,5	0,15

Operation Phase

Usually, degradation of organic matter in the wastewater treatment process is accompanied by a large amount of hydrogen sulfide (H_2S) emissions, which is the source of odor nuisance. Hydrogen sulfide is generated mainly during anaerobic treatment of wastewater. Emissions of harmful substances during the operation of the treatment plant are calculated in the following Paragraph.

Calculation of Harmful Substances Emitted in Ambient Air

According to the legislation, the quantitative and qualitative calculation of emission can be carried out in two ways:

1. Through instrumental measurements;
2. Through calculation method.

In this report, calculation is performed in accordance with calculation method [ref. 4,5].

Calculation of maximum emission of the ***i***-type pollutant substances, emitted in air from separate device in time unit by aerated treating water, is given below:

$$M_{ic}^{c} = M_{iB} + M_{is}, \text{ g/s}$$

where,

M_{iB} - ***i***-type emission of pollutant substances, emitted in a time unit as a result of evaporation from the surface of the device (g/sec);

M_{is} - ***i***-type emission of pollutant substances, emitted in a time unit from separate aerobic device (g/sec).

$$M_{iB} = 5{,}47 * 10^{-8} * (1{,}312+U) * F * C_i * K_2 / m^{0,5} * (t_ж+273) \ g/s$$

where,

U - wind speed m/sec;

F – total surface area of separate device m^2;

F_O - the area of open surface of separate device m^2;

K_2 - coefficient, depending on the device covered surface ratio F_0/F, which is obtained according to the Table;

C_i - concentration in saturated vapor of ***i***-type emission of pollutant substances (mg/m^3)

(C_i - in case of concentration absence, it is possible to calculate it)

$$C_i = 120 * (m_i * n_i/273 + t_ж) * 10^{A-B/(c+t)}$$

where,

n_i - volumetric share of pollutant substances in water that should be treated;

A,B,C – Constants for the Antoine Equation;

m_i - Relative molecular mass of ***i***-type pollutant substances is given in Annex [10];

$t_ж$ - Waste water temperature,°C, average temperature of the flow 18 °C.

$$M_{is} = 0.001 \cdot Q_j \cdot C_i, \ g/sec.$$

where,

Q_J - Aeration air flow of purifying water for separate j-type device (m^3/sec);

In our case unaerated chamber is given.

The total volume of ***i***-type pollutant substances that are emitted annually from separate devices, are calculated according to the following formula:

$$M_{ic}^{annual} = 0{,}0036 * M * t \ , \ t/a.$$

Where,

t - annual operation time of the device, hr.

Coefficient of the covered surface of the device - K_2 – is determined by the ratio - F_0/F, Where F-is the total surface area of each device, while F_0 - is open surface area of separate device.

F_0/F	0,0001	0,001	0,01	0,1	0,5	0,8	>0,8
K_2	0	0,01	0,1	0,2	0,3	0,6	1,0

Intermediate meaning for **F_0/F** value, coefficient **K_2** is determined by interpolarised formula:

Interval	Interpolarised formula K_2
$F_O/F <= 0{,}0001$	0
$0{,}0001 < F_O/F <= 0{,}01$	$10 \times F_O/F$
$0{,}01 < F_O/F <= 0{,}1$	$(F_O/F + 0{,}08) / 0{,}9$
$0{,}1 < F_O/F <= 0{,}5$	$0{,}25 \times F_O/F + 0{,}175$
$0{,}5 < F_O/F <= 0{,}8$	$F_O/F - 0{,}2$
$F_O/F > 0{,}8$	1

Calculation parameters of pollutant emissions

Name	Molecular mass	Constants for the Antoine Equation		
		A	B	C
Nitrogen dioxide	**46,01**	20,5324	4141,29	3,65
Ammonia	**17,03**	16,9481	2132,50	-32,98
Hydrogen sulphide	**34,08**	16,1040	1768,69	-26,06
Carbon oxide	**28,01**	14,3686	530,22	-34,44

Methane	**16,03**	15,2243	897,84	-7,16
Methyl mercaptan	**48,11**	16,1909	2338,38	-34,44
Ethyl mercaptan	**62,13**	16,0077	2497,23	-41,77

Concentration of pollutants in the saturated vapor (mg / m^3) in aerobic treatment facilities are given in Table.

№	Name of device	Hydrogen sulphide	Ammonia	Ethyl mercaptan	Methyl mercaptan	Carbon oxide	Nitrogen dioxide	Methane
1	Intake-dispensing chamber	0,0032	0,022	0,0000021	0,0000037	0,069	0,0036	1,25
2	Active sludge tank (anaerobic tank)	0,0022	0,018	0,0000014	0,0000028	0,068	0,0039	2,04
3	Secondary settler	0,0011	0,01	0,0000011	0,0000027	0,061	0,0035	0,15
4	Primary settler (biological filter)	0,0015	0,012	0,0000018	0,0000035	0,06	0,0036	0,18
5	Sludge bed	0,0010	0,01	0,0000013	0,0000027	0,060	0,0038	0,15

Emission Calculation

Emission Calculation from Intake Chamber:

$M_{301} = 5,47 * 10^{-8} * (1,312+3,9) * 99,5 * 0,0036 * 1 / 46,01^{0,5} * (18+273) = 0.00000438$ g/s

$M_{301} = 0.00000438$ g/a * 3600 s * 24hr * 365 day * $10^{-6} = 0,00013812$ t/a

$M_{303} = 5,47 * 10^{-8} * (1,312+3,9) * 99,5 * 0,022 * 1 / 17,03^{0,5} * (18+273) = 0.00004401$ g/s

$M_{303} = 0.00004401$ g/a * 3600 s * 24hr * 365 day * $10^{-6} = 0,00138789$ t/a

$M_{333} = 5,47 * 10^{-8} * (1,312+3,9) * 99,5 * 0,0032 * 1 / 34,08^{0,5} * (18+273) = 0.000004525$ g/s

$M_{333} = 0.000004525$ g/a * 3600 s * 24hr * 365 day * $10^{-6} = 0,0001427$ t/a

$M_{337} = 5,47 * 10^{-8} * (1,312+3,9) * 99,5 * 0,069 * 1 / 28,01^{0,5} * (18+273) = 0.00010763$ g/s

$M_{337} = 0.00010763$ g/a * 3600 s * 24hr * 365 day * $10^{-6} = 0,00339422$ t/a

$M_{410} = 5,47 * 10^{-8} * (1,312+3,9) * 99,5 * 1.25 * 1 / 16,03^{0,5} * (18+273) = 0.00257769$ g/s

$M_{410} = 0.00257769$ g/a * 3600 s * 24hr * 365 day * $10^{-6} = 0,081290032$ t/a

$M_{1715} = 5,47 * 10^{-8} * (1,312+3,9) * 99,5 * 0,0000037 * 1 / 48,11^{0,5} * (18+273) = 0.0000000044$ g/s

$M_{1715} = 0.0000000044$ g/a * 3600 s * 24hr * 365 day * $10^{-6} = 0.0000001387$ t/a

$M_{1728} = 5,47 * 10^{-8} * (1,312+3,9) * 99,5 * 0,0000021 * 1 / 62,13^{0,5} * (18+273) = 0.00000000221$ g/s

$M_{1728} = 0.00000000221$g/a * 3600s * 24hr * 365 day * $10^{-6} = 0.0000000697$ t/a

Emission Calculation from Anaerobic Tank

$M_{301} = 5,47 * 10^{-8} * (1,312+3,9) * 4684 * 0,0039 * 1 / 46,01^{0,5} * (18+273) = 0.00022343$ g/s

$M_{301} = 0.00022343$ g/a * 3600 s* 24hr * 365 day * $10^{-6} = 0.00704608$ t/a

$M_{303} = 5,47 * 10^{-8} * (1,312+3,9) * 4684 * 0,018 * 1 / 17,03^{0,5} * (18+273) = 0.00169529$ g/s

M_{303} = 0.00169529 g/a * 3600 s * 24hr * 365 day * 10^{-6} = 0,0536275 t/a

M_{333} = 5,47 * 10^{-8} * (1,312+3,9) * 4684 * 0,0022 * 1 / 34,08 ^{0,5} * (18 +273) = 0.00014646 g/s
M_{333} = 0.00014646 g/a * 3600 s * 24hr * 365 day * 10^{-6} = 0,00461876 t/a

M_{337} = 5,47 * 10^{-8} * (1,312+3,9) * 4684 * 0,068 * 1 / 28,01 ^{0,5} * (18 +273) = 0.0049933 g/s
M_{337} = 0.0049933 g/a * 3600 s * 24hr * 365 day * 10^{-6} = 0,1574687 t/a

M_{410} = 5,47 * 10^{-8} * (1,312+3,9) * 4684 * 2,04* 1 / 16,03 ^{0,5} * (18 +273) = 0.1980369 g/s
M_{410} = 0.1980369 g/a * 3600 s * 24hr * 365 day * 10^{-6} = 6,24529 t/a

M_{1715} = 5,47 * 10^{-8} * (1,312+3,9) * 4684* 0,0000028 * 1/48,11^{0,5} *(18 +273) = 0.000000156 g/s
M_{1715} = 0.000000156 g/a * 3600 s * 24hr * 365 day * 10^{-6} = 0.000004919 t/a

M_{1728} = 5,47 * 10^{-8} *(1,312+3,9)* 4684* 0,0000014 * 1/62,13^{0,5} * (18 +273) = 0.000000069 g/s
M_{1728} = 0.000000069 g/a * 3600 s * 24hr * 365 day * 10^{-6} = 0,000002175 t/a

Emission Calculation from Secondary Sedimentation Tank

M_{301} = 5,47 * 10^{-8} * (1,312+3,9) * 706,5 * 0,0035 * 1 / 46,01 ^{0,5} * (18 +273) = 0.0000302 g/s

M_{301} = 0.0000302 g/a * 3600 s * 24 hr * 365 day * 10^{-6} = 0,0009523 t/a

M_{303} = 5,47 * 10^{-8} * (1,312+3,9) * 706,5* 0,01 * 1 / 17,03 ^{0,5} * (18 +273) = 0.00014206 g/s
M_{303} = 0.00014206 g/a * 3600 s * 24 hr * 365 day * 10^{-6} = 0.00448 t/a

M_{333} = 5,47 * 10^{-8} * (1,312+3,9) * 706,5 * 0,0011 * 1 / 34,08 ^{0,5} * (18 +273) = 0.00001104 g/s
M_{333} = 0.00001104 g/a * 3600 s * 24 hr * 365 day * 10^{-6} = 0,00034815 t/a

M_{337} = 5,47 * 10^{-8} * (1,312+3,9) * 706,5 * 0,061 * 1 / 28,01 ^{0,5} * (18 +273) = 0.0006756 g/s
M_{337} = 0.0006756 g/a * 3600 s * 24 hr * 365 day * 10^{-6} = 0.0213057 t/a

M_{410} = 5,47 * 10^{-8} * (1,312+3,9) * 706,5 * 0.15* 1 / 16,03 ^{0,5} * (18 +273) = 0.0002196 g/s
M_{410} = 0.0002196 g/a * 3600 s * 24 hr * 365 day * 10^{-6} = 0.006925306 t/a

M_{1715} = 5,47 * 10^{-8} * (1,312+3,9) * 706,5 * 0,0000027 * 1/48,11^{0,5} *(18 +273) = 0.0000000228 g/s
M_{1715} = 0.0000000228 g/a * 3600 s * 24 hr * 365 day * 10^{-6} = 0,000000719 t/a

M_{1728} = 5,47 * 10^{-8} *(1,312+3,9)* 706,5* 0,0000011 * 1/62,13^{0,5} * (18 +273) = 0.00000000818 g/s
M_{1728} = 0.00000000818 g/a * 3600 s * 24hr * 365 day * 10^{-6} = 0.000000257 t/a

Emission from Trickling Filter

M_{301} = 5,47 * 10^{-8} * (1,312+3,9) * 113,5, * 0,0036 * 1 / 46,01 ^{0,5} * (18 +273) = 0.00000499 g/s
M_{301} = 0.00000499 g/a * 3600 s * 24hr * 365 day * 10^{-6} = 0,00015736 t/a

M_{303} = 5,47 * 10^{-8} * (1,312+3,9) * 113,5 * 0,012 * 1 / 17,03 ^{0,5} * (18 +273) = 0.00000273 g/s
M_{303} = 0.00000273 g/a * 3600 s * 24hr * 365 day * 10^{-6} = 0.00008609 t/a

M_{333} = 5,47 * 10^{-8} * (1,312+3,9) * 113,5 * 0,0015 * 1 / 34,08 ^{0,5} * (18 +273) = 0.000002419 g/s
M_{333} = 0.000002419 g/a * 3600 s * 24hr * 365 day * 10^{-6} = 0.00007628 t/a

$M_{337} = 5,47 * 10^{-8} * (1,312+3,9) * 113,5 * 0,06 * 1 / 28,01^{0,5} * (18+273) = 0.0001067$ g/s

$M_{337} = 0.0001067$ g/a * 3600 s * 24hr * 365 day * $10^{-6} = 0.003364$ t/a

$M_{410} = 5,47 * 10^{-8} * (1,312+3,9) * 113,5 * 0.18 * 1 / 16,03^{0,5} * (18+273) = 0.0004234$ g/s

$M_{410} = 0.0004234$ g/a * 3600 s * 24hr * 365 day * $10^{-6} = 0.0133523$ t/a

$M_{1715} = 5,47 * 10^{-8} * (1,312+3,9) * 113,5 * 0,0000035 * 1/48,11^{0,5} * (18+273) = 0.00000000475$ g/s

$M_{1715} = 0.00000000475$ g/a * 3600 s * 24hr * 365 day * $10^{-6} = 0,000000149$ t/a

$M_{1728} = 5,47 * 10^{-8} * (1,312+3,9) * 113,5 * 0,0000018 * 1/62,13^{0,5} * (18+273) = 0.00000000215$ g/s

$M_{1728} = 0.00000000215$ g/a * 3600 s * 24hr * 365 day * $10^{-6} = 0,0000000678$ t/a

Emission Calculation from Sludge Bed

$M_{301} = 5,47 * 10^{-8} * (1,312+3,9) * 2755 * 0,0038 * 1 / 46,01^{0,5} * (18+273) = 0.000128$ g/s

$M_{301} = 0.000128$ g/a * 3600 s * 24 hr * 365 day * $10^{-6} = 0,004036$ t/a

$M_{303} = 5,47 * 10^{-8} * (1,312+3,9) * 2755 * 0,01 * 1 / 17,03^{0,5} * (18+273) = 0.0005539$ g/s

$M_{303} = 0,0005539$ g/a * 3600 s * 24 hr * 365 day * $10^{-6} = 0.0174677$ t/a

$M_{333} = 5,47 * 10^{-8} * (1,312+3,9) * 2755 * 0,0010 * 1 / 34,08^{0,5} * (18+273) = 0.00003915$ g/s

$M_{333} = 0.00003915$ g/a * 3600 s * 24 hr * 365 day * $10^{-6} = 0,00123463$ t/a

$M_{337} = 5,47 * 10^{-8} * (1,312+3,9) * 2755 * 0,068 * 1 / 28,01^{0,5} * (18+273) = 0.0029369$ g/s

$M_{337} = 0.0029369$ g/a * 3600 s * 24 hr * 365 day * $10^{-6} = 0.092618$ t/a

$M_{410} = 5,47 * 10^{-8} * (1,312+3,9) * 2755 * 0,15 * 1 / 16,03^{0,5} * (18+273) = 0.008564$ g/s

$M_{410} = 0.008564$ g/a * 3600 s * 24 hr * 365 day * $10^{-6} = 0.270074$ t/a

$M_{1715} = 5,47 * 10^{-8} * (1,312+3,9) * 2755 * 0,0000027 * 1/48,11^{0,5} * (18+273) = 0.0000000889$ g/s

$M_{1715} = 0.0000000889$ g/a * 3600 s * 24 hr * 365 day * $10^{-6} = 0,000002803$ t/a

$M_{1728} = 5,47 * 10^{-8} * (1,312+3,9) * 2755 * 0,0000013 * 1/62,13^{0,5} * (18+273) = 0.0000000377$ g/s

$M_{1728} = 0.0000000377$ g/a * 3600 s * 24 hr * 365 day * $10^{-6} = 0,00000118$ t/a

Total Emissions of Pollutants:

Name	Max. Single emission, g/sec	Total emission, t/a
Nitrogen dioxide	0,000391	0,01232986
Ammonia	0,00243799	0,07704918
Hydrogen sulphide	0,00020359	0,00648936
Carbon oxide	0,00882013	0,27815062
Methane	0,20982159	6,616931638
Methyl mercaptan	0,00000027685	0,0000087287
Ethyl mercaptan	0,00000011924	0,0000037495

Parameters of Atmospheric Emissions

Air emission parameters of hazardous substances are given in Tables

Characterization of emission sources of harmful substances

Name of the station, device or site	Source of emission of harmful substances			Source of generation of harmful substances					Harmful substances		Volume of harmful substances emitted from a source, t/a
	#*	Name	Number	#*	Name	Number	Daily working time	Number of working days in a year	Name	Code	
1	2	3	4	5	6	7	8	9	10	11	12
Aerobic wastewater treatment system	ϑ-1	Unorganized	1	1	Intake chamber 99,5m²	7	24	8760	Nitrogen dioxide	301	0,00013812
									Ammonia	303	0,00138789
									Hydrogen sulphide	333	0,0001427
									Carbon oxide	337	0,00339422
									Methane	410	0,081290032
									Methyl mercaptan	1715	0.0000001387
									Ethyl mercaptan	1728	0.0000000697
				2	Active sludge tank (anaerobic tank) 4684 m²	7	24	8760	Nitrogen dioxide	301	0.00704608
									Ammonia	303	0,0536275
									Hydrogen sulphide	333	0,00461876
									Carbon oxide	337	0,1574687
									Methane	410	6,24529
									Methyl mercaptan	1715	0.000004919
									Ethyl mercaptan	1728	0,000002175
				3	Secondary Settler 706.5 m²	7	24	8760	Nitrogen dioxide	301	0,0009523
									Ammonia	303	0.00448
									Hydrogen sulphide	333	0,00034815
									Carbon oxide	337	0.0213057
									Methane	410	0.006925306
									Methyl mercaptan	1715	0,000000719
									Ethyl mercaptan	1728	0.000000257
				4	Primary Settler (biological filter) 113,5 m²	7	24	8760	Nitrogen dioxide	301	0,00015736
									Ammonia	303	0.00008609
									Hydrogen sulphide	333	0.00007628
									Carbon oxide	337	0.003364

									Methane	410	0.0133523
									Methyl mercaptan	1715	0,000000149
									Ethyl mercaptan	1728	0,0000000678
Aerobic wastewater treatment system	ბ-1	Unorganized	1	5	Sludge Bed 2755 m²	7	24	8760	Nitrogen dioxide	301	0,004036
									Ammonia	303	0.0174677
									Hydrogen sulphide	333	0,00123463
									Carbon oxide	337	0.092618
									Methane	410	0.270074
									Methyl mercaptan	1715	0,000002803
									Ethyl mercaptan	1728	0,00000118

Characterization of emission sources of harmful substances

# of emission sources	Parameters of emission sources		Parameters of dust/gas/air mixture near the outlet of the emission sources			Code of harmful substances	Volume of emitted harmful substances		Coordinates of emission sources in coordinate system of the facility, m					
									Point source		Linear source			
											First end		Second end	
	Height	Diameter or dimension of cross-section	Velocity, m/sec	volume, m³/sec	Temperature , t⁰C		g/s	t/a	X	Y	X_1	Y_1	X_2	Y_2
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
g-1	2	-	-	-	18	301	0,0003910	0,0123299	-	-	-91,0	0	96,0	0
						303	0,0024380	0,0770492						
						333	0,0002036	0,0064894						
						337	0,0082013	0,2781506						
						410	0,2098216	6,6169316						
						1715	0,0000003	0,0000087						
						1728	0,0000001	0,0000037						

Description of gas and dust trap

Harmful substance			Gas and dust trap		Concentration of harmful substances, g/m³		Quality of purification of gas and dust trap, %	
# of harmful substance generation source	# emission source	Code	Name	Number, unit	Prior to the treatment	After the treatment	Design	Actual
1	2	3	4	5	6	7	8	9

Gas and dust traps are not considered in technological cycle.

Atmospheric Emissions, their purification and utilization

Harmful substance		Volume of harmful substances emitted from sources (column 4 column 6)	Including			Trapped		Total volume of emissions (column 3-column 7)	% of trapped emissions compared to emitted (column 7/ column.3) X100
			Emitted without treatment		Passed the treatment facility				
Code	Name		Total	From organized emission sources		Total	Utilized		
1	2	3	4	5	6	7	8	9	10
301	Nitrogen dioxide	0,0123299	0,0123299	-	-	-	-	0,0123299	0,00
303	Ammonia	0,0770492	0,0770492	-	-	-	-	0,0770492	0,00
333	Hydrogen sulphide	0,0064894	0,0064894	-	-	-	-	0,0064894	0,00
337	Carbon oxide	0,2781506	0,2781506	-	-	-	-	0,2781506	0,00
410	Methane	6,6169316	6,6169316	-	-	-	-	6,6169316	0,00
1715	Methyl mercaptan	0,0000087	0,0000087	-	-	-	-	0,0000087	0,00
1728	Ethyl mercaptan	0,0000037	0,0000037	-	-	-	-	0,0000037	0,00

Report on Calculation of Atmospheric Emissions

Based on the visual audit, there are no stationary sources of air pollution within or in the vicinity of the project area. Therefore, recommendations provided in Article 5 Paragraph 8 of the № 408 Decree of the Government of Georgia (on the approval of technical regulations for calculating standards of permissible discharges of harmful substances in the ambient air) should be considered during the assessment of atmospheric ambient air pollution within the project area. Population of the adjacent areas is less than 10 000 people. Therefore, background values equal to zero.

As the distance between the project area and the nearest settlement is 0.3 km (control point №5) to the northwest, 0.58 km (control point №6) to the North and 0.6 km (control point №7) to the South, modeling the air quality [3] performed with regard to the control points (№ 1, 2, 3, 4) located in 500 m standardized zone from additional sources. Geometric center of the treatment plant is considered to be the source of coordinates.

Control Points

№	Coordinates of control points (m)		Height (m)	Type of the control point	Comment
	X	Y			
1	-65,00	580,00	2	On the border of 500 meters zone	To the North
2	606,00	5,00	2	On the border of 500 meters zone	To the East
3	22,00	-582,00	2	On the border of 500 meters zone	To the South
4	-607,00	-4,00	2	On the border of 500 meters zone	To the West
5	-330,00	237,00	2	Control point on the border of the populated area	Nearest settlement to the West
6	226,00	642,00	2	Control point on the border of the populated area	Nearest settlement to the North
7	234,00	-632,00	2	Control point on the border of the populated area	Nearest settlement to the South

7 individual substances and 1 partial exposure group (6003) were included in emission calculation. MPC criteria are adopted according to [2], climatic characteristics according to [3]. Scattering calculation is adopted according to [6].

List of references used in calculations:

1. საქართველოს გარემოს დაცვისა და ბუნებრივი რესურსების მინისტრის 2013 წლის 8 აგვისტოს №56 ბრძანება „ატმოსფერულ ჰაერში მავნე ნივთიერებათა ზღვრულად დასაშვები გაფრქვევის ნორმების გაანგარიშების მეთოდის შესახებ“
2. საქართველოს შრომის, ჯანმრთელობისა და სოციალური დაცვის მინისტრის 2001 წლის 16 აგვისტოს N 297/ნ ბრძანება „გარემოს ხარისხობრივი მდგომარეობის ნორმების დამტკიცების შესახებ“;
3. საქართველოს ეკონომიკური განვითარების მინისტრის 2008 წლის 25 აგვისტოს ბრძანება № 1-1/1743 „დაპროექტების ნორმების-„სამშენებლო კლიმატოლოგია“.
4. Расчет количества загрязняющих веществ выделяющичся в атмосферныи воздух от неорганизованных источников загрязнения станций аерации сточных вод. Москва 1994 год;
5. «Методическое пособие по расчету, нормированию и контролю выбросов загрязняющих веществ в атмосферный воздух», СПб., 2005.
6. УПРЗА ЭКОЛОГ, версия 3.00 ФИРМА "ИНТЕГРАЛ" Санкт-Петербург 2001-2005г.

Printout Version of Calculated Emission of Hazardous Substances

УПРЗА ЭКОЛОГ, версия 3.1

Serial number 01-01-2568, Scientific-Research Firm «Gamma»

Enterprise number473; Tskaltubo Treatment Plant

Initial data option: 1, new option of initial data
Calculation option: new option of calculation
Calculation is conducted: in summer
Calculation module: "ОНД-86"
Design constants: E1= 0,01, E2=0,01, E3=0,01, S=999999,99 km²

Meteorological parameters

Average temperature of the hottest month	26° C
Average temperature of the coldest month	2° C
Coefficient depending on the temperature of the atmosphere stratification, A	200
Maximum wind speed for the area (repeatability of exceeding is 5%)	19 m/s

Enterprise structure (sites, workshop)

Number	Name of the site (workshop)

Emission Sources Parameters

Recording:
"%" - Background has been exluded during the calculation of sources of emissions
"+" - Sources of emissions have been calculated together with background
"-" - Source has not been calculated and its contribution is not included in the background
In case of absence of elevations, source is not calculated

Types of sources:
1 – point;
2 – Linear;
3 – Unorganized;
4 - Combination of point type sources;
5 - Unorganized, time variable emission capacity;
6 - Point, umbrella or horizontal type sources;
7 - Combination of point type emissions from umbrella or horizontal type sources ;
8 – highway (road)

Recoding during calculation	Site №	plant. №	Source №	Name of source	Option	Type	Height of the source (m)	diameter (m)	Volume of gas-air mixture (m^3/s)	Speed of gas-air mixture (m/s)	Temperature of gas-air mixture (°C)	Relief factor	coordi. X1 axis (m)	Coordi. Y1 axis (m)	Coordi. X2 axis (m)	Coordi.Y2 axis (m)	Width of the source (m)
%	0	0	1	Treatment device	1	3	2,0	0,00	0	0,00000	0	1,0	-91,0	0,0	96,0	0,0	150,00

Substance code	Substance	Emission (g/s)	Emission (t/a)	F	summer	Cm/MPC	Xm	Um	Winter:	Cm/MPC	Xm	Um
0301	Nitrogen (IV) oxide (nitrogen dioxide)	0,0003910	0,0123299	1		0,070	11,4	0,5		0,070	11,4	0,5
0303	Ammonia	0,0024380	0,0770492	1		0,435	11,4	0,5		0,435	11,4	0,5
0333	Sulfide	0,0002036	0,0064894	1		0,909	11,4	0,5		0,909	11,4	0,5
0337	Carbon monoxide	0,0082013	0,2781506	1		0,059	11,4	0,5		0,059	11,4	0,5
0410	Methane	0,2098216	6,6169316	1		0,150	11,4	0,5		0,150	11,4	0,5
1715	Methyl mercaptan	0,0000003	0,0000087	1		0,099	11,4	0,5		0,099	11,4	0,5
1728	Ethyl mercaptan	0,0000001	0,0000037	1		0,085	11,4	0,5		0,085	11,4	0,5

Emission from sources according to substances

Recording:
"%" - Background has been exluded during the calculation of sources of emissions
"+" - Sources of emissions have been calculated together with background
"-" - Source has not been calculated and its contribution is not included in the background
In case of absence of elevations, source is not calculated
Sources marked or not marked with (-) sign are not considered

Types of sources:
1 – point;
2 – Linear;
3 – Unorganized;
4 - Combination of point type sources;
5 - Unorganized, time variable emission capacity;
6 - Point, umbrella or horizontal type sources;
7 - Combination of point type emissions from umbrella or horizontal type sources ;
8 – highway (road)

Substance: 0301 Nitrogen (IV) oxide (nitrogen dioxide)

№ site	№ Plant	№ source	Type	Recording	Emission (g/s)	F	Summer			Winter		
							Cm/MPC	Xm	Um (m/s)	Cm/MPC	Xm	Um (m/s)
0	0	1	3	%	0,0003910	1	0,0698	11,40	0,5000	0,0698	11,40	0,5000
Total:					0,0003910		0,0698			0,0698		

Substance: 0303 Ammonia

№ site	№ Plant	№ source	Type	Recording	Emission (g/s)	F	Summer			Winter		
							Cm/MPC	Xm	Um (m/s)	Cm/MPC	Xm	Um (m/s)
0	0	1	3	%	0,0024380	1	0,4354	11,40	0,5000	0,4354	11,40	0,5000
Total:					0,0024380		0,4354			0,4354		

Substance: 0333 Hydrogen Sulfide

№ site	№ Plant	№ source	Type	Recording	Emission (g/s)	F	Summer			Winter		
							Cm/MPC	Xm	Um (m/s)	Cm/MPC	Xm	Um (m/s)
0	0	1	3	%	0,0002036	1	0,9089	11,40	0,5000	0,9089	11,40	0,5000
Total:					0,0002036		0,9089			0,9089		

Substance: 0337 Carbon monoxide

№ site	№ Plant	№ source	Type	Recording	Emission (g/s)	F	Summer			Winter		
							Cm/MPC	Xm	Um (m/s)	Cm/MPC	Xm	Um (m/s)
0	0	1	3	%	0,0082013	1	0,0586	11,40	0,5000	0,0586	11,40	0,5000
Total:					0,0082013		0,0586			0,0586		

Substance: 0410 Methane

№ site	№ Plant	№ source	Type	Recording	Emission (g/s)	F	Summer			Winter		
							Cm/MPC	Xm	Um (m/s)	Cm/MPC	Xm	Um (m/s)
0	0	1	3	%	0,2098216	1	0,1499	11,40	0,5000	0,1499	11,40	0,5000
Total:					0,2098216		0,1499			0,1499		

Substance: 1715 Methyl mercaptan

№ site	№ Plant	№ source	Type	Recording	Emission (g/s)	F	Summer			Winter		
							Cm/MPC	Xm	Um (m/s)	Cm/MPC	Xm	Um (m/s)
0	0	1	3	%	0,0000003	1	0,0989	11,40	0,5000	0,0989	11,40	0,5000
Total:					0,0000003		0,0989			0,0989		

Substance: 1728 Ethyl mercaptan

№ site	№ Plant	№ source	Type	Recording	Emission (g/s)	F	Summer			Winter		
							Cm/MPC	Xm	Um (m/s)	Cm/MPC	Xm	Um (m/s)
0	0	1	3	%	0,0000001	1	0,0852	11,40	0,5000	0,0852	11,40	0,5000
Total:					0,0000001		0,0852			0,0852		

Sources of emission according to exposure groups

Recording:
"%" - Background has been exluded during the calculation of sources of emissions
"+" - Sources of emissions have been calculated together with background
"-" - Source has not been calculated and its contribution is not included in the background
In case of absence of elevations, source is not calculated
Sources marked or not marked with (-) sign are not considered

Types of sources:
1 – point;
2 – Linear;
3 – Unorganized;
4 - Combination of point type sources;
5 - Unorganized, time variable emission capacity;
6 - Point, umbrella or horizontal type sources;
7 - Combination of point type emissions from umbrella or horizontal type sources ;
8 – highway (road)

Total exposure group: 6003

№ site	№ Plant	№ source	Type	Recording	Emission (g/s)	№ site	F	Summer			Winter		
								Cm/MPC	Xm	Um (m/s)	Cm/MPC	Xm	Um (m/s)
0	0	1	3	%	0303	0,0024380	1	0,4354	11,40	0,5000	0,4354	11,40	0,5000
0	0	1	3	%	0333	0,0002036	1	0,9089	11,40	0,5000	0,9089	11,40	0,5000
Total:						0,0026416		1,3443			1,3443		

Calculation has been made according to substances

Code	Substance	Maximum permissible concentration			MPC correction coefficient	Background concentration	
		Type	Reference value	Used in the calculation		Recording	Interpretation
0301	Nitrogen (IV) oxide (nitrogen dioxide)	Max. single	0,2000000	0,2000000	1	No	No
0303	Ammonia	Max. single	0,2000000	0,2000000	1	No	No
0333	Sulfide	Max. single	0,0080000	0,0080000	1	No	No
0337	Carbon monoxide	Max. single	5,0000000	5,0000000	1	No	No
0410	Methane	Estimated safe exposure level	50,0000000	50,0000000	1	No	No
1715	Methyl mercaptan	Max. single	0,0001000	0,0001000	1	No	No
1728	Ethyl mercaptan	Max. single	0,0000500	0,0000500	1	No	No
6003	Total impact group: (2) 303 333	Group	-	-	1	No	No

Selection of design meteoparameters

Automatic selection

Wind speed selection is conducted automatically

Wind direction

Start of the sector	End of the sector	Wind selection bid
0	360	1

Rated area

Calculated Areas

№	Type	Full description of the area				Width (m)	Bid (m)		Height (m)	Note
		Coordinates of the central point, I side (m)		Coordinates of the middle point, II side (m)						
		X	Y	X	Y		X	Y		
1	Automatic	0	0	0	0	114	0	0	0	

Reference points

№	Coordinates of points (m)		Height (m)	Type of point	Note
	X	Y			
1	-65,00	580,00	2	At border of 500 m zone	To the North
2	606,00	5,00	2	At border of 500 m zone	To the East
3	22,00	-582,00	2	At border of 500 m zone	To the South
4	-607,00	-4,00	2	At border of 500 m zone	To the West
5	-330,00	237,00	2	At border of the settlement	Nearest settlement to the West
6	226,00	642,00	2	At border of the settlement	Nearest settlement to the North
7	234,00	-632,00	2	At border of the settlement	Nearest settlement to the South

Calculation results according to substances
(Calculating points)

Point types:
0–customer's calculation point
1–point on the border of protection zone
2– point on the border of factory zone
3–point on the border of sanitary-protection zone
4–point on the border of the populated zone
5–development border

№	Coordinate X(m)	Coordinate(m)	height(m)	concentration (MPC)	Wind direction.	Wind speed	Background (part of MPC)	Background before exclusion	Point type
Substance: 0301 Nitrogen (IV) oxide (nitrogen dioxide)									
5	-330	237	2	1,0e-3	125	19,00	0,000	0,000	4
2	606	5	2	7,8e-4	270	19,00	0,000	0,000	3
4	-607	-4	2	7,7e-4	90	19,00	0,000	0,000	3
1	-65	580	2	7,2e-4	173	19,00	0,000	0,000	3
3	22	-582	2	7,2e-4	358	19,00	0,000	0,000	3
7	234	-632	2	6,5e-4	340	19,00	0,000	0,000	4
6	226	642	2	6,4e-4	199	19,00	0,000	0,000	4
Substance: 0303 Ammonia									
5	-330	237	2	6,3e-3	125	19,00	0,000	0,000	4
2	606	5	2	4,9e-3	270	19,00	0,000	0,000	3
4	-607	-4	2	4,8e-3	90	19,00	0,000	0,000	3
1	-65	580	2	4,5e-3	173	19,00	0,000	0,000	3
3	22	-582	2	4,5e-3	358	19,00	0,000	0,000	3
7	234	-632	2	4,1e-3	340	19,00	0,000	0,000	4
6	226	642	2	4,0e-3	199	19,00	0,000	0,000	4
Substance: 0333 Hydrogen Sulfide									
5	-330	237	2	0,01	125	19,00	0,000	0,000	4
2	606	5	2	0,01	270	19,00	0,000	0,000	3
4	-607	-4	2	0,01	90	19,00	0,000	0,000	3
1	-65	580	2	9,3e-3	173	19,00	0,000	0,000	3
3	22	-582	2	9,3e-3	358	19,00	0,000	0,000	3
7	234	-632	2	8,5e-3	340	19,00	0,000	0,000	4
6	226	642	2	8,4e-3	199	19,00	0,000	0,000	4
Substance: 0337 Carbon monoxide									
5	-330	237	2	8,5e-4	125	19,00	0,000	0,000	4
2	606	5	2	6,5e-4	270	19,00	0,000	0,000	3
4	-607	-4	2	6,5e-4	90	19,00	0,000	0,000	3
1	-65	580	2	6,0e-4	173	19,00	0,000	0,000	3
3	22	-582	2	6,0e-4	358	19,00	0,000	0,000	3
7	234	-632	2	5,5e-4	340	19,00	0,000	0,000	4
6	226	642	2	5,4e-4	199	19,00	0,000	0,000	4
Substance: 0410 Methane									
5	-330	237	2	2,2e-3	125	19,00	0,000	0,000	4
2	606	5	2	1,7e-3	270	19,00	0,000	0,000	3
4	-607	-4	2	1,7e-3	90	19,00	0,000	0,000	3

1	-65	580	2	1,5e-3	173	19,00	0,000	0,000	3
3	22	-582	2	1,5e-3	358	19,00	0,000	0,000	3
7	234	-632	2	1,4e-3	340	19,00	0,000	0,000	4
6	226	642	2	1,4e-3	199	19,00	0,000	0,000	4

Substance: 1715 Methyl mercaptan

5	-330	237	2	1,4e-3	125	19,00	0,000	0,000	4
2	606	5	2	1,1e-3	270	19,00	0,000	0,000	3
4	-607	-4	2	1,1e-3	90	19,00	0,000	0,000	3
1	-65	580	2	1,0e-3	173	19,00	0,000	0,000	3
3	22	-582	2	1,0e-3	358	19,00	0,000	0,000	3
7	234	-632	2	9,2e-4	340	19,00	0,000	0,000	4
6	226	642	2	9,1e-4	199	19,00	0,000	0,000	4

Substance: 1728 Ethyl mercaptan

5	-330	237	2	1,2e-3	125	19,00	0,000	0,000	4
2	606	5	2	9,5e-4	270	19,00	0,000	0,000	3
4	-607	-4	2	9,4e-4	90	19,00	0,000	0,000	3
1	-65	580	2	8,8e-4	173	19,00	0,000	0,000	3
3	22	-582	2	8,8e-4	358	19,00	0,000	0,000	3
7	234	-632	2	8,0e-4	340	19,00	0,000	0,000	4
6	226	642	2	7,9e-4	199	19,00	0,000	0,000	4

Substance: 6003 Total impact group (2) 303 333

5	-330	237	2	0,02	125	19,00	0,000	0,000	4
2	606	5	2	0,01	270	19,00	0,000	0,000	3
4	-607	-4	2	0,01	90	19,00	0,000	0,000	3
1	-65	580	2	0,01	173	19,00	0,000	0,000	3
3	22	-582	2	0,01	358	19,00	0,000	0,000	3
7	234	-632	2	0,01	340	19,00	0,000	0,000	4
6	226	642	2	0,01	199	19,00	0,000	0,000	4

15.3 Annex 3. Noise Propagation Calculation

On construction phase the main sources of noise is assumed to be the machinery and transport equipment working simultaneously in construction sites and nearby construction camps, namely:

- Bulldozer, the noise level of which is 90 dBA;
- Dump truck (85 dBA),
- Crane (92 dBA).

On operation phase the main source of noise propagation will be working pumping stations (3 pumps may work simultaneously). In addition, source of noise propagation may be electrical substation (transformer).

Based on literary and Fund sources, noise generated from pumping stations usually reaches 60-90 dBA. Capacity of the proposed transformer would not be significant and its noise level will be about 80-85 dBA.

The calculation point for construction and operation phases is the residential house situated in the northwest, which is in 300 m from the site border (from site center the distance is 400 m).

Octave sound pressure levels in the reference point are calculated according to the following formula:

$$L = L_p - 15\lg r + 10\lg \Phi - \frac{_a r}{1000} - 10\lg \Omega, \quad (1)$$

Where,

L_p – Octave level of the noise source capacity;

Φ – noise source direction factor, non-dimensional, is determined through trial and changes from 1 to 8 (depends on spatial angle of sound radiation);

r – Distance from the source of the noise to the reference point;

Ω – Spatial angle of sound radiation, which will be: $\Omega = 4\pi$- when located in the space; $\Omega = 2\pi$- when located on the surface of the area; $\Omega = \pi$ - double ribbed angle; $\Omega = \pi/2$ – triple ribbed angle;

$_a$ – Sound damping in the air (dBA/km) tabular description.

Average geometric frequencies of the octave lines, H Hz.	63	125	250	500	1000	2000	4000	8000
$_a$ dBA/km	0	0.3	1.1	2.8	5.2	9.6	25	83

Noise source levels on the noise-generating section are summarized according to the formula:

$$10\lg \sum_{i=1}^{n} 10^{0,1Lpi} \quad (2)$$

Where:

L_{pi} – is i-type noise source capacity.

Following assumptions are made to perform the calculation:

1) If distance between some noise sources, located on the same site is less than distance to the reference point, sources are combined into one group.
2) To assess the total level of noise sources combined into one group, as a distance to accounting point was used their distance from geometric center;
3) For simplicity, the calculations are performed for the sound equivalent levels (dBA) and average value of its octave indicator is taken as sound damping coefficient in the air βave=10.5 dBA/km;

The calculation was conducted for simultaneous operation of all the machinery-equipment on the selected site, considering the minimum screening of the noise (worst case scenario).

By putting the data in the second formula, we will obtain the total noise level from the generation point:

$$\text{Operation phase: } 10\lg\sum_{i=1}^{n}10^{0,1Lpi} = 10\lg\left(10^{0,1x90}+10^{0,1x90}+10^{0,1x90}+10^{0,1x85}\right)= 95{,}2 \text{ dBA.}$$

It should be mentioned that installations will be arranged in closed premises. Besides, noise propagation will be limited by the infrastructure of treatment plant. Overall, the total noise level at generation point will be reduced by 25 dBA and it will be 70 dBA.

By putting the data in the first formula, we will obtain noise level from reference point, the nearest receptor:

Construction phase:

$$L=L_p-15\lg r+10\lg\Phi-\frac{ar}{1000}-10\lg\Omega, \quad = 94{,}6 - 15*\lg300+10*\lg2-10.5*300/1000-10x\lg2\ \pi=49{,}4 \text{ dBA}$$

Operation phase:

$$L=L_p-15\lg r+10\lg\Phi-\frac{ar}{1000}-10\lg\Omega, \quad = 70 - 15*\lg400+10*\lg2-10.5*400/1000-10x\lg2\ \pi=22 \text{ dBA}$$

15.4 Annex 4. Water Quality Impact Assessment after Mixing Effluents with Tskaltubostskali River

Wastewater from WWTP is considered to be discharged into Tskaltubostskali River, which belongs to the category of industrial-household water body. For water quality assessment the methodology given in the following technical regulation will be used: Technical Regulation –"Methods of calculation of maximum permissible discharges of pollutants together with wastewater into surface water bodies", approved by the order No 414 of the Government of Georgia, dated as December 31, 2013.

According to the mentioned methodology, maximum permissible discharges of various pollutants are determined, which is allowed to be discharged at the project section, considering background concentration in the recipient water body, water body category, maximum allowable concentrations of substances in the water and their assimilation ability. Results have been compared to the capacity of the project WWTP.

According to the above-mentioned methodology, maximum permissible concentrations of pollutants (C_{MPCs}) in wastewater, discharged into the river are calculated according to the following formulae:

For Suspended Solids:

$$C_{\text{ზ.ღ.ჩ.}} = p\left(\frac{a \cdot Q}{q} + 1\right) + C_{\text{ვ}} \qquad (1)$$

where,

a – factor, indicating the level of mixing and dilution of wastewater and river water (dilution provision factor). The coefficient is calculated according to I.Rodzileri formula.

Q – Minimum design flow in the river m³/s. Average river flow with 97% provision is taken which is **2,25 m³/s** (see Table 5.2.3.1.);

q – is maximum wastewater flow m³/s. According to the par.4.2. of EIA report, peak wastewater flow for 2028 is **483 m³/h (0,1342 m³/s);**

P- possible growth of suspended solid concentration in the river after wastewater discharge in mg/l. It is determined according to 'Rules for Protection of Surface Water from Contamination' and comprises **0,75 mg/l;**

C_{backgr} - Background concentration of suspended solids in the river in mg/l. According to the table, given in par. 5.1.3. of EIA report, average background concentration of suspended solids at the design section is determined as **68 mg/l;**

For Biological Oxygen Demand (BOD_{ful}):

$$C_{\text{zdC}} = \frac{a \cdot Q(C_t - C_r \cdot 10^{-Kt})}{q \cdot 10^{kt}} + \frac{C_t}{10^{-kt}} \qquad (2)$$

where,

C_t – is the BOD_{total} maximum permissible concentration in mg/l at design section, after mixing wastewater with river water. According to the Technical Regulation – "Protection of Surface Water Contamination", approved by the decree №425 of the Government of Georgia on December 31, 2013, for Tskaltubostskali river it is **6 mg/l.**

C_r – is the background value for BOD $_{total}$ in the river in mg/l. According to the table, given in par. 5.1.3. of EIA report, at the design section, average background concentration of BOD is determined as **2,3 mg/l;**

10^{-kt} - The coefficient that determines the oxidation of the organic substances in the water body and is equal to **1.**

For other pollutants (in our case COD, Total Nitrogen, Total Phosphorus):

$$C_{\text{ზ.ღ.ჩ.}} = \frac{aQ}{q}(C_{\text{ზ.ღ.ბ.}} - C_{\text{ფ.}}) + C_{\text{ზ.ღ.ბ.}} \qquad (3)$$

Where,

C_{MPC} – Maximum permissible concentration of pollutant substances in mg/l according to the water body category and equals to 30 mg/l for COD. As for total nitrogen and total phosphorus:

According to Technical Regulation – "Protection of Surface Water Contamination", approved by the decree №425 of the Government of Georgia on December 31, 2013, MPCs for the above-mentioned substances are not determined.

However, according to normative document:

- MPC for ammonium nitrogen (NH_4) is 0,39 mg/l;
- MPC for nitrates (NO_3) - 45 mg/l, which corresponds to nitrate nitrogen value - 10,2 mg/l;
- MPC for nitrites (NO^2) - 3,3 mg/l, which corresponds to nitrite nitrogen value - 1,2 mg/l.

Thus we have received inorganic nitrogen MPC value:

0,39 mg/l (ammonium nitrogen) + 10,2 mg/l nitrate nitrogen) + 1,0 mg/l (nitrite nitrogen) = 11,6 mg/l.

In general, concentration of organic nitrogen in surface water is 5% of inorganic nitrogen.

Taking into consideration aforementioned, we assume the value of MPC for total nitrogen as:

11,6 + 11,6 x 0.05 = 12.2 mg/l.

According to normative document, MPC for polyphosphates (PO_4) is 3.5 mg/l, which corresponds to inorganic phosphorus 1,14 mg/l. In general the concentration of organic phosphorus in surface water is also 5% of inorganic phosphorus.

Taking into consideration aforementioned, MPC for total phosphorus should not exceed:

1,14 + 1,14 x 0.05 = 1,2 mg/l

In result of calculations, we have received MPC values for total nitrogen and total phosphorus in surface water **12.2 mg/l and 1,2 mg/l respectively.**

In the formulae 3 above $C_{backgr.}$ Is background concentration of pollutant substances in water body in mg/l. According to par. 5.1.3. of EIA report, average background concentration of pollutant at the design section is determined as :

- COD - **15 mg/l;**
- Total Nitrogen – **3,1 mg/l;**
- Total Phosphorus **- 0,2 mg/l.**

According to I. Rodzileri formula:

$$a = \frac{1-}{1+\frac{Q}{q}\cdot} \qquad (4)$$

where,

β – is interim factor and is determined by following formula:

$$:= e^{-\sim\sqrt[3]{L}} \qquad (5)$$

L – is the distance between wastewater discharge point and the design section in river stream direction, in meters. A design section in 830 m from wwastewater discharge point (road bridge on Tskaltubostskali river leading to Gvishtibi village) is selected;

α- coefficient, considering hydraulic factors of mixing and is determined by the following formula:

$$\alpha = \ell \cdot i \sqrt[3]{\frac{E}{q}} \qquad (6)$$

ℓ - factor, depending on the place of wastewater discharge into the river. While discharging at the bank it is 1.0, and at the maximum water speed points it is – 1,5, the estimated value is **1,0.**

i – River curvature factor, equals to:

$$i = \frac{L}{L} \qquad (7)$$

L_{backgr}- is the distance between wastewater discharge point and the design section in river stream direction, in meters. It equals to **830 m.**

$L_{alignment}$ – The shortest distance between these points (according to the alignment) and it is 800 m. (river flows straitforward and does not meander).

Accordingly, **i** equals to:

$$\frac{830}{800} = 1.0375$$

E – is the factor of turbulent diffusion, which equals to:

$$E = \frac{V \quad *H}{200} \qquad (8)$$

V_{ave}, H_{ave} – is the average speed and depth at the design section. Average water layer depth at the design section is **0,4 m**, and average speed - **1,2 m³/s.**

Accordingly:

$$E = \frac{0.4 \times 1.2}{200} = 0{,}0024$$

Taking into consideration the aforementioned, according to the formula 6:

$$\sim = 1 \times 1 \sqrt[3]{\frac{0{,}0024}{0.1342}} = 0.27134$$

and according to the formula 5:

$$\beta = 0.0781$$

By inserting the data into Rodzileri formula, we will get:

$$a = \frac{1 - 0.0781}{1 + \frac{2.25}{0.1342} 0.0781} = 0.399$$

Maximum permissible concentrations of pollutants (C_{MPC}) have been determined by using formulae (1), (2) and (3) for design section. Obtained results are given in the table. The capacity of the project WWTP for both phases is also given here.

Maximum Permissible Concentrations (MPC) (mg/l) of pollutants in the wastewater for the project section of Tskaltubostskali River

Pollutants	Maximum Permissible Concentrations (MPC) of pollutants in the wastewater (mg/l)	Efficiency of treatment plant, mg/l	
		Phase 1- project year 2028	Phase 2- project year 2038
Suspended Solids	73,8	35,0	35,0
BOD	30,8	25,0	25,0
COD	130,4	125,0	125,0
Total Nitrogen	73,1	40,0	15,0
Total Phosphorus	7,9	7,3	2,0

15.5 Annex 5. Waste Management Plan

Introduction

The present paragraph describes waste management plan for waste, generated during Tskaltubo WWTP construction and operation project implementation. The Waste Management Plan is developed based on the project of the planned activities and it will be adjusted/updated prior to the construction, as well as before commissioning.

The present waste management plan is prepared based on the requirements of "Waste Management Code". Under the paragraph 1, article 14 of this law, "the natural or legal person, whose activity causes the generation of more than 200 t non-hazardous waste or more than 1000 t of inert waste or hazardous waste in any amount, is obliged to develop "waste management plan of the company". The waste management plan should be updated in every 3 years or when substantial amendments will be made to the existing waste types or amounts or to their treatment procedures.

As during planned activities (WWTP construction and operation phases) generation of significant amount of non-hazardous and inert wastes, as well as hazardous waste is expected, Tskaltubo WWTP waste management plan is developed, which includes:

- The information about the measures considering waste prevention and recovery;
- The description of generated waste separation methods;
- Methods and conditions for temporary storage of waste;
- Waste transportation rules;
- Waste treatment methods used. Based on the capabilities existing at this stage, the information about person/organization who will be responsible for further treatment of wastes;
- Requirements for the safe treatment of waste;
- Waste control methods.

Developer of the Tskaltubo WWTP project is Municipal Development Fund of Georgia LEPL. WWTP will be operated by UNWSC. The information on mentioned organizations is given in Table.

	Construction Phase	Operation Phase
Developer company	Municipal Development Fund LEPL	United National Water Supply Company LLC
Legal Address	D. Aghmashenebeli No 150, Tbilisi	Vazha Pshavela Avenue 76b, Tbilisi
Type of the activity	Construction of Tskaltubo Wastewater Treatment Plant	Operation of Tskaltubo WWTP
Chairman	Director – Gagi Buadze	To be clarified before commissioning
Contact person	Ana Rukhadze	To be clarified before commissioning
Contact Tel:	(99532) 2437001; 2437002; 2437003; 2437004	To be clarified before commissioning
E-mail	mdf@mdf.org.ge	info@water.gov.ge
Consulting company	Gamma Consulting LTD	
Director of Gamma Consulting LTD	Zurab Mgaloblishvili	
Contact Tel:	2 60 44 33; 2 60 15 27	

Waste Management Plan Aims and Objectives

The present waste management plan sets the rules for industrial and household collection, transportation, disposal, deactivation and utilization, generated during Tskaltubo Wastewater Treatment Plant construction and operation process, in compliance with requirements of sanitary-hygienic and epidemiological standards and regulations.

The main objectives of waste management process:

- To provide waste identification according to their types;
- To provide waste separation and collection, to keep rules necessary for their temporary storage, in order to exclude their impact on environment or human health;
- To provide waste transportation so that exclude waste scattering, loss, creating emergency situations, posing threats for the environment or human health;
- To reduce the amount of waste;
- Reusing wastes;
- To define personnel responsibility on waste management;
- To provide industrial and household waste record.

The present plan includes all types of planned activities, when waste will be generated, including:

- Usual work (construction and operation) conditions;
- Unusual work conditions (e.g.: during repairing works);
- Work in emergency situations.

To follow the directives set in the plan is mandatory for all staff of the company and for contractors engaged in the construction.

Waste Management Hierarchy and Principles

In Georgia waste management policy and Georgian legislation in waste management field is based on the following hierarchy:

- Prevention;
- Preparation for reusing;
- Recycling;
- Other recovery types, including energy recovery;
- Disposal.

When defining certain responsibilities regarding waste management hierarchy, the following should be considered:

- Environmental benefits;
- Technical feasibility by using the best available equipment
- Economic practicability.

The waste management should be implemented avoiding threats to environment and human health, namely, so that wastes management:

- Does not pose threats to water, air, soil, flora and fauna;
- Does not cause noise and odor occurrence;
- Does not impact negatively on the whole area of the country, especially- on protected areas and cultural heritage.

Waste management is carried out in consideration of the following principles:

- „The principle of taking preliminary security measure" – The measures should be taken in order to prevent threats to the environment posed by wastes, even when there is no scientifically approved data;
- The principle of "polluter pays" – the waste generator or waste holder is obliged to cover waste management expenses;

- „Proximity principle“ – wastes should be treated on the nearest waste treatment facility, considering environmental and economic efficiency;
- „The principle of self-dependence“ – integrated and adequate network of municipal waste disposal and recovery facilities should be set up and operate.

List of Waste Generated during project Implementation

Considering specifics of the planned activities, project solutions and gained experience, types and approximate amount of waste, expected during the project implementation have been determined and given in Table.

Waste code	Name	Physical condition	Hazardous yes/no	Hazardous characteristic	Approximate amount of generated wastes as to the years			Disposal/recovery operations	Contractor company	Basel code Y
					2017-2018 Construction phase	2018-2019 Operation phase	2019-2020 Operation phase			
08 01 11*	Waste paint and varnish containing organic solvents or other hazardous substances (as well as paint cans)	Liquid/solid	Yes	H-3B – „Flammable“ H 5 – „Harmful“	60-70 kg/a	20-30 kg/a	20-30 kg/a	D 10	Will be transferred to the organization, appropriately licensed on hazardous waste management	Y12
08 03 17*	Waste printing toner containing hazardous substances (Laser printers)	Solid	Yes	H 5 – „Harmful“	10-20 kg/a	10-20 kg/a	10-20 kg/a	D 9	Will be transferred to the organization, appropriately licensed on hazardous waste management	Y12
12 01 10*	Synthetic machining oils/lubricants (liquid, generated from the transport vehicles and special machinery used in the maintenance of the construction equipment)	Liquid	Yes	H 3-A - „Easy flammable“ H 3-B - „Flammable“ H 5 - „Harmful“	100-200 kg/a	20-30 kg/a	20-30 kg/a	R9	Will be transferred to the organization, appropriately licensed on hazardous waste management	Y8
12 01 13	Welding wastes (welding electrodes)	Solid	No	-	30-60 kg	10-20 kg/a	10-20 kg/a	D1/R4	Will be disposed on the household waste or transferred to the contractor	-
13 07 03*	Other fuels (including mixtures)	Liquid	Yes	H 3-A - „Easy flammable“ H 3-B - „Flammable“ H 5 - „Harmful“	10-20 kg/a	10-20 kg/a	10-20 kg/a	R9	Will be transferred to the organization, appropriately licensed on hazardous waste management	Y8
13 07 08*	Biodegradable oils and other oily lublicants of engine and train of gears	Liquid	Yes	H 3-A - „Easy flammable“ H 3-B - „Flammable“H 5 - „Harmful“	10-20 kg/a	10-20 kg/a	10-20 kg/a	R9	Will be transferred to the organization, appropriately licensed on hazardous waste management	Y8

13 07 09*	Biodegradable oils and other oily lublicants of engine and train of gears	Fluid	Yes	H 3-A – "Easy flammable" H 3-B - „flammable" H 5 - „harmful"	10-20 kg/a	10-20 kg/a	10-20 kg/a	R9	Will be transferred to the organization, appropriately licensed on hazardous waste management	Y8
15 01 01	Paper and cardboard packaging	Solid	No	-	300-500 kg/a	30-60 kg/a	30-60 kg/a	D1	Will be disposed on the household waste	-
15 01 02	Plastic packaging (polyethylene wastes, packaging sealing material, tubes, etc.)	Solid	No	-	500-700 kg/a	50-70 kg/a	50-70 kg/a	D1	Will be disposed on the household waste	-
15 02 02*	Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances (oil contaminated cloths, wiping cloths and protective clothing)	Solid	Yes	H 3-B - „Flammable" H 5 - „Harmful"	100-150 kg/a	50-100 kg/a	50-100 kg/a	D 10	Will be transferred to the organization, appropriately licensed on hazardous waste management	-
16 01 03	End-of life tires	Solid	No	-	1000-2000 kg/a	300-500 kg/a	300-500 kg/a	D1/ R1, R3, R4	Will be transferred to a sub-contractor having tires utilization facility	Y13
16 01 07*	Oil filters	Solid	Yes	H 5 - „Harmful" H-15	50-100 kg/a	20-50 kg/a	20-50 kg/a	D10	Will be transferred to the organization, appropriately licensed on hazardous waste management	-
16 01 17	Ferrous metal	Solid	No	-	60-70 t/a	1-5 t/a	1-5 t/a	R4	Will be transferred to scrap metal disposal points	-
16 01 18	Non-ferrous metal	Solid	No	-						
16 06 01*	Lead batteries (lead batteries of transport vehicles and special machinery used in the construction process)	Solid	Yes	H 6 – „Toxic" H-15	100-200 kg/a	100-200 kg/a	100-200 kg/a	D 9	Will be transferred to the organization, appropriately licensed on hazardous waste management	Y31

17 01 07	Mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	Solid	No	-	2500-2700 m^3/a	-	-	D1	Under agreement with local government will be used for backfilling/vertical planning of various areas.	-
17 02 01	Wood (generated in the result of demolition and cleaning)	Solid	No	-	(amount of trees and vegetation, generated in the result of demolition and cleaning will be determined after taxation)	-	2-5 m^3	D1/R1	Usable material will be transferred to municipal government for further usage. Unusable part will be disposed on household waste landfill.	-
17 02 02 **17 02 03**	Glass, plastics, (generated in the result of demolition and cleaning)	Solid	No	-	1-2 m^3	-	-		Disposed on the construction waste landfill of Tskaltubo town.	~
17 04 11	Cables other than those mentioned in 17 04 10	Solid	No	-	20-50 kg/a	-	-	D1/R4	Disposed on the construction waste landfill.	-
17 05 03*	Soil and stones containing dangerous substances (soil and ground contaminated by petroleum hydrocarbons)	Solid	Yes	H 5 - „Harmful“	Depended on spillage scale			D2/R9	Will be transferred to the organization, appropriately licensed on hazardous waste management	-
17 05 05*	Dredging spoil containing dangerous substances (soil and ground contaminated by petroleum hydrocarbons)	Soil	Yes	H 5 - „Harmful“	Depended on spillage scale			D2/R9	Will be transferred to the organization, appropriately licensed on hazardous waste management	-
17 06 05*	Asbestos containing construction materials	Solid	Yes	H 7 - „Carcinogenic“	During visual observation of the area, presence of asbestos has not been proved. During demolition, it is possible to find asbestos containing material.			D1	Bury on construction waste landfill at the depth of not less than 25 cm (with the help of the contractor)	Y36

19 08 01	Screening (solid waste accumulated on the screens of the treatment facility)	Solid	No	-	-	90 m^3/a	90 m^3/a	D1	Will be disposed on household waste landfill.	-
19 08 02	Waste during desanding (waste accumulated in the sand trap of WWTP)	Solid	No	-	-	57 t/a	57 t/a	D1	Will be disposed on household waste landfill.	-
19 08 05	Sediments, generated in the result of recycling of wastewater in urban area/settlements (excess sludge, temporary disposed on sludge drying beds)	Solid	No	-	-	2900 m^3/a	2900 m^3/a	D1	Will be disposed on household waste landfill.	-
20 01 21*	Fluorescent tubes and other mercury-containing waste (fluorescent bulb and other mercury containing materials)	Solid	Yes	H 6 - „Toxic“	5-20 kg/a	5-10 kg/a	5-10 kg/a	D 9	Will be transferred to the organization, appropriately licensed on hazardous waste management.	Y 29
20 03 01	Mixed municipal waste	Solid	No	-	42 m^3/a	10 m^3/a	10 m^3/a	D 1	Sealed and labeled containers will be placed on a territory for waste disposal. Waste will be disposed on Tskaltubo landfill.	Y 46
20 03 04	Septic tank sludge	Fluid	No	-	≈713 m^3/a	-	-	D 4	By means of special vehicles it will be removed and discharged in the nearest sewerage system in compliance with conditions of sewerage system operator company.	-

Description of Waste Management Process

Measures Considered for Waste Prevention and Recovery

Following measures for waste prevention and recovery will be considered during the implementation of the planned activities:

During dismantling and construction works:

- Any type of building materials, items or substances will be brought into the territory in the amount required for the construction works/ properly implementation of technological process. Long-term storage of the material on the site does not occur;
- A large part of building materials, structures, subjects necessary for technological processes will be brought in finished forms (e.g.: inert materials, concrete mixture, timber, etc.);
- During purchasing of building materials, structures, subjects for technological processes the priority will be given to the environmental and quality products. Products will be checked for compliance with international standards (e.g. PCB of Persistent Organic Pollutants in purchased oil products will be controlled);
- Preference will be given to re-use or recycling, biologically degradable and safe for the environment substances, materials and chemical compounds;
- Borders of the construction corridors will be strictly controlled in order not to exceed designated areas and to avoid additional inert and vegetation waste generation;
- Generated waste will be reused as much as possible (e.g.: metal structures, spoil ground existing on the area, plastic materials, etc.).

On WWTP operation phase:

- During implementation of repairing and maintenance works, waste prevention and recovery measures planned for construction phase will be considered;
- At intervals internal sewage network treatment and recovery will be provided, proofness of internal network pits will be ensured, which will reduce the amount of solid wastes accumulated on the grilles of water intake and the amount of sand in the sand grit;
- According to the project, large part of sludge accumulated in the structural objects will be returned into technological cycle to ensure biological treatment process;
- Repair of machinery, used within the project implementation, will be provided outside the treatment plant site, on maintenance shops;
- The personnel will be trained on waste (especially garbage) prevention issues.

Waste Separation, Disposal, Labeling

During the implementation of the planned activities, waste separate collection methods according to their types and hazards will be organized and implemented:

- Different colors of metal/plastic containers with relevant labeling will be arranged on corresponding sections of the WWTP site:
  - One of them will be designated for the collection of household waste;
  - Others - for collection of solid hazardous waste such as: Vehicle oil filters, packing material containing hazardous substance waste or/and oil polluted rags, other cleaning products, paint containers free from liquid mass containing hazardous substances, absorbents, filter materials and others. Special containers should be located near waste generation places;
- **Oil and oil product waste,** such as oils, lubricants and other oily lubricants, will be collected on the places of generation and separately from other waste;
  - Oil waste, lubricants, oil products, their mixture with water and sludge, containing oil products and extracted from WWTP will be stored in closed tanks or containers, protected from leakage and equipped with firefighting device;

- **Outdated and malfunctioning batteries** (not drained of accumulator acid) will be removed directly to a temporary storage area (storage facility) and disposed in wooden boxes, which will have a metal pallets;
- **Luminescent lamps** and other mercury-containing items will be placed in well-closed plastic bags and then in a cardboard packaging and will be removed to a temporary storage area;
- **Ferrous and non-ferrous scrap** will be accumulated on-site of generation in a specially designated area;
- **Used tires** will be collected on waste generation areas, on open areas with solid pavement;
- **Soil and ground** contaminated with hazardous substances will be stored on the roofed area with concrete cover. The area should have slope toward draining channels or/and they should be placed in sealed metal tanks, which for prevention also should be placed on roofed area with concrete surface;
- **Excavated, unused soil and concrete remains** will be directly disposed on a landfill for construction wastes;
- **Wood waste** will be collected on-site of generation, on a specially designated area; Sawdust-in a shed or on area covered with polyethylene;
- **Asbestos waste**, (if any identified during dismantling works), will be collected and removed with sacks of asbestos waste and/or solid, sealed containers of asbestos, if it is required to store the waste. It is necessary to water asbestos waste in order to reduce dust emission during placing asbestos waste in sacks.
- **On operation phase solid wastes** accumulated on the intake grilles will be collected on area with solid surface. Drained water generated on the area will be connected to treatment system;
- **On operation phase material** extracted from sand trap will be removed to the area with solid surface;
- **On operation phase the excess sludge** accumulated in structural units of the treatment plant (useless for technological cycle) will be pumped to the sludge drying bed; For optimal drying a maximum height of 200mm of sludge will be stored at a time. This process is repeated until 600mm of sludge is stored on the drying bed.

Following will be prohibited:

- Accumulation of waste at the site of generation for a long time;
- Storing hazardous waste in containers designated for solid household waste;
- Mixing liquid and solid hazardous waste;
- Mixing hazardous waste with other waste types in order to neutralize it;
- Collection and storage of liquid hazardous waste in an open area, unprotected from atmospheric precipitation;
- Burning of rubber and other waste;
- Discharge hazardous waste into underground and/or surface water;
- Mechanical impact on accumulators.

Waste Packing

Hazardous waste, generated during the project implementation, should be packed properly for temporary storage, in order to reduce impact of waste hazardousness on human health and environment, namely:

- Hazardous waste should be packed with proper material, including containers for solid and semi-solid waste and tanks for liquid waste, which are resistant to waste, kept in them;
- Packing of hazardous waste, keeping them in closed and undamaged condition should be provided, except the case when they are filled or emptied;

- Hazardous waste package should be labeled, where the sign of hazardousness should be provided;[9];
- Asbestos waste are collected in 200 μm (minimum thickness) very stable polyethylene sacks, with the maximum length of 1,200 mm, and width - 900 mm. Sacks should be labeled with warning labels, indicating the information about asbestos containment and warning about dust generation and the risk of breathing the dust in.

In addition, waste containers should comply with the size, shape, composition and hazardous feature of waste. It is strictly prohibited to use damaged containers. Each container should have a cap. Harmful waste should be isolated from other waste.

The aforementioned should be carried out by protecting following rules:

- Warning signs will be provided on containers where hazardous waste are stored;
- Hazardous waste handling rules will be provided on places of hazardous waste disposal;
- It is prohibited to enter areas for hazardous waste sites and on the area without protective means – corresponding warning signs will be provided;
- Proper signs will be provided on containers for household waste;
- Areas for temporary storage of waste (especially in case of hazardous waste) will be marked with proper warning signs;
- Old signs on waste containers will be removed and replaced by new ones;
- All signs on waste containers and in temporary storage areas should be easily readable to enable the personnel to understand easily their content;
- Warning signs should be provided in Georgian and foreign language (if required), which can be understood by personnel, working in the company.

A person responsible for waste management is obliged to provide labeling of waste collecting containers with proper inscriptions or signs, so that it can be possible to determine and precisely describe their content. This is also necessary to protect waste management and safety rules. Besides it is necessary to place warning and prohibiting signs/inscriptions.

Methods and Conditions for Temporary Storage of Waste

Following conditions should be considered for temporary storage sites of waste generated during the planned activities:

- During the construction and operation phases, storage facility (container type) will be arranged for hazardous waste, in accordance to the following requirements:
    - Facilities will have appropriate designation and will be protected from exposure to atmospheric precipitation and strangers encroachment;
    - Warehouse floor and walls will have hard covers;
    - Warehouse ceiling will be arranged with wet strength materials;
    - The facility will be equipped with a wash stand and tap, water intake trap;
    - Shelves and racks will be arranged for placement of waste;
    - Waste will be placed only in hermetic packages, which will have the proper labeling.

Temporary storage of waste will meet the following requirements:

- Pavement of the site will be solid;

[9]Sign of hazardousness on waste package should comply with signs, given in Annex 5 to the decree No 32 of the GoG, dated as January 3, 2014, on approval of the technical regulation on "The Rule of Waste Transportation by Transportation Means".

- The whole perimeter of the site will be fenced in order to exclude spills of harmful substances into the river or soil;
- Convenient access road to the site should be ensured;
- Precipitation and wind exposure to the waste is subject to the effective protection (shed, waste container, etc.);
- Appropriate signs will be arranged throughout the perimeter and site will be protected from strangers;
- If immediate removal of asbestos waste is impossible (e.g. due to requirements related to the volume of removable waste), it should be kept in solid container or bunkers, which will be labeled and closed hermetically after completion the working day, in order to exclude access by unauthorized persons.

Waste Transportation Rules

waste transportation is carried out [10] based on the written agreement between the waste producer/holder and waste transporter, considering the specificity of transportation, the agreement should contain information about special processing measures of vehicles; about organizing of accompanying of vehicles (if necessary); about providing drivers with personal protection means and about neutralization of risks and danger of hazardous wastes.

Waste producer/holder is mandatory to use safe and undamaged containers for waste transportation; to provide compatibility of a container to the transporting wastes during transportation of the hazardous wastes, not to place incompatible wastes in the same containers; not to place wastes in unwashed container that was previously used for transportation of such wastes or material, which are not compatible for the current waste type.

During transportation of hazardous wastes, waste producer is mandatory to prepare the information sheet of the hazardous waste (see the information sheet below), separately for each waste. The sheet should contain information about waste generation, classification and hazardous features, as well as information about safety measures and first aid in case of accident. The information sheet of hazardous wastes should also include samples of signs hazard for marking of containers/transport means. The mentioned sheet should be also accompanied each transportation of hazardous wastes.

Information sheet of hazardous wastes

<table>
<tr><td colspan="2">Code of hazardous wastes
_____</td><td colspan="3">Name of hazardous wastes
_____</td></tr>
<tr><td rowspan="3">Hazardous properties</td><td colspan="2">Classification system</td><td>H codes</td><td>Hazard defining characteristics</td></tr>
<tr><td colspan="2">Main:</td><td></td><td></td></tr>
<tr><td colspan="2">Additional:</td><td></td><td></td></tr>
<tr><td>Process/activity that generate hazardous wastes</td><td colspan="4"></td></tr>
<tr><td>Physical properties</td><td>Solid □</td><td colspan="3">Note</td></tr>
</table>

[10] Decree №143 of the Government of Georgia on "Waste Transportation Rule", dated as March 29, 2016

	Liquid □ Sludge □ Gas □	
Chemical properties	Acid □ Alkaline □ Organic □ Inorganic □ Soluble □ Insoluble □	Note
Type of packaging or container _____	**Hazard signs that should be used for storage/transportation**	
First aid _____	**Measures for emergency situations** _____	

Dump trucks with covered top will be used for sludge transportation operations to avoid sludge scattering or dusting risks during transportation process. Sludge must be loaded on trucks using auto-loader. Sludge transportation will be provided by United Water Supply Company of Georgia LLC.

Waste Treatment / Final Disposal

According to the accumulation, all hazardous waste will be transferred to the contractor company that has the permit of neutralization the wastes granted by the Ministry of the Environment and Natural Resources protection of Georgia in frames of the law of Georgia on "Environmental Impact Permit".

Asbestos waste (if any identified during dismantling works) will be removed on the landfill for the construction materials and will be buried at least 25 m depth. Leaving of asbestos-containing materials on an open landfill is prohibited.

Household and other wastes, which are allowed to be removed and disposed on the household landfill, will be removed according to accumulation (2-3 times in a month) on the nearest landfill.

The disposal of logged trees should be agreed with local self-government. The material useful for burning can be handed to the local population. The useless material will be disposed on the landfill.

Other types of wood waste (rods, boards, etc.) will be used again where possible or after appropriate procedures will be handed over to the local authorities/communities. The part of useless plant waste will be removed to the existing landfill.

Metal waste and scrap will be delivered to the scrap-receiving points.

On operation phase the waste accumulated on grilles and in the sand trap during technological process, as well as the sludge, after dewatering will be disposed to the nearest landfill (it is recommended to use the landfill, located near Dapnari village in Samtredia municipality). In future another scenario for sludge handling can be discussed - Sludge drying (composting) and further usage as fertilizer. As the country does not have legislative basis for using the sludge, generated on WWTP operation phase for agricultural purposes, the only alternative of sludge handling for the initial years of operation is its disposal on landfill.

General Requirements for the Safe Handling of Waste

- Personnel who are engaged in the field of waste management (collection, storage, transportation, receipt/delivery) would have undergone appropriate training on health and safety issues;
- Instructions for handling hazardous wastes, warning and prohibiting signs should be posted on the visible areas of the working facilities;
- Staff will be provided with special uniforms, footwear and personal protective equipment. If necessary, staff clothing are subject to special treatment, especially after performing works related to hazardous waste;
- Personnel should be able to carry out first aid in case of poisoning or trauma during working with waste;
- A person who has not taken the proper training, has no special clothing or has signs of sickness, will not be allowed on working area;
- On the site of waste accumulation, the disposal of waste, more than allowable rate, is prohibited. The waste disposal is not allowed near the heating and sparking sources.
- In case of disposing several types of waste together, their compatibility will be considered;
- Storing of strange objects, personnel clothing, uniforms, individual protection means, as well as eating on waste accumulation area is prohibited;
- During working with waste, personal hygiene norms should be protected; after finishing the work it is necessary to wash hands;
- In case there are some signs of poisoning, a person should stop working and must apply to the nearest medical center and notify the authorities of the structural unit;
- Firefighting equipment will be provided on fire hazardous waste collection sites. In such areas, smoking and using open fire is strictly forbidden;
- Personnel should be aware of the waste properties and firefighting rules. Extinguishing of burning easily inflammable or combustible liquids is possible through fire-extinguishers, sand or asbestos tissues;
- To extinguish the burning solvents with water is prohibited.
- Persons, who provide removal of asbestos, should be trained in such a way that they perform this work quite safety and without damage their and others health.

Waste Control Methods

Implementer company is mandatory to allot the Environmental Manager[11], information about his/her identity (name, surname) should be sent to the Ministry.

Responsibilities of the Environmental Manager related to the waste are as follows[12]:

a) Preparation and updating of the Waste Management Plan of the company;

b) Organizing implementation of the Waste Management Plan;

c) Responsible for implementation of internal control on performance of waste management requirements considered by the legislation of Georgia

[11] Waste Management Code, Article 15

[12] Waste Management Code, Article15, paragraph 2.

Duties of the Environmental Manager don't reduce responsibility of the implementer company to fulfill the requirements considered by the Waste Management Code and its bylaw normative acts (Article 15, paragraph 3).

Within the ongoing process of the activity, the Environmental Manager has a corresponding journal, where special entries are made. Amount of generated, accumulated and removed wastes will be properly documented.

Environmental Manager will permanently control:

- Suitability of waste collection containers;
- Labeling of the container;
- Condition of temporary disposal sites/storage for waste;
- Amount of accumulated wastes;
- Protection of periodicity of waste removal from structural unit area;
- Fulfillment of environmental and vehicles security requirements.

The Environmental manager will provide trainings for the staff working with wastes. Trainings should include information about the following issues:

- Waste management Code – general requirements;
- Planning of waste managements (company management plan; agreement rule of the plan);
- Waste list and classification;
- Recording-reporting of wastes;
- Special requirements of collection the hazardous wastes and treatment;
- Permits and registration of activity related to the waste management;
- Expanded commitment of a manufacturer;
- Waste management technologies;

15.6 Annex 6. Emergency Response Plan

Goals and objectives of Emergency Response Plan

The goal of Emergency Response Plan is to develop and determine guidelines for personnel of treatment facility constructing and operating companies, so that they, in a coordinated manner could rationally and efficiently response to any-scaled technogenic accidents and also to any other types of emergency situations, which may occur during construction and operation process, therefore protect personnel, population and environment.

Objectives of Emergency Response Plan are:

- Definition of expected emergency types, considering specifications of planned activities (treatment facility construction and operation);
- Determination of staff of groups for each emergency type. Also determination of their equipment, emergency action plan and responsibility;
- Determination of internal and external notification system. Also determination of notification equipment and methods and provision of emergency notification when necessary;
- Rapid use of internal resources and if necessary, mobilization of additional resources according to the prescribed manner and determination of corresponding procedures;
- Functionality of organization system for emergency response;
- Compliance with requirements of legislative, normative and internal terms of industrial safety during emergency response process.

Given Emergency Response Plan considers requirements of Georgian laws and legislative norms.

Types of Emergency Situation Anticipated during the Project Implementation

Considering specificities of planned activities, following types of emergency situations are expected:

- Fire/ explosion;
- Spill of hazardous substances, including oils;
- Damage of treatment facility and emergency discharge of untreated wastewater;
- Personnel traumatism and incidents related to their health safety;
- Traffic accidents;
- Natural disaster (earthquake, floods and so on).

It is noteworthy, that emergency situations, listed above, may be subsequent and development of one emergency situation may initialize another one.

Fire/explosion

Risk of fire eruption-propagation and explosion occurs both during construction and operation phases. Considering natural conditions of project implementation area, main factor of accident may be anthropogenic, namely: indifference of personnel and violation of safety norms, violation of storage rules for fuels, oils and other explosive substances and etc. However, fire and explosion may also be caused by the natural disaster (e.g. earthquake).

Sensitive districts for fire eruption and explosion, during construction phase, are: construction camps, construction sites and warehouses of easily flammable and explosive materials.

Subsequent process of fire/explosion may be:

- Salvo emission/spill of hazardous substances;
- Traumas of personnel or population and accidents related to their health.

Salvo Spill of Hazardous Substances Including Oil Products

The reason of emergency situation development, during treatment facility construction and operation process, may become malfunction of machinery or oil-replacing equipment, also deterioration of hermetic vessel, which may cause spill of hazardous substances and pollution of soil and water.

Sensitive districts, where hazardous substances spill may occur, are construction camps (mainly warehouses) and all construction sites, where machinery and other equipment are intensively used.
On operation stage, high risks occur on warehouses of oils, lubricants and other hazardous substances.

Subsequent processes of such emergencies may be:

- Fire/explosion;
- Poisoning of personnel or population.

Damage of the Treatment Facility and Emergency Discharge of Sewage Water

Reason for emergency discharge of sewage water from treatment facility during operation process may be technical problem, inattentiveness of personnel, natural hazards and etc.

In case of emergency discharge of sewage water, significant pollution of Tskaltubostskali River will occur, which will be especially significant during touristic season.

Main mitigation measure for such emergency is prevention of accidental damage to WWTP, and in case it still occurs, operative solution to the problem. Use of capacities of WWTP, sewer and pumping stations reservoirs capacities for temporary detention of sewerage wastewater, must be considered as one of mitigation measure.

Personnel Traumatism and Risks Associated with their Health and Safety

Except incidents related to other emergency situations, personnel traumatism may also be related to:

- Incidents related to heavy machinery/equipment used for project implementation;
- Fall from large heights;
- Poisoning with used chemical substances;
- Electric shock, during working near aggregates under high voltage (especially during operation phase).

Traffic Accidents

Trucks and heavy machinery will be used during construction works. During their movement on public and access roads, following are expected:

- Collision with transport means, real estate or livestock of local population;
- Collision with local population;
- Collision with project personnel;
- Collision with other project machinery;
- Collision with local infrastructure facilities; generally, intensive transport operations will not be implemented during operation phase, therefore risks of traffic accidents is not high on this stage.

Significant subsequent processes of accidents are:

- Fire/explosion;
- Personnel or population traumas and incidents related to their health and safety.

Natural Type Emergency Situations

Appropriate, timely and planned reaction to the natural emergency situations, during HPP cascade construction and operation process, has great significance, because natural disaster may become provoking factor of any abovementioned emergency situation.

General Preventive Measures for Different Emergency Situations

Preventive measures for fire/explosion:

- Periodical training and testing of personnel on fire prevention issues;
- Storage of easily flammable and explosive substances at safe places. Installation of corresponding warning signs at their warehouses;
- Implementation of fire safety rules and arrangement of functional firefighting equipment at the territory;
- Implementation of electricity safety rules, arrangement of lightning-rods and control of their functionality;
- Easily flammable and explosive materials, scattered accidently during works, must be cautiously collected and disposed in waste bin. Places, where flammable and explosive materials were left or scattered, must be treated carefully until final removal;

Preventive measures for hazardous substance spill:

- Strict supervision over implementation of fuel and chemicals' storage and use terms. Fitness of storage vessel must be checked before storing;
- Termination of works / suspension of equipment and machinery operation and implementation of maintenance work after detection of minor spill, so that incident would not become large-scale.

Preventive measures for damage of treatment facility and emergency discharge of waste water:

- Systematic control of facility's functionality and implementation of operation rules;
- Occasional personnel training on operational rules and technical safety issues;
- Occasional personnel training and testing on environmental issues;
- Scheduled and unplanned maintenance of technological system;
- Operative termination of defects causing emergency situation.

Preventive measures for personnel traumatism/injury:

- Periodical training and testing of personnel on labor safety issues;
- Provision of personnel with individual protection means;
- Dangerous zones must be fenced and easily noticeable in the night (lighting signs must be installed around the pits);
- Personnel must be insured by special ropes and cartridges during implementation of high elevation works;
- Existence of medical kits at predetermined points;
- Installation of warning signs and safety lightings at dangerous zones:
    - Safety lighting must ensure lighting of working surface within 5% of normal lighting and no less than 2 luxes inside the building and 1 lux on the outside perimeter;
- Preparation of special staff (H&SE officer), which will control implementation of safety norms at construction sites and will register facts of violation;

Preventive measures for traffic accidents:

- Any vehicle must undergo technical check before starting work. Special attention must be paid to functionality of breaks. Body lifting mechanisms are checked on tippers;

- Selection of optimal transport movement routes and speed restrictions (movement speed on straight sections must not exceed 10 km/h and on turns 5 km/h);
- Operation of any kinds of machinery and equipment below high voltage ETLs is prohibited;
- Ground loading on trucks is allowed only from sides or back;
- Concrete layering means – grids, bunkers and shovel must be equipped with locks in order to prevent accidental spill of concrete mix. Unloading of concrete mix must not be conducted higher than 1 m elevation. If concreting surface is inclining more than 30^0 works must be conducted using special protective belt.
- Improvement of temporary and permanent access roads and their maintenance throughout the whole cycle of the project;
- Installation of warning, prohibiting and pointing road signs at access roads and construction camps;
- During movement of special and oversized machinery they should be escorted by specially equipped machinery and trained experienced personnel.

Anticipated Emergency Scales

According to expected emergencies, liquidation resources and legislative requirements, accidents and emergency situations are sorted in 3 groups. Table gives description of emergency situations according to their level, indicating corresponding reaction.

Description of emergency situations according to their levels

Emergency situation	Level		
	Level I	**Level II**	**Level III**
General	Internal resources are sufficient for accident liquidation	Accident liquidation requires external resources and workforce	Accident liquidation requires engagement of regional or state resources
Fire/explosion	Local fire, which does not require external engagement and is rapidly controlled. Meteorological conditions do not promote fast propagation of fire. There are no flammable or explosive districts/warehouses and materials nearby.	Relatively large fire, which may propagated fast due to meteorological conditions. There are other flammable and explosive districts/warehouses and materials nearby. Local fire-fighting brigade must be engaged.	Huge fire, which propagates quickly. There is high risk of adjacent district flaming and provocation of other emergency situations. Regional fire service needs to be engaged for incident liquidation.
Spillage of hazardous substances	Local spillage, which does not require external engagement and it is possible to terminate it using internal resources. There are no risks of propagation to large areas.	Large spillage (0.3 t to 200 t of hazardous substance spillage). There are risks of propagation to large areas and of water pollution risks.	Huge spillage (200 t and more). As storage of hazardous substances' large volumes is not planned during construction and operation processes, risks of III level accident is minimal.
Damage of the facility and emergency discharge of wastewater	Damage of facility's technological units, which may be restored rapidly. Short-term wastewater discharge to the riv. Enguri.	Damage of facility reservoirs and technological pipelines, which will be associated with long-term discharge of untreated wastewater.	-
Personnel injury/traumatism	• Single traumatism incident; • Light fractures, bruises; • I degree burns (damage of superficial layer of skin); • Medical aid of injured personnel and incident liquidation is possible using local medical equipment.	• Several accidents of traumatism; • Severe fractures – fractures near joints; • II degree burns (deep layers of skin is damaged); • Injured personnel needs to be transported to medical facility.	• Number of traumatism accidents; • Heavy fractures; • III and IV degree burns (damage of skin, tissues beneath it and muscles); • Damaged personnel needs to be transported to regional hospital or to Tbilisi, to the medical facility with corresponding profile.
Traffic accidents	Non-valuable pieces of equipment, transport means and infrastructure is damaged. Human health is not endangered.	Valuable pieces of equipment, transport means and infrastructure are damaged. Human health is endangered or there is II level of traumatism.	Especially valuable pieces of equipment, transport means and infrastructure and critical objects are damaged. There is high risk of other emergency situations provocation. Human health is endangered or there is III level of traumatism.
Natural accidents	Natural happening, which is characteristic to the region seasonally or periodically (strong rain, snow, flood). Standard measures should be implemented for securing hydraulic facilities, equipment and human health.	Natural happening, scale of which is seldom for the region. Stability of hydraulic facilities and safety of equipment is endangered. Accident must be liquidated as soon as possible, in order to avoid provocation of other emergencies. Additional resources are required.	Especially hazardous natural disaster, e.g. earthquake, debris flow, avalanche and etc. which seriously endanger hydro-mechanical facilities and safety of equipment. Regional or state emergency agencies are needed to be engaged,

Note: Considering specificities of planned activities and design territory location, only first and second level emergency situations are expected to occur.

Emergency Response

Response in Case of Fire

The strategic actions of the person and the personnel working in the vicinity, who detected fire or smoke, are:

- Termination of works on every site, except for safety measures;
- Assessment of the situation, reconnaissance of fire hearth and adjacent territories;
- Withdrawal of the equipment-devices from the areas, where the fire spreading is possible. Electrical equipment should be turned out from the circuit;
- In case if fire is strong and it is hard to approach the fire hearth, some kind of fire or explosive hazardous sites/substances are located adjacently, then:
  - Get away from the danger zone:
    - Act in accordance with the evacuation scheme in case of evacuation;
    - If you have to cross closed space full of smoke, bow down, an air is most clear at the floor, cover mouth and nose with wet cloth;
    - If you are not able to evacuate due to the exit in flames, cry for help on loud voice;
  - Inform senior manager/operator about the accident;
  - Wait for rescue team and when they appear, inform them about the fire reasons and the situation in the vicinity of fire hearth;
- In case if the fire is not strong, the fire hearth is easily approachable and getting near to it is not dangerous for your health. At the same time, there are certain risks of fire distribution on adjacent territories, then, act as follows:
  - Inform senior manager/operator about the accident;
  - Search for the nearest fire stand and supply yourself with necessary fire inventory (fire extinguisher, axe, crowbar, bucket and etc.);
  - Try to liquidate fire hearth with fire extinguisher, in accordance with the instruction shown on the fire extinguisher;
  - In case if there is no fire stand on the site, use sand or water for fire hearth liquidation or cover it with less flammable thick cloth;
  - In case if the electrical equipment turned into the circuit are near the fire hearth, it is prohibited to use water;
  - In case of fire in the closed space, do not window the room (except for special needs), because the fresh air supports fire and fire scale growth.

Strategic actions of site manager/chief operator in case of fire:

- Gathering detailed information on fire hearth location, existing/stored devices-equipment in the vicinity and substances;
- Information transfer in accordance with the notification scheme;
- Visiting the accident place and reconnaissance of the situation, risks analysis and assessment of expected fire scales (I, II or III scale);
- Ask whole personnel to use vehicles and fire extinguishing equipment;
- Controlling and managing the personnel actions.

Strategic action of construction works manager/head of facility in case of fire:

- Information transfer in accordance with the accident notification scheme;
- Controlling and managing internal personnel together with the H & SE officer before the fire team will appear (then the fire team chief is leading the squad);
- Supporting the action of the fire team (the special equipment existing on the site might be needed and etc.);
- After the accident is over, carrying out the accident results liquidation measures together with the H & SE officer;

- Preparing the report and handing it to the construction works conducting company/HPP operating company.

In case of landscape fire, emergency service is participating in fire liquidation measures. As well as HPP personnel (in accordance with the instruction of head of the power house and H & SE officer), also local population in case of necessity. During forest fire extinguishing, except for the above listed instruction, also are used the following basic approaches:

- Forest fire lower boundaries sweeping with green branches, brooms and bag cloths;
- On the low fire boundaries of the forest, throwing ground with shovels and spades;
- Blocking line or channel arrangement to stop the fire distribution;
- Inhibiting channel arrangement must take place in direction of construction camps, construction sites and in direction to the territories where easily flammable and explosive substances are disposed, in case of fire distribution risks.

Response to Hazardous Material Spill

This section discusses only I and II scale emergency response strategy. The types of hazardous substances spill response are significantly determined by ground surface, also, the initial condition. Consequently, emergency response is presented for the following scenarios:

- Hazardous substances spill on impervious surface (asphalt, concrete cover);
- Hazardous substances spill on pervious surface (ground, gravel, vegetation)
- Spill of the hazardous substances in the river.

In case of hazardous substances (mainly oil products) spill on the impervious surface, it is necessary to implement the following strategic actions:

- Information transfer according to the emergency notification scheme;
- Stopping every device-equipment working on the site;
- Blocking the pollution source (if any);
- Ask personnel to mobilize equipment and personal protection means for emergency response;
- Block the entrances of household-fecal sewage systems (lids of wells);
- In case of necessity, it is necessary to arrange barriers with suitable impervious material (sand bags, plastic sheets, plastic coat and others) in such way, that it will stop spilled material or limit its movement;
- Barriers must be arranged perpendicular to the sidewalks or in shape of horseshoe, so that the open side will be directed to meet the substances flow;
- Gather the spilled oil products by using brooms and linens;
- For drying in the spilled substances, absorbent pads usage is necessary;
- Gather the oil products in such way, that it will be possible to collect them in container and then removal;
- After absorption of the oil, these pads should be placed in polyethylene bags (if needed, these pads might be reused);
- The site should be completely cleaned from residual oil products, in order to exclude the wash-off of the pollutants by the rain water;
- After completion of cleaning operations, every cleaning material must be collected, wrapped and warehoused in relevantly safe areas.

In case of hazardous substances spill on the pervious surface, it is necessary to implement the following strategic actions:

- Information transfer according to the other personnel and emergency service;
- Stopping every device-equipment working on the site;
- Ask personnel to mobilize equipment and personal protection means for emergency response;

- Block the entrances of household-fecal sewage systems (lids of wells);
- Absorbents should be placed together in such way to create continuous barrier (fence) in front of the edge of moving oil products. Ends of the barrier must be folded in front, so that it will have a shape of a horseshoe;
- Spilled oil products containment place must be covered with polyethylene membrane sheets, in order to prevent the oil occurrence in the lower layers of soil;
- It should be noted, that if it is not available to lay down the polyethylene sheets, then the barrier arrangement will cause the oil accumulation on one place, which in turn will cause soil saturation with oil and oil products occurrence in the lower layers;
- For drying in the spilled substances, absorbent pads usage is necessary;
- Gather the oil products in such way, that it will be possible to collect them in container and then remove;
- After absorption of the oil, these pads should be placed in polyethylene bags (if needed, these pads might be reused);
- The site should be completely cleaned from residual oil products, in order to exclude the wash-off of the pollutants by the rain water;
- After completion of cleaning operations, every cleaning material must be collected, wrapped and warehoused in relevantly safe areas.
- Processing of vegetation and upper layer of the soil on existing on the ground surface must begin right after removal of the pollution source or after stopping the leakage;
- When the whole spilled oil products will be cleaned, removal and remediation works implementation must start under supervision of construction works manager/head of the facility and invited specialists with a relevant competence.

In case of oil products spill in the river or drainage channels, it is necessary to implement the following strategic actions:

- Information transfer according to the emergency notification scheme;
- Information of population living downstream the river about the spill;
- Stop every device-equipment working on site (if there is a case of turbine oils spill in the water, it is an obligatory condition to stop the work of hydro-turbines in sequence);
- Blocking the pollution source (if any);
- Ask personnel to mobilize the necessary equipment for emergency response and personal protection means;
- Clear the vegetation existing on the river bank with the scythe;
- Immediately fence the polluted section of the river with wood boards. In case of additional necessity, usage of ground filled bags is available;
- Removal of oil products gathered on the river surface must be carried out with sanitation vehicles;
- Absorbent pads must be used for drying the oil products spilled on the soil;
- After absorption of the oil, pads must be placed in polyethylene bags for waste.

Response to Treatment Plant Damage and Emergency Discharge of Sewage Waters

Risks of treatment facility damage and emergency discharge of sewage waters may be attributed to I and II level emergency situations. In the first case, termination of defect will be possible in short terms by the facility personnel, as for the second – involvement of special services may be required;

The only response measure is timely liquidation of damage and termination of wastewater discharge to the riv. Enguri. There are no measures for impact reduction during such emergency situation. The water will be cleaned after self-cleaning process.

Response during Accidents Related to Human Injuries and Incidents Related to their Health and Safety

The person who is taking care of injured person, must notify ambulance about an accident as a first action. Before the rescue will appear, injured person must receive first aid service in accordance with the tactics given below in following chapters. Before carrying out medical service, it is necessary to assess the situation and determine if approaching and helping an injured person might create some threat.

First Aid during the Bone Fracture

Open and closed bone fractures are being distinguished:

- For the open fracture is characterized the violence of skin cover integrity. In this case, there is wound and bleeding in the damaged area. There is a high risk of infection in case of open fracture. In case of open fracture:
  - Promptly call helper, so that helper will immobilize the damaged area of the injured person, while you will process the wound;
  - Cover the wound with clean cloth and directly press on it to stop the bleeding. Do not press directly on broken bone fragments;
  - Without touching the wound with fingers, surround the damaged area with a clean cloth and fit ix;
  - If the broken bone fragment is seen in the wound, place the soft cloth around the bone fragment in such way, that the cloth will not be removed and the bandage would not impact on bone fragments. Fix the bandage I such way, that it will not disrupt the blood circulation below the wrapped place;
  - Carry out a broken bone immobilization, in the same way as during covered fracture;
  - Check pulse, capillary filling and sensitivity below the wrapped place once in every 10 minutes.
- We are dealing with a closed fracture, if the ski integrity is not damaged in the injured area. In this case, hemorrhage and edema are observed in the injured area. In case of closed fracture:
  - Ask injured person to stay still and fix the damaged part of the fracture above and below it by hand, before it will be immobilized (fixed);
  - For a good fixation, fix the injured part of the body on uninjured part. If the fracture is on the hand, fix it on the body with triangle bandage. If the fracture is on the leg, fix the damaged leg on another leg;
  - Check pulse, sensitivity and capillary filling below the wrapped place once in every 10 minutes. If the blood circulation or sensitivity is reduced, make a less tight bandage.

First Aid during Wounds and Bleeding

There are three types of bleeding:

- There is a little blood. In this case is risk of infection:
  - Clean the wound of injured person with any colorless liquid suitable for drinking;
  - Wrap the wound with clean cloth.
- There is a lot of blood. In this case there is a risk of blood loss:
  - Cover the wound with several layers of cloth and make press bandage;

  - If the blood is still leaking, tight the cloth to the wound again (do not take of the blood-drenched cloth) and strongly press on blood source area.
- The blood is pouring like a fountain from the wound. In this case the blood loss is very fast. In this case you must push finger (or fingers) on the artery projection area to avoid this and then put a bandage.

The areas of load on the artery are: the lower third of an arm and upper third of the thigh. The bandage should be fixed like this:

  - The bandage is fixed only in extreme case, because often it leads to irreversible damage;
  - The bandage is fixed above wound;
  - The location where the bandage will be fixed must be covered with cloths. If the wound area is bare, we should place clean cloth under the bandage;
  - First bandage must be tight (fixed as possible), then the bandage is getting tight and in addition placed 3-4 times (rope, belt and etc can be used instead of bandage);
  - The bandage should be fixed for 1 hour in the winter and for 2 hours in summer. Then we should release and after 5-10 minutes fix it slightly above from the original location;
  - Check if the bandage is properly fixed – if it is properly fixed, there should be no pulse on limb;
  - What we should not do;
  - Do not put a hand in the wound;
  - Do not take anything from the wound. If some foreign body is seen in the wound, we should try to maximally fix it (put a bandage around this body).
- Internal bleeding is hardly determinable damage. Suspect internal bleeding, when the shock signs are observed after getting injured, but there is no significant blood loss. In case of internal bleeding:
  - Lay injured person on his back and rise his legs up;
  - Remind tight clothes on neck, chest, waist;
  - Do not give food, medicine or drinks to injured person. If injured person is conscious and is very thirsty, just wet his lips;
  - Warm injured person – cover with blanket or cloth;
  - Check the pulse in every 10 minutes, as well as breathing and consciousness. If the person is losing mind, place him in safe location.

First Aid in Case of Burn

The burn might be developed by hot objects and steam impact (thermal burn), by chemical substances impact on the skin (chemical burn), electricity impact (electrical burn). In order to properly carry out first aid, you must determine the degree of burn, which depends on damage depth and damage area (on what part is the burn distributed).

- The first aid measures during the burn are:
  - It is dangerous to breath in the smoke, so if there is a smoke in the room and it is not available to window fast, remove the injured person on a safe place, on a fresh air;
  - If the clothes are burning on the person, do not start to roll his body, pour the water on the body (in case of electrical burning, usage of water next to the equipment in the circuit, is prohibited);
  - If there is no possibility to use water, cover the body with non-synthetic cloth;
  - It is necessary to start cooling the burnt area in time with cold water (in case of I and II scale burn, water it for 10-15 minutes, in case of III and IV scale burn wrap it with clean wet cloth and then cool it in the water in such wrapped conditions);

- Remove the cloth and other objects, from the damaged area, which may interrupt blood flow. Do not remove cloth pieces, which are stick to the damaged area;
- Cover the damaged area with sterile wrapping. This would reduce the likelihood of infection;
- Breathing in a hot air is possible when burnt, which leads to the burning of respiratory tracts. If the victim has hard noisy breathing, facial or neck burn, singed hair cover of face and nose, swelled mouth and lips, swallowing difficulty, cough, hoarseness voice – suspect the respiratory tracts burn and wait for the medical service;
- Constantly check breathing and pulse before the medical service will come, be ready to carry out reanimation measures;
- It is not allowed to take off the clothes particles from the burnt skin, cause this may lead to the deepening of the damage;
- It is not allowed to destroy the integrity of blebs, because the skin cover is damaged and it makes a favorable conditions for the invasion of infection in the body;
- Do not use ointments, lotions or oils for processing the damaged parts;
- It is prohibited to process the chemical burn areas with neutralizing solutions/ For example, alkaline caused burn treatment with acid.

First Aid in Case of Electrical Trauma

There are three types of electrical trauma:

- The trauma caused by high-voltage electricity. The damage developed as a result of high voltage traumas, are fatal in most cases. Severe burns are being developed at this time. Due to the strong muscle compression the injured person is often threw away on a significant distance, which leads to serious injuries. In case of high-voltage power trauma:
  - It is prohibited to get close to the injured person, before the electricity will be turned off and if necessary, the isolation will be made. Remain 18 m radius safe distance. Do not let other witnesses to approach the injured person;
  - After receiving electric trauma, as soon as approaching the injured person, open the breathing ways without moving head back, by moving the lower jaw in front;
  - Check breathing and circulation signs. Be prepared to make reanimation measures;
  - If the injured person is unconscious but is breathing, place him in a safe location;
  - Carry out first aid in case of burns and other injuries.
- The electrical trauma caused by low-voltage electricity. Low-voltage electricity trauma may turn into serious damages and even death reason. Often, this kind of electrical trauma is caused by damaged plugs, wiring and equipment. When standing on a wet floor or touching undamaged electrical wiring with wet hands, the risks of getting the electrical trauma are sharply increasing. In case of low-voltage power caused trauma:
  - Do not touch the injured person, if he is touching the power source;
  - Do not use metal object for removing the power source;
  - If you are able, stop power supply (turn off the power switch). If it is not available, turn off the electrical equipment from the power source;
  - If you are not able to switch off the electricity, then stand on dry insulation thing (for example: a plank of wood, on rubber or plastic pad, on book or pile of newspapers);
  - Remove the victim's body from the power source by broom, stick, and chair. You can move the victim's body away from the power source, or vice versa, the power source away from the body, if it is more convenient;
  - Without touching the body of injured person, tie a rope around his foot and shoulders and move away from the power source;

- At least, grab the injured person in dry not-tight cloth and move him away from the power source;
- If the victim is unconscious, open the airways, check the breathing and pulse;
- If the victim is unconscious, is breathing and has a pulse, place in a safe location. Cool the burned areas and wrap it;
- If the visible injuries are not seen on the victim and feels good, advice to take a rest.

- The electrical trauma caused by lightning/thunder:
  - Various traumas, burns, face and eyes damage is often by the electrical trauma. Sometimes the lightning may cause a sudden death.
  - Quickly move damaged person form the place of the accident and serve with first aid as in case of different type of the electrical trauma.

Response during Traffic Accidents

During the accident of road transport, it is necessary to implement the following strategic actions:

- To stop vehicles/equipment;
- Transmission of information in accordance with the emergency report scheme;
- In case if there is no danger for human health and there are no risks of provoking other emergency situations (for example: collision of other vehicles, explosion, fire, oil spill, hydrodynamic accident or others), then:
  - Get out of the vehicle/equipment or get away from the accident place and stand on a safe distance;
  - Wait for the police/rescue team to come.
- In case of further threats, act as follows:
  - Get out of the vehicle/equipment or get away from the accident place and stand on a safe distance;
  - If the vehicle accident has occurred on the dangerous section of the road of public use (for example: in the turning, there visual field on the road is limited), then ask to the accident witness to stop the cars moving in direction of an accident location;
  - If you are alone on the accident place, place the warning signs or sharp color safe signs on the road away from the place of an accident, so that those signs will be visible for the drivers moving in direction of an accident place and will ensure the car stop;
  - In case of explosion, fire, oil spill, hydraulic accident and others, ac in accordance with the strategy given in the relevant paragraphs;
  - In case if there is a threat on the health of a person, do not try to move the body;
  - If the injured person is lying in the middle of the street, cover him with something and confine the accident location, so that it will be seen from a distance;
  - Remove everything from him, which might be making asphyxia (belt, scarf);
  - First aid to the injured in accordance with the first aid strategy given in the relevant paragraphs (but remember, by extra movement of the injured person, you might create additional risks to his health).

Response during Natural Type Emergency Situations

Response in Case of Earthquake

The response on the earthquake starts when feeling the first fluctuation, if the earthquake is weak, stay where you are, and do not panic. After the personnel will feel safe, they shall act in accordance with the following strategy

- Ask the personnel to shut down every construction device-mechanism, as well as operational devices during its operation in a relevant order;

- Before the supporting team will appear, an earthquake consequences liquidation measures are led by construction works manager/head of the treatment facility, according to the following strategy:
  - Injured persons should be taken out from the ruins and rescue those ones, which occurred in half-ruined or in the flamed building;
  - The liquidation and elimination of those energetic accidents and technological lines should take place, which threat to human life;
  - Easily flammable and explosive substances should be carried out from the dangerous zones;
  - Buildings and structures under dangerous conditions should be compulsorily demolished or strengthened;
  - When implementing rescue activities it is prohibited, without necessity, walking above the ruins, entering ruined buildings, being near them if there is a chance of further collapse of the building;
  - When entering a heavy smoke and blocked building, it is necessary to tie a rope on the waist, the free ending of which must be holding by a person standing at the entrance of the building;
  - It is necessary to use individual protection means when implementing rescue and liquidation activities.

Response in Case of Sudden Flooding
Personnel, being near to the natural disaster, must act in accordance with the following strategy:

- In case of threat, implement an immediate evacuation from the hazardous zone;

After the personnel will feel safe, they shall act in accordance with the following strategy:

- In case of necessity, ask the personnel to shut down every construction device-mechanism, as well as operating devices during its operation in a relevant order;
- Before the rescue team appears, the liquidation measures of natural disaster consequences are led by construction works manager/head of the power station by the following strategy:
  - The personnel should be evacuated from the dangerous zone;
  - Easily flammable and explosive materials should be removed from the dangerous zones;
  - When implementing rescue and liquidation works, it is important to use individual protection means.

Equipment Necessary for Emergency Response
In process of construction and operation, in terms of accident development, the standard equipment must exist on high risk sites, namely:

Personal protection means for emergency response: on construction stage – on construction camps; on operation stage – in special room in power house. Personal protection means are:

- Helmets;
- Safety glasses;
- Uniforms with reflective stripes;
- Waterproof boots;
- Gloves.

Fire extinguishing equipment:

- Standard fire extinguisher: on every site, as well as on every special machines and equipment;
- Buckets, sand, shovels and etc;
- Properly equipped fire stands;
- Fire truck – the nearest fire fighters team truck will be used (from Zugdidi).

Emergency medical service equipment:

- Standard medical boxes: Standard medical boxes for vehicles: on every project vehicle and equipment;
- Ambulance car – the ambulance car of Zugdidi medical center will be used.

Spill response equipment:

- Heavy duty plastic bags;
- Absorbent pads;
- Gloves;
- Drip trays;
- Buckets;

Polyethylene film

Necessary Qualification and Personnel Training

Testing of each system of emergency response must be periodically implemented, obtained experience must be documented and weak spots should be improved (the same should take place in case of accident realization).

The whole staff, employed on treatment facility construction and operation, must undergo introductory training, which includes emergency response course. Personnel additional training registration system should exist and be kept at offices of customer or contractors.

15.7 Annex 7. Brochure for Public Grievances

The aim of MDF is to ensure that project implementation will not cause any complications for residents and other stakeholders near project area, who can potentially be within the impact zone. We are open to any opinion and complaint, related to the project activity in order to achieve the above-mentioned goal and for protection of the environment.

What kind of complaint can I submit?

Complaint can be filed by anybody, who assumes, that project implementation has negative impact on them, on local population or environment. The complaint can consist, for example:

- Negative impact on local population (excessive dust, noise, odor, etc);
- The damage to the environment by project implementation;
- Activities dangerous for working personnel and population health and safety;
- Vulnerability of rights of personnel, engaged in the project.

How to appeal?

- Any person can file a complaint XXX using following ways:
- Via following tel. number: XXX
- Via e-mail on following address: XXX
- On web-site: XXX
- Personally: XXX
- By filling in the attached Complaint Form and sending/ placing in the postbox on the following addresses
    1. XXXXX

How MDF will response to my complaint? MDF will make following steps to response your complaint:

Step 1: Complaint receipt confirmation: MDF will contact you to confirm and if possible resolve a problem within the following dates:

- Depending to the issue – in 5 to 10 working days to require information.
- Immediately- in case of filing oral complaint and from 5 to 10 working days- in case of written complaint.

This confirmation will include your claim number, identity and contact details of persons from XXX side, who will be responsible to response on your claim, and supposed data of completion of the investigation of your complaint (if necessary).

Step 2: Investigation: MDF will start an investigation following your complaint. During investigation we may need to contact you. MDF will try to finish investigation in following 20 working days.

Step 3: Redress of grievance: After investigation of the subject of your complaint we will contact you with our findings and our proposed response. If our investigation finds that the complaint is not related to the project activity, or ongoing works are within the framework of the national and international standards concerning to the subject mentioned in the grievance, we will give you a written explanation. Otherwise, we will propose you problem resolution ways. If you are satisfied with our response, we will offer you to sign a statement of satisfaction if you would like to do so. If you are not satisfied with our response, we will continue to negotiate with you in order to find other way to redress the grievance.

Step 4 Follow-up measures: MDF may contact you on the next stage as well, to recheck the situation in order to find out whether project implementation causes any additional complications.

Confidentiality: If you would like to keep your complaint confidential, MDF will guarantee that your identity and contact details will not be disclosed without your permission and they will be accessible only for the team directly working on your complaint. If it is not possible for the team to conduct an

investigation without disclosure of your identity (for example, if it is necessary to give evidence in the court) investigation teams will negotiation with you on how would you like to proceed.

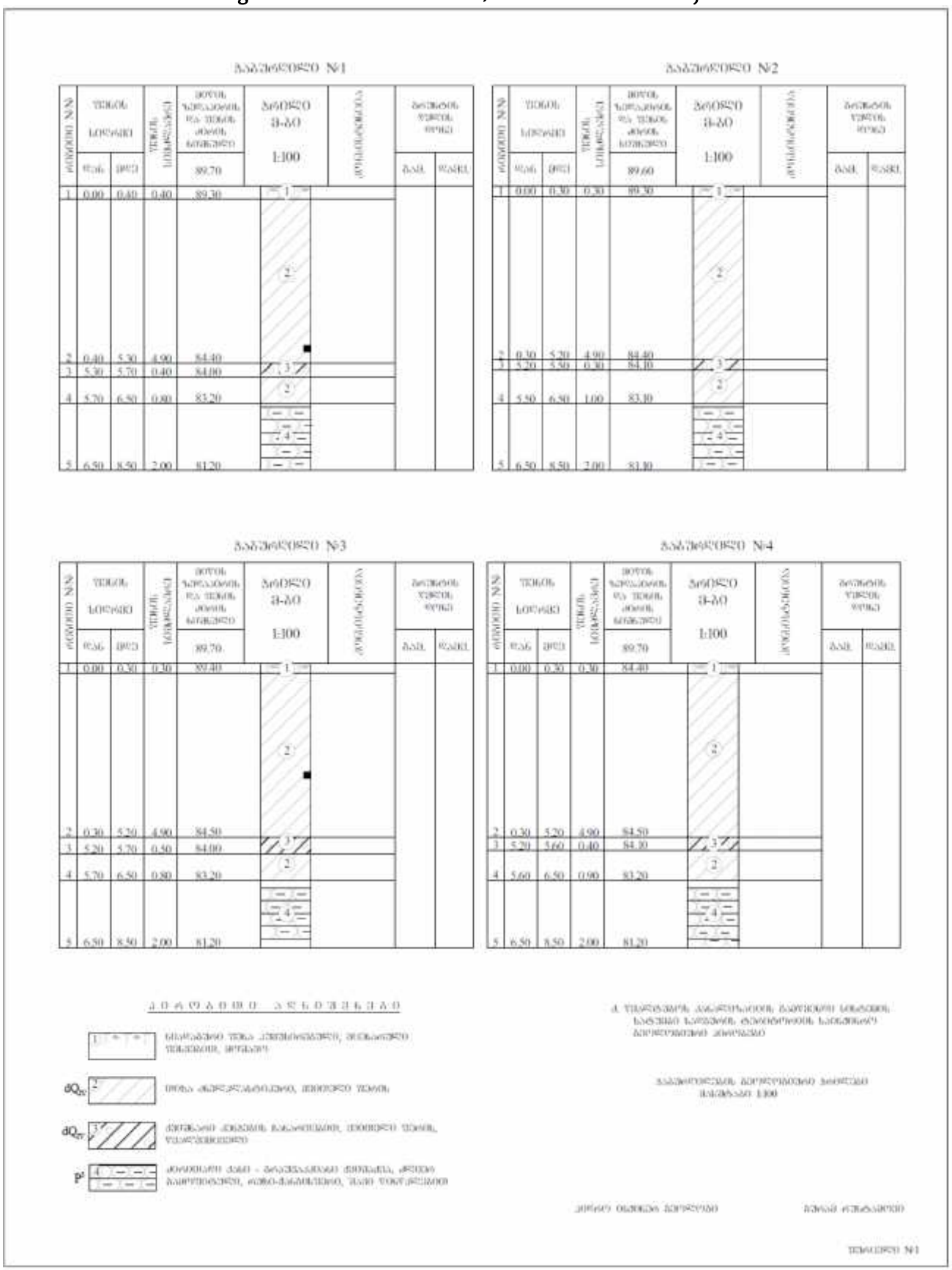
Anonymity: If you wish you can file a complaint without indicating your name and contact details in the attached form. The complaint will be examined but it will be rather difficult for MDF to investigate the case.

Complaint form for Public grievances

<table>
<tr><td colspan="5">Complaint number [(is filled by MDF]):</td></tr>
<tr><td rowspan="4">Contact details</td><td colspan="4">Name:</td></tr>
<tr><td colspan="4">Address:</td></tr>
<tr><td colspan="4">Tel.:</td></tr>
<tr><td colspan="4">e-mail:</td></tr>
<tr><td>How would you prefer to be contacted? Please, select the cell</td><td>By mail</td><td>by phone</td><td colspan="2">By e-mail</td></tr>
<tr><td colspan="5">Name, surname and private information (from identification card).
[It is assumed as obligatory - needs to be confirmed]</td></tr>
<tr><td colspan="5">For more information about your complaint. Please describe the problems; Who it happened to, when, where and how many times.</td></tr>
<tr><td colspan="5">What will you propose to redress your grievance?</td></tr>
<tr><td rowspan="3">How to submit this form to GUE?</td><td colspan="4">By mail: XXX</td></tr>
<tr><td colspan="4">By placing into the postbox: XXX Georgia</td></tr>
<tr><td colspan="4">By e-mail: Please, send us your complaint, your version of redressing the grievance and suitable contact details via e-mail: XXXX</td></tr>
<tr><td>Signature:</td><td colspan="2"></td><td>Date:</td><td></td></tr>
</table>

15.8 Annex 8. Engeneering-Geological Materials

Lithological Columns of Boreholes, Drilled within the Project Area



ჭაბურღილი №1

[illegible] №№	[illegible]: [illegible]	[illegible]	[illegible]	[illegible] 88.80	ჭრილი მ-ბი 1:100	[illegible]	[illegible]	[illegible]
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2	0.40	1.50	1.20	87.30	2			
3	1.50	2.00	0.50	86.80	3			
4	2.00	6.20	4.20	82.60	2			
5	6.20	8.00	1.80	80.80	4			

ჭაბურღილი №2

[illegible] №№	[illegible]: [illegible]	[illegible]	[illegible]	[illegible] 88.60	ჭრილი მ-ბი 1:100	[illegible]	[illegible]	[illegible]
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2	0.30	2.50	2.20	86.10	2			
3	2.50	3.00	0.50	85.60	3			
4	3.00	5.70	2.70	82.90	2			
5	5.70	8.00	2.30	80.60	4			

ჭაბურღილი №3

[illegible] №№	[illegible]: [illegible]	[illegible]	[illegible]	[illegible] 88.90	ჭრილი მ-ბი 1:100	[illegible]	[illegible]	[illegible]
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2	0.40	5.00	4.60	83.90	2			
3	5.00	5.50	0.50	83.40	3			
5	5.50	9.00	3.50	79.90	4			

ჭაბურღილი №4

[illegible] №№	[illegible]: [illegible]	[illegible]	[illegible]	[illegible] 88.85	ჭრილი მ-ბი 1:100	[illegible]	[illegible]	[illegible]
1	0.00	0.50	0.50	88.35	1		0.40	0.40
2	0.50	5.00	4.50	83.85	2			
3	5.00	5.50	0.50	83.35	3			
5	5.50	9.00	3.50	79.85	4			

ჭაბურღილი №5

[illegible] №№	[illegible]: [illegible]	[illegible]	[illegible]	[illegible] 88.40	ჭრილი მ-ბი 1:100	[illegible]	[illegible]	[illegible]
1	0.00	0.30	0.30	88.10	1			
2	0.30	4.50	4.20	83.90	2		1.50	1.50
3	4.50	5.40	0.90	83.00	3			
4	5.40	7.40	2.00	81.00	2			
5	7.40	7.80	0.40	80.60	3			
6	7.80	8.50	0.70	79.90	2			
7	8.50	9.50	1.00	78.90	4			

პირობითი აღნიშვნები

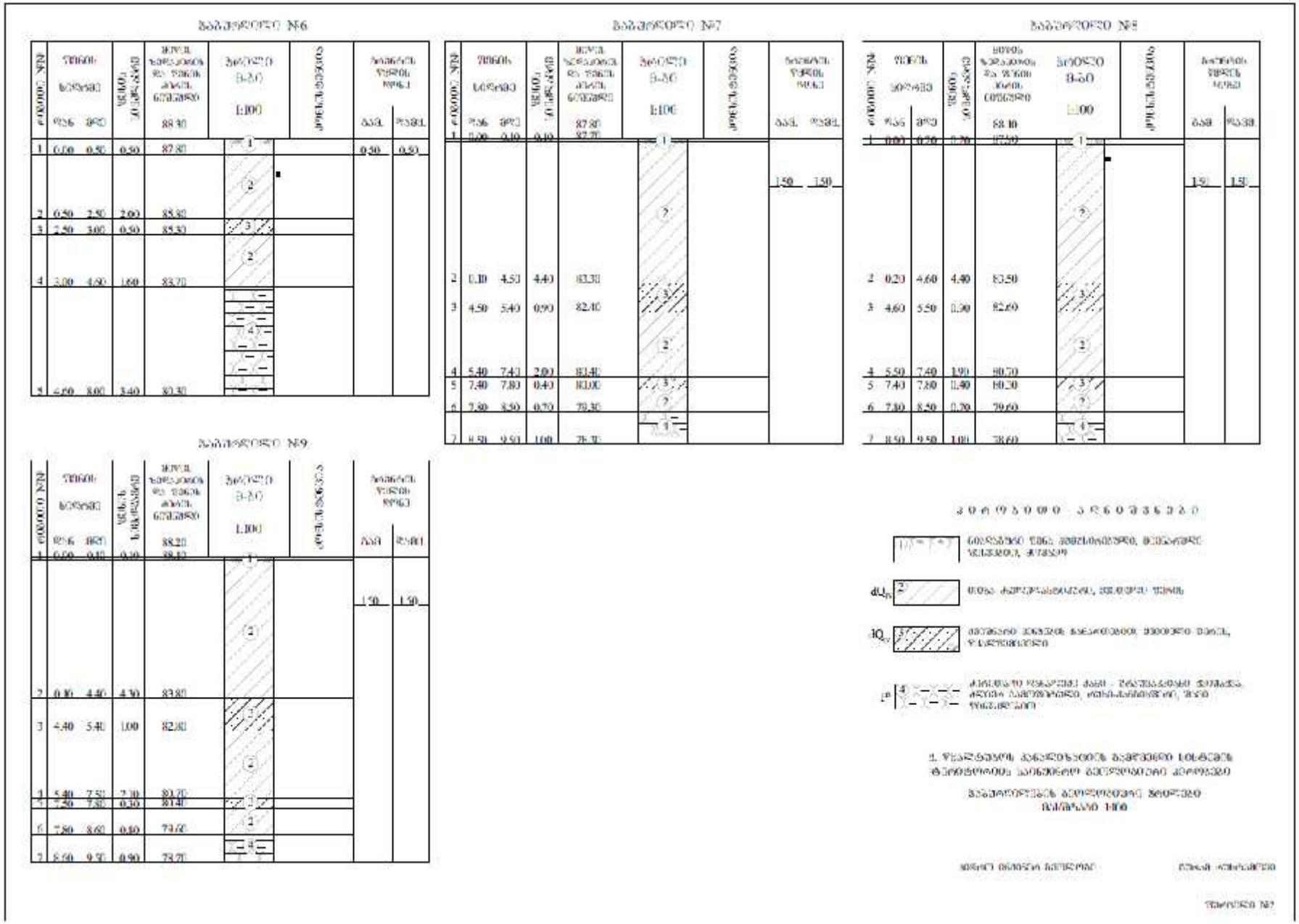
- tQ_{IV} — [illegible]
- 1 — [illegible]
- dQ_{IV} 2 — [illegible]
- dQ_{IV} 3 — [illegible]
- P^2 4 — [illegible]

[illegible]

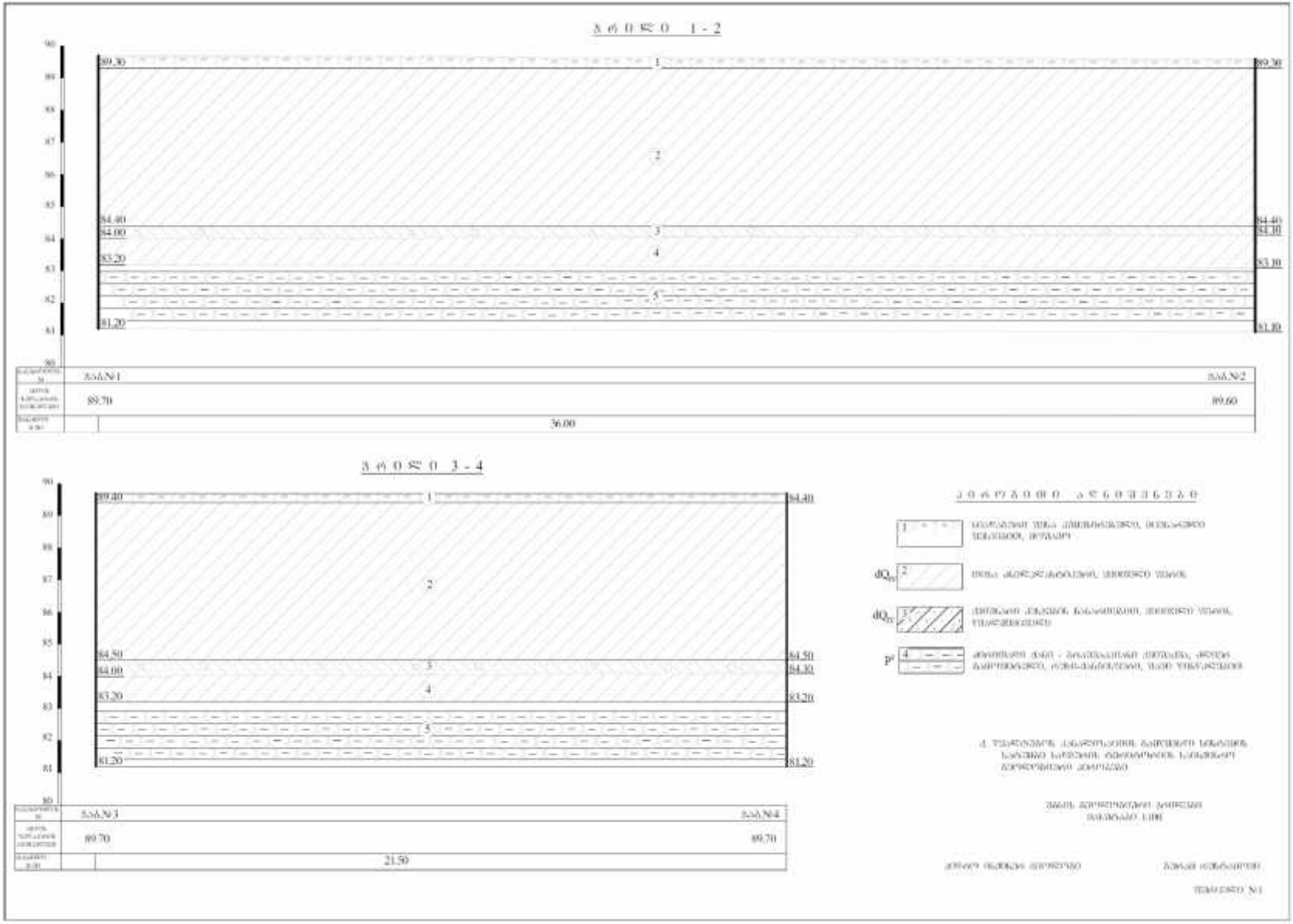
[illegible] 1:100

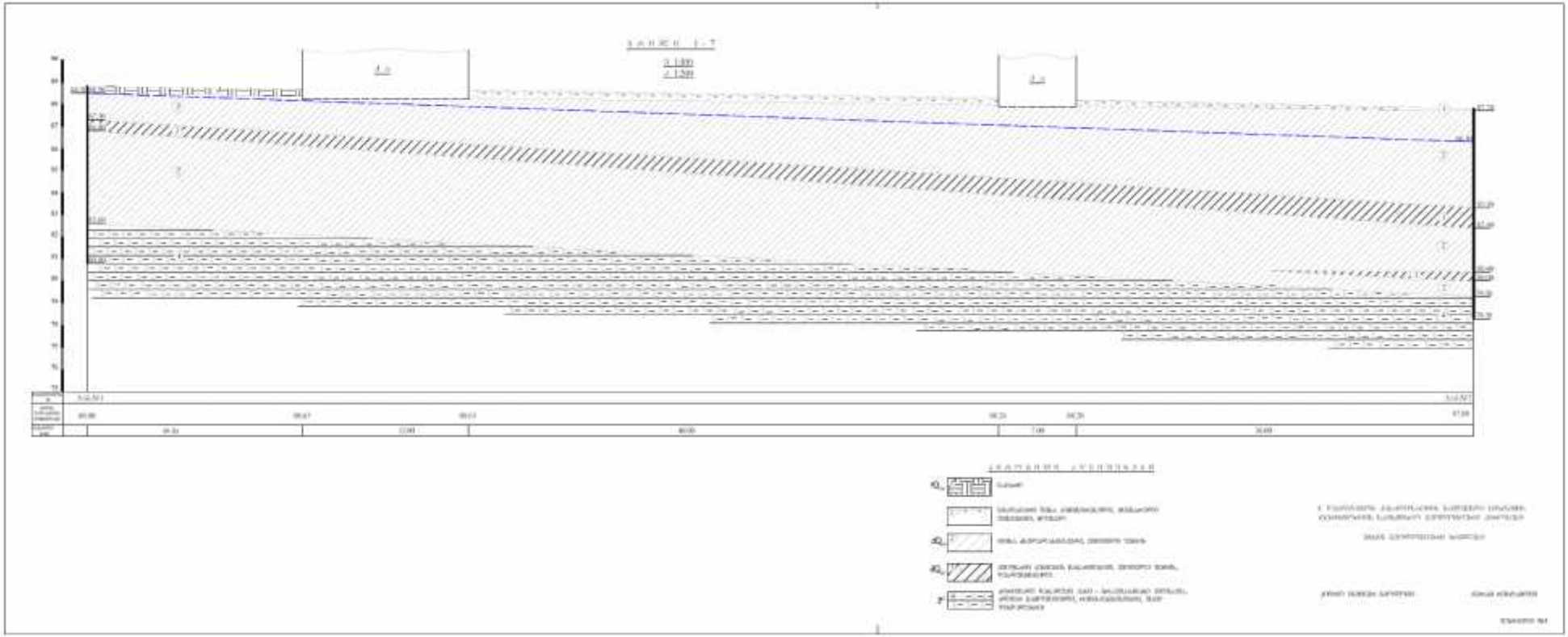
[illegible] [illegible]

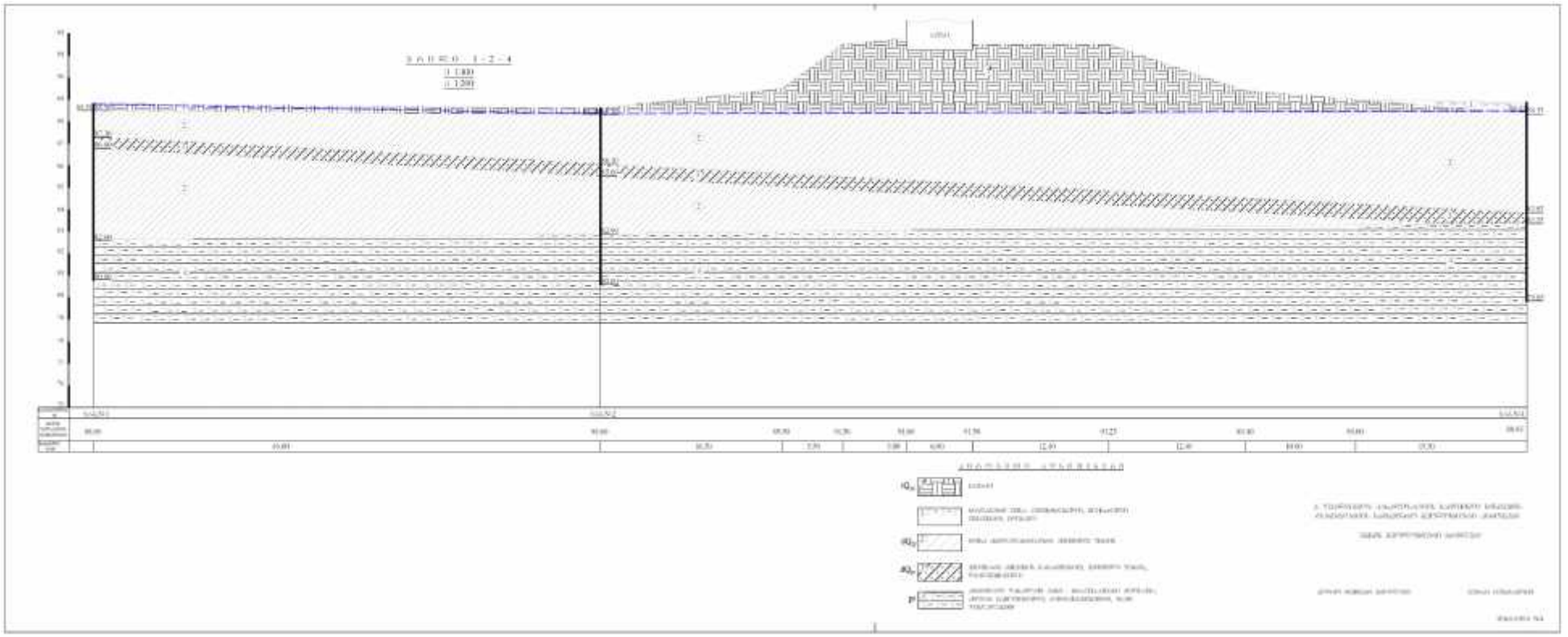
[illegible] №1



Engineering-Geological Sections of The Project Area







Laboratory Examination Results of Soils, Presented within the Project Area

[illegible]					გრუნტების ლაბორატორიული გამოკვლევის შედეგები																	ლაბორატორია [illegible]
					ობიექტის დასახელება [illegible]																	
[illegible]	[illegible] N	[illegible]	[illegible]	ლაბ. N	პლასტიკურობა			[illegible]	სიმკვრივე			[illegible]	ფორიანობის კოეფ-ტი		[illegible]	[illegible]	[illegible]	ჭრისადმი წინაღობა		გაჯირჯვება		გრუნტის დასახელება
		h			W_L	W_p	I_p	W	ρ	ρ_d	ρ_s	n	e	e_L	I_L	S_r	I_{ss}	φ	c	ε_{sw} / We_{sw}	P_{sw} / Wp_{sw}	
		მ			-	-	-	%	გ/სმ³			%	-	-	-	-	-	გრად.	კპა	- / %	მპა / %	
1	ჭაბ. №1	5.0	[illegible]	101	0.57	0.26	0.31	25.2	1.85	1.48	2.72	45.7	0.841	1.550	-0.03	0.82	0.39	20	63			თიხა
2	ჭაბ. №3	3.5	[illegible]	102	0.64	0.27	0.37	28.5	1.86	1.45	2.72	46.8	0.879	1.741	0.04	0.88	0.46			0.084 / 31.4	0.11 / 30.0	თიხა

შენიშვნა: [illegible]